

# MECHANIZATION IN FOREST TREE NURSERIES IN THE UNITED STATES

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There are 87 State nurseries, 30 forest industry nurseries, 13 Federal forest nurseries, and 10 Soil Conservation District and County nurseries in the United States, operated for the production of forest and windbarrier tree and shrub planting stock. In addition, scores of private nurseries produce tree planting stock, some of which is used for forestation work. Total production at all of these nurseries exceeds 1 billion trees annually.

Most early nursery operations were carried out manually. Then mechanization began to enter into nursery management, beginning significantly in the early 1930's. Since then, mechanized operations have become a vital part of forest tree nursery practices; however, the types of equipment used often become antiquated, or are used continuously with little or no modification.

There has never been a concerted effort to formally design, fabricate, and test forest tree nursery equipment in the United States. Nurserymen, as a group, are great "gadgeteers." They each feel their nursery is special, and thus any piece of equipment developed should be modified to fit their particular situation. Their equipment development efforts, in most cases, have had to be sporadic and generally poorly planned, poorly financed (if at all), and most often tailored to fit their specific needs and capabilities. They use whatever materials are on hand, or those that can be obtained easily and cheaply.

Once a piece of machinery is put in use, improvements are made on it as field operations indicate necessary. Seldom are any production cost figures for the equipment available. How often have we heard this expression: "Well, you know, we had some parts, the idea, and some time last winter, so we built it."

One nursery staff forester (1) summarized the

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situation \_this way: "As is common with equipment development, no plans are available-our mechanics work by the old eye-ball 'method and design the equipment with rough hand-drawn sketches."

The few industries in this country which have produced equipment for use in forest tree nurseries, have done so generally as an adjunct operation. Often the machinery developed is merely a piece of agricultural equipment modified for forestry purposes. This further illustrates the lack of any concerted effort in the past to develop commercial equipment specifically for forest tree nursery work. Fortunately, in the last decade, a few manufacturers have focused attention on forest tree nursery equipment needs.

These and other efforts will be noted in the text that follows.<sup>2</sup> This article is not intended as a complete review of mechanized nursery operations in the United States; it merely highlights some current mechanization work.

## Production Techniques

*Seed cleaning and handling equipment.* Since the mid-forties, a number of seed - extracting plants have been constructed in the United States. Most of the new plants incorporated favorable features of their predecessors, and additional improvements based on weaknesses of the older plants. Most established seed extractories use agricultural crop types of seed cleaning machinery, often with slight modifications. Moisture meters are used at most extractories to insure that the tree seed moisture content is at the proper level for storage. One nurseryman (2) reported using a "homemade" mechanical seed treater which will treat large volumes of seed

<sup>2</sup>The author is grateful to the many nurserymen whose responses to his request for information on nursery equipment made this article possible. Numbers in parenthesis following references to equipment refer to contributors listed at the end of the article. Inquiries should be sent directly to the appropriate person.

with fungicides and repellents as rapidly as the seed can flow in from the hopper (fig. 1). Slurry solutions are calibrated according to species and size of seed being treated.

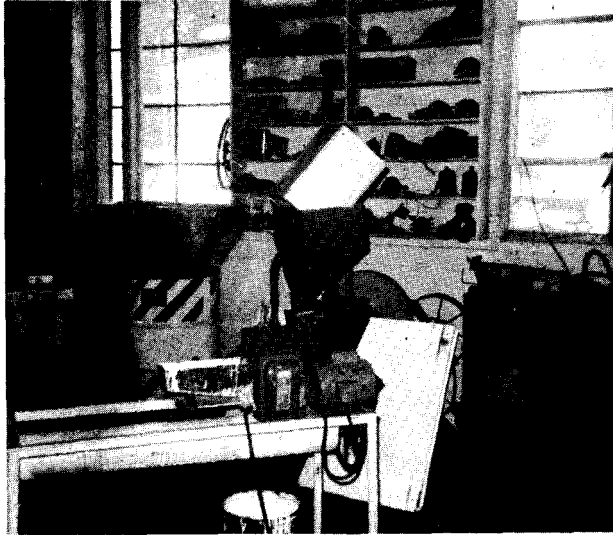


Figure 1.—View of "homemade" mechanical seed treater. Using micro-switches, this machine treats seed uniformly, rapidly, and safely. (Photo courtesy Archie Hakala).

