The Acorn Seeder, and Project Status at the Missoula Technology and Development Center[1]

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Abstract.–A new style acorn seeder was designed, built, and tested at the USDA Forest Service J.W. Tourney Nursery in Houghton, Michigan. Initial results indicate that the seeder performed excellently. Results are described in Part I of this paper. Part II highlights the various projects underway in the Nursery and Reforestation Programs at the Missoula Technology and Development Center at Missoula, Montana.

PART I -- TILE ACORN SEEDER

The James W. Tourney Nursery is a USDA Forest Service tree nursery located in the western upper peninsula of Michigan. Established at Watersmeet, Michigan, in 1935, the Nursery currently produces approximately four million seedlings annually for the National Forests in the Lake States.

Over the last few years there has been added emphasis on regeneration of oak stands. This has resulted in increased orders for quality oak planting stock. Research into nursery cultural regimes and their effect on field survival of oak has shown that seedbed density is a critical factor in seedling growth and survival. Currently Toumey is growing oak at a target density of six seedlings per square foot. At this low density, in-row spacing is critical. Spacing that is too wide or spots that are missed will increase the per-seedling cost of bed treatments. Too many seedlings per linear foot can reduce seedling growth and survival.

For lack of a better method to achieve consistent acorn spacing during sowing, Tourney Nursery was sowing acorns by hand. We had tried mechanical acorn planters, but had not found one that achieved the desired precision in spacing.

Roy Kangas, of the Forestry Sciences Laboratory in Houghton, Michigan, through cooperative efforts with Jud Isebrands and the Forestry Sciences Laboratory in Rhinelander, Wisconsin, had identified the need for a mechanical acorn planter. Roy came up with the idea of a rotating drum and spent part of the winter working on the concept. When Roy presented his concept to the personnel at Tourney Nursery last summer, they were intrigued and jumped at the chance to help him with this project.

The first step in making an acorn planter was to find a way to get acorns out of a container one at a time. First Roy tried moving an outer plate around a horizontal drum with holes in the bottom. The acorns would bridge or come through several at a time. Then he left the outer plate stationary and started turning the drum. With the hole on the bottom, this still did not give consistent results. Roy then moved the outer plate hole to the 9 o'clock position and added a sheet metal pickup on the inside of the drum to carry a single acorn above the mass of acorns. The angled pickup, combined with centrifugal force, allowed the acorn to exit when the outer plate ended. This method produced consistent, satisfactory results; thus, the rotating drum concept was adopted (fig. 1).

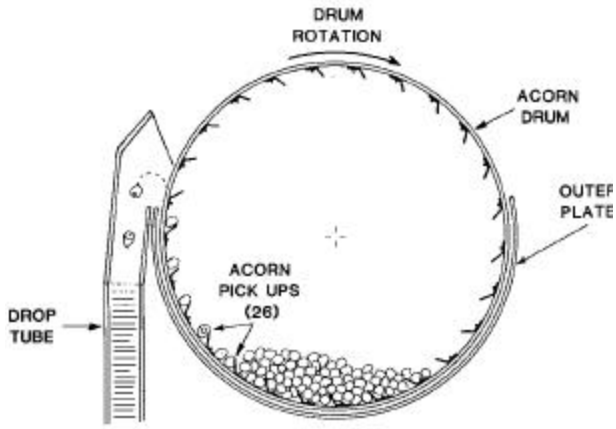

Figure 1.--Acorn seeder drum.

1/Paper presented at the Intermountain Nursery Conference held in Park City, Utah, August 1991.

2/Ben Lowman, Program Leader, Missoula Technology and Development Center; Richard Hallman, Program Leader, Missoula Technology and Development Center; Gary Dinkel, Nursery Manager, J.W. Tourney Nursery, Watersmeet, Michigan; and Roy Kangas, Welder, Forestry Sciences Laboratory, Houghton, Michigan.

The prototype built for Tourney Nursery was built on an old Wind River seeder frame with the adjustable cone gear box. The drum that was selected is a 16-inch diameter fiberglass drum. It was cut to 50 inches wide, with five rows of holes; thus, five rows can be planted at one time. The 1-1/8-inch holes were placed 3.1 inches apart around the drum, resulting in 26 holes around the circumference for each row. Therefore, a five-row unit plants 130 acorns with one revolution of the drum. Drum speed is 27 RPM = 1 MPH at eight nuts per foot. The drum was driven from a bed roller on the front of the drill. The speed of the drum and thus the number of acorns planted per row foot could be adjusted through the adjustable cone gear box. This gear box was later abandoned in favor of a more direct drive type of system where the drum speed could be adjusted by changing gears.