*Seeders.* The *Wind River* and the *Whitfield* are two seeders in wide use. New York State (3) has a special seeder made from Brillion parts, which sows five rows, 12 inches apart, and applies banded fertilizer and seed simultaneously.

For broadcast sowing, some nurserymen are using the *Gandy* fertilizer spreader and seeder. Slight modification permits adaptation of the *Gandy* (4) for use with the hydraulic lift system of many tractors. The machine works well for broadcast seeding of various coniferous and hardwood species.

The *Stan Hay Seeder* (5), from Britain, has been adapted for use in several U.S. forest tree nurseries. Its double row seeding and its greater precision are important where strict bed densities are required for uniform quality stock production.

*Mulch spreader.* In recent years, a number of forest nurseries, (3, 6, 7, 8, 9, 17, 20) have initiated hydro-mulching as a seed bed cover practice. Hydro-mulch is a wood fiber product designed to be mechanically applied.

In several nurseries (7, 17), a seeder and the

hydro-mulcher are drawn in tandem over prepared seed beds. The seed is thus sown and immediately covered with a mulch layer, greatly reducing washing, surface drying, and wind erosion of seed bed surfaces.

*Devices for seed bed density control.* Various thinning devices are in use for thinning seed beds where heavy seedling stands occur. One machine (11) utilizes rotating cutters which sever the seedlings at the ground line (fig. 2).

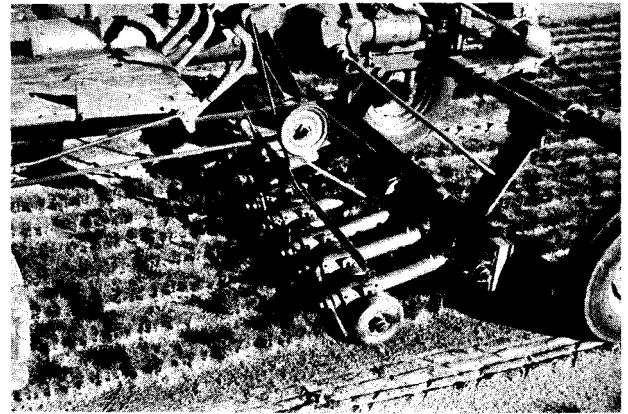


Figure 2.—Seven-row rotating cutter-thinning machine used at the General Andrews Nursery in Minnesota. (Photo courtesy R. Hance).

*Seedling undercutting and root pruning equipment.* A machine has been developed and patented by an Illinois nurseryman (13) which is reputed to undercut and partially lift all kinds of stock under most soil conditions—except those which are extremely wet or dry (fig. 3).

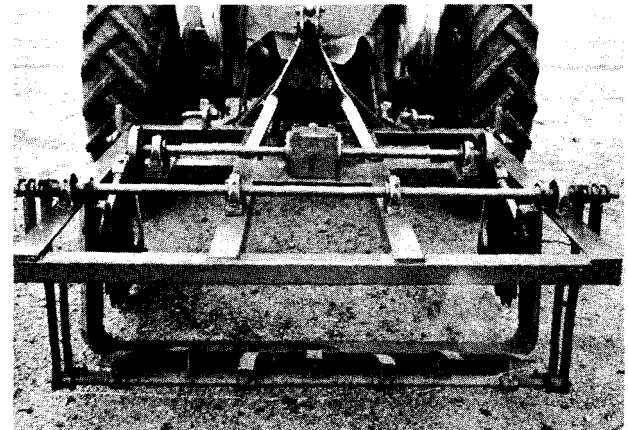


Figure 3.—A view of the Wycoff machine which undercuts and partially lifts seedlings. (Photo courtesy H. Wycoff).

The State of Washington (12) is working on a powered coulter disk lateral root pruner. They have attached a power hub to a disk. This is chain driven from a hydraulic motor mounted on a three-point hookup. They plan to mount the root pruner under the center of the tractor, thus enabling the operator to have a better view of its operation.

*Seedling harvesters.* Labor costs for nursery workers have steadily increased since early 1960. In addition, the number of available and capable male laborers has decreased. Many nurseries faced with such serious labor problems have hired women to carry out less strenuous hand operations. However, a critical need still exists

for male laborers to perform the lifting and allied operations.

In 1968, a special cooperative project to produce a forest tree seedling harvester was started by the Forest Service at their Missoula Equipment Development Center. Shortly thereafter, several States began developmental work on harvesters. Since then, several working models have been developed and put into production.

Developmental work on the seedling harvesters has generated much interest in the United States in the past 2 years. The concerted efforts which have gone into this nursery equipment work equals, or exceeds, that done on any other single equipment development project in American for-

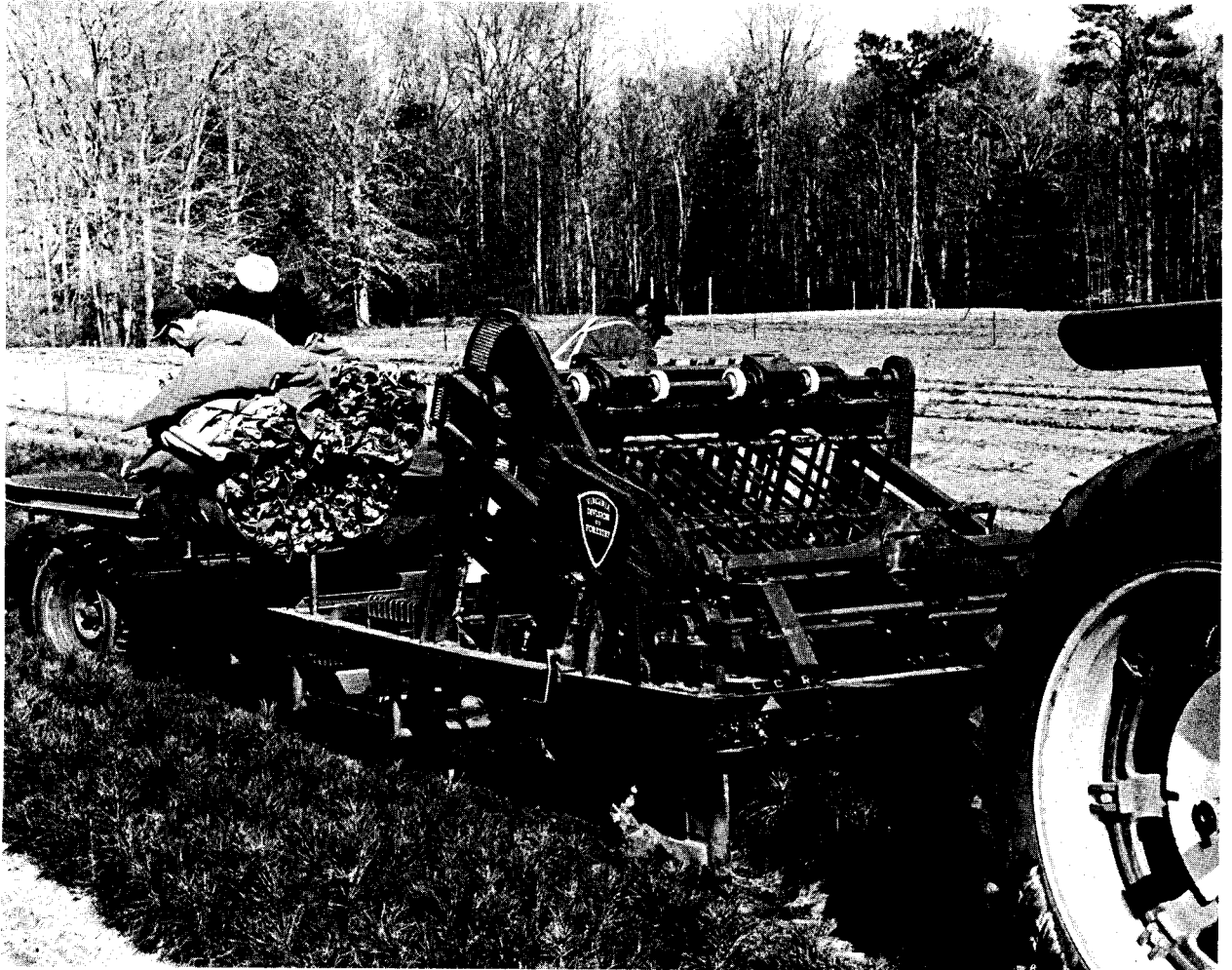


Figure 4.—The Virginia Division of Forestry's 8-Row Tree Seedling Harvester. The unit harvests 600,000 to 1,000,000 trees a day. (Photo courtesy Virginia Division of Forestry).

est nursery history-and it has paid off!

The Virginia Division of Forestry (14) has developed two models. The latest is an eight-row lifter, which undercuts the trees, carries them between rubber belts over bars oscillated by an eccentric bearing system to remove soil, and delivers them to an elevated conveyor belt near the rear of the machine. From this point, the lifted seedlings are placed in containers for transfer to the packing shed (fig. 4).

The machine is powered by a Model 656 Hydrostatic tractor. Under ideal conditions, it operates at 16-20 feet per minute, lifting from 800,000 to 1,200,000 1-0 loblolly seedlings per 8-hour day.

The Florida Division of Forestry (9) has built three tree harvesting machines-one single-row

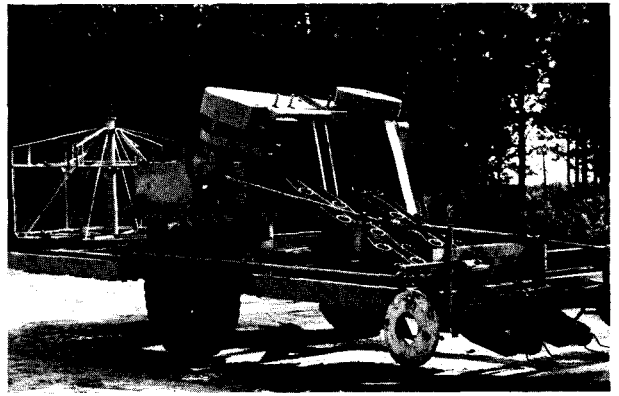


Figure 5.—Photo of the 2-Row Florida Tree Seedling Harvester. The revolving rack at the rear holds 16 tubs into which lifted seedlings are deposited by hand. (Photo Courtesy Florida Division of Forestry).