The adjustable outer plate was adjusted so the acorns would exit into the tubes at the 9:30 o'clock position. Formed sheet metal strips were used for the pickup apparatus versus individual pickups for each hole. Three-inch flexible tubes guide the acorns to the floating furrow openers. The furrow openers are suspended from cables so they can move up if obstacles are encountered. By adjusting the length of the cable, the depth is adjusted.

The machine was first used the fall of last year to sow northern red oak acorns at Toumey Nursery (fig. 2). The machine performed excellently. Acorn density and placement were comparable to Hand-sown beds. Acorn spacing was very consistent and numbers per row foot usually varied by less than one acorn. The nursery planted approximately one hundred bushels of acorns in the first afternoon.

Substantial cost savings were realized from using the acorn seeder in the sowing operations. Hand sowing requires approximately three person-hours per bushel. The machine planting reduced this to fewer than .4 person-hours per bushel. Further savings may be realized since consistent spacing results in more uniform and higher quality seedlings. This would reduce the cull rate at shipping time.

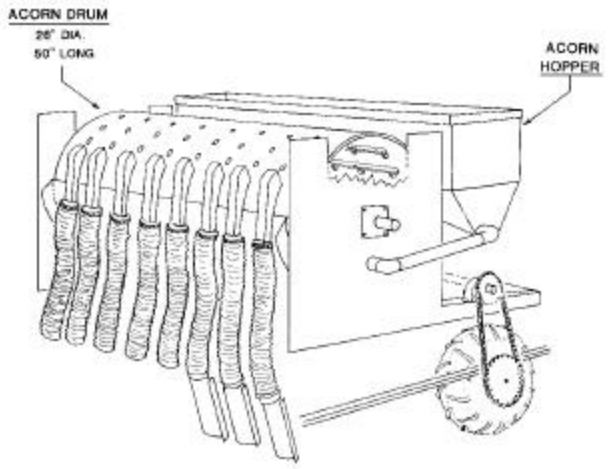

Figure 2.--Acorn seeder.

Future refinements are expected to include: a hopper system to feed the drum so more acorns can be carried on the machine; a dirt screen on the bottom of the outer plate to remove dirt; and a different type of furrow closer.

The present acorn seeder could easily be adapted to plant ten rows in a 4-foot wide bed or plant other large-seeded species such as plum, cherry, or walnut. The machine also has the potential to tumble pre-germinated acorns to clip the radicles prior to planting and thus increase the number of large lateral roots on seedlings.3/

If there is enough interest, Holland Trans-planter Company of Holland, Michigan, has agreed to build the acorn seeder. Contact them if you are interested in purchasing an acorn seeder:

Holland Transplanter Co.
510 East 16th Street
P.O. Box 1527
Holland, MI 49422-1527
(616) 392973579

PART II -- MISSOULA TECHNOLOCY & DEVELOPMENT CENTER PROJECT STATUS

For more than 20 years the Missoula Technology and Development Center has been providing improved equipment, materials, and techniques in all phases of Reforestation including site preparation, planting and seeding, thinning, and tree improvement. The Center's work has improved efficiency and safety throughout the Forest Service. Current work is summarized in this paper.

Reforestation Technical Services

Through this continuing project, Center personnel provide a variety of services to field units. Services include conducting surveys to determine current reforestation field problems and translating those problems into projects in our program. The Technical Services project allows us to investigate promising new techniques and equipment that, after evaluation, may become part of the Forest Service inventory of equipment.

In addition, Technical Services provides a forum for answering inquiries from field personnel concerning equipment, materials, and techniques applicable to reforestation activities.

Papers presented at professional meetings, technical reports, and drawings are funded through this project.

3/ Ponder, Felix. Clipping Roots of Oak Seedlings: A "Radicle" Approach to Better Roots. North Central Research News, (n.d.).

Current work includes:

A new edition of the Reforestation Catalog.

Drawings of the Self-propelled Tree Seed Orchard Netting Retrieval System.

Evaluation of Hand-held scarification equipment.

Field Storage

A longstanding problem in reforestation has been the loss of seedlings because of inadequate storage facilities and improper storage methods. Tree seedlings require cool temperatures to maintain their dormancy while awaiting planting. Many schemes have been used to alleviate this problem including reflective blankets and even snow caves. MTDC was assigned the task of coordinating development of a temperature-controlled portable storage facility that could be moved to field locations easily. As a result, two pick-up transportable refrigeration storage units have been developed and tested for field use.

A portable pickup-sized refrigeration unit was produced by Polar Products of Torrance, California, for use as a tree seedling cooler. The 12-volt refrigerator operates from the vehicle electrical system, a photovoltaic array with a backup battery, or 110 VAC