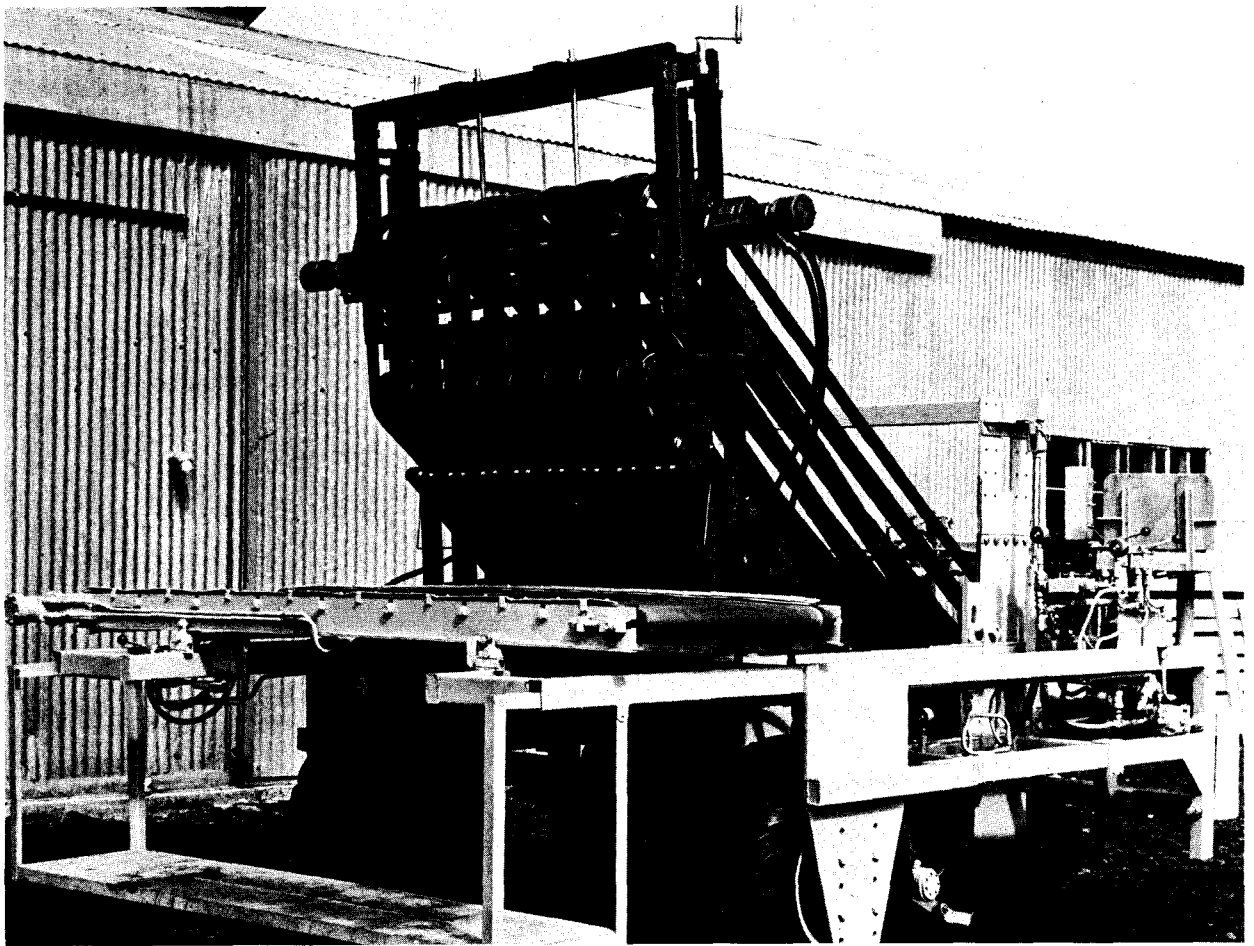


Figure 6.—View of the USDA Forest Service 8-Row Seedling Harvester.

lifter and two double-row lifters. Their machines also use rubber belts to carry undercut seedlings from their bed position, up past a rotating drum which removes the soil from the roots, to a delivery point for bulk packaging at the rear of the machine (fig. 5). From this point, the seedlings are taken by tractor-trailer to the packing shed for further processing. These machines can harvest from 600,000 to 1,000,000 trees each per 8-hour day.

The North Carolina Forest Service (16) has modified a potato digger which uses a wide chain-type conveyor belt to carry lifted seedlings to an assembly and bulk packaging point at the rear of the machine. Dirt is shaken from the roots as the batch of broadcast seeded seedlings ride up the chain conveyor to the assembly point.

The Weyerhaeuser Company (5), at their Longview, Wash., Technical Center has developed an eight-row seedling harvester with trailing conveyor and stretcher packing system. This lifting machine vibrates the soil area around the roots just prior to their being lifted from the beds. Belts convey the lifted seedlings to a continuous wooden-slat conveyor which carries the seedlings back to a "stretcher-type" packing container, which transports the seedlings to the packing shed for repackaging.

The eight-row harvester developed by the USDA Forest Service (23) has undergone nursery trials in the West and Southern United States. The two-wheel machine weighs approximately 5,500 pounds, with about 1,200 pounds on the hitch. The machine measures 91 feet from the hitch point to the rear wheels, with a 4-inch overhang behind the wheels. It is 8 feet high and 7 inches wide (fig. 6).

The harvester undercuts and lifts tree seedlings, carrying them between "V" rubber belts to a collection point at the rear of the machine where a reversible belt moves them off to the side of the lifter and deposits them in special containers. The containerized seedlings then go to the packaging center.

All controls on the machine are hydraulically powered. An *International* 656 Hydrostatic Tractor with high capacity attachment is needed to provide adequate hydraulic power at low travel speeds. The machine can operate at bed speeds from 7.5 feet/minute upward, and will harvest

from 750,000 to over 1,000,000 trees per 8-hour day.

*Cottonwood cuttings segmenter.* The Mississippi Forestry Commission (18) has developed a "gang saw" for preparing cottonwood cuttings for distribution. The cutter consists of a number of circular saw blades, spaced about 20 inches apart. Continuous belts move by the blades carrying cottonwood stems which, in passing the saw blades, are cut to the proper length for shipment to the field.

*Packing systems.* Nurserymen are always in need of newer, cheaper ways to package their tree and shrub planting stock. One of the newer packaging methods involves the use of polyethylene-lined kraft paper bags (7,17). Plant material can be left in the bags under shaded cool conditions for a number of weeks without seedling loss. Care must be taken not to puncture the bags.

Some nurserymen are using *Kim-Pac* (9), a cotton-batting type material, for packing around the roots in regular nursery bundles. Hydromulch (6,17), a wood fiber product, is also used in this manner. Both materials eliminate the chances of infection with *Sporotrichosis*, a fungus disease associated with sphagnum moss.

The Minnesota Division of Lands and Forestry (11) has modified an *Allis-Chalmers* round hay baler for packaging tree seedlings. It is equipped with a 5 hp. electric motor, a 50-foot conveyor assembly belt, and an automatic paper cutter and mass distribution system (fig. 7).



Figure 7.—A view of the modified baler showing the bench for receiving the baled trees. A moss bin is located above the conveyor belt just ahead of the wrapping machine. (Photo courtesy Frank Wood).

A number of nurseries are working on modernizing their packaging system (8,12,19), incorporating as much "push-button" equipment as possible. Included are automatic mudding sprayers, automatic tiers, staplers, and strappers.

### Weed Control

Weeds find their way into forest nursery beds the world over. They are an omnipresent problem.

Various chemicals are used for weed control, with both conifers and hardwood seedling production. Both pre- and post-emergence types are widely used.

The use of jellied methyl-bromide fumigants prior to sowing is increasing as more nurseries build or buy the equipment necessary to carry out this operation (13,19,21).

The Minnesota Division of Lands and Forestry (2) has developed a pressurized soil fumigation applicator. The drum of fumigant (Vapam) is placed on a special platform attached to the tractor (fig. 8) with pressure couplings from a belt-driven air compressor connected directly to the drum. Feed lines join the drum to spray injectors mounted on cutting blades. These blades inject the fumigant as a wide band 5-6 inches below the soil surface with the volume of fumigant injected regulated by pressure valves and gauges.

Another improvement in mass nursery area fumigation operations is a machine (16) that injects the fumigant, lays the polyethylene sheet that covers the fumigated beds, and edge-glues the sheet to an adjoining sheet of polyethylene film covering previously treated soil. Thus, an entire field can be successively fumigated and covered under one large polyethylene film. The entire fumigation process is thus speeded up and more effective control is obtained. A special nozzle and glue are required. The Riddick Equipment Company, of Williamston, N.C., manufactures the machine.

Several nurseries have developed special spraying equipment (3). Some of this is mounted on the front of the tractor permitting the operator to give closer attention to this application.

Various mechanical devices have been developed for mechanical weeding and cultivating

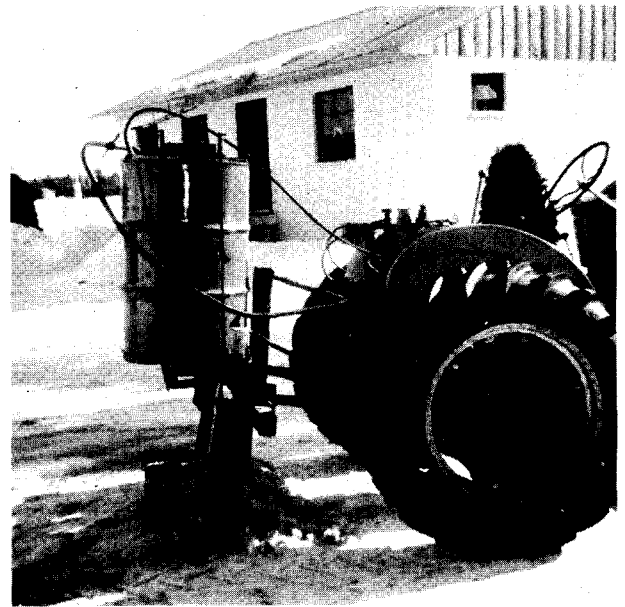


Figure 8.—The tractor-mounted, pressurized soil fumigation applicator developed by the Minnesota Division of Lands and Forestry. Use of an air compressor on the barrel containing the fumigant speeds the operation. No pump is necessary. (Photo courtesy of Archie Hakala).

seedling beds. *The Budding InRow Weeder* (10), made in Dutton, Mich., is being used satisfactorily in a number of forest nurseries. This machine consists of four rubber-fingered weeder cones and two spring steel-fingered mulching cones. Two weeder and one mulching cone operate on each side of the row. The weeders are mounted on a floating bar attached to the tractor. Forward motion and contact with the soil cause the cones to rotate rapidly. The cones are set at an appropriate angle, so that the rubber fingers weed and loosen the soil around the plants simultaneously.

Other unique semiautomatic weeding units in use (4,11,15) include cultivator types and selfpowered slow-moving carriages upon which women weeders ride over the beds, hand pulling weeds as the carriage moves along.

### Container Production

Expanding demands by tree planters for containerized planting stock have fostered increased production of it in recent years. The container-

ized material includes both coniferous and hardwood species.

Containers vary in size, shape, and in 'the type of material used to make the container. Metal, plastic, paper, fiberboard, waxed paper, polyethylene film, and molded fiber containers are in current use, or have been used in the past.

Size varies from tubes 1/2 inch in diameter, and 3 inches long to containers 3 inches in diameter and 12 inches or more long.

The Technical Center of the Weyerhaeuser Company (5), at Longview, Wash., has developed a machine which fills a cardboard tube with a soil mixture, and plants a seedling in the tube. These tubelings are then grown for several months in the nursery before being sent to the field.

Several commercially manufactured automatic container dirt filling and seeding machines could be, or have been, adapted for use with forestry species.

Nurseries of the Forestry Divisions in both California and Colorado regularly produce large quantities of containerized forest tree and shrub planting stock. The material markedly increases survival on adverse field sites. Each State has developed special equipment for carrying out its operation. California (21) has a large cement mixer to prepare the potting media. An eccentric shake helps firm the media in the containers. Racks of media-filled containers are broadcast seeded by a special seeder developed for this purpose. The racks containing the seeded tubes are palletized to facilitate moving them to the shaded growing area. Colorado (22) has designed a machine to make the rectangular roofing paper containers used in its program.

Although no large scale tubed seedling production program is underway in the United States, a number of industries, State, and Federal agencies have undertaken small scale trials. The several advantages of the system favor its expansion. It is destined to become another of the silvicultural methods available for good forest land management.

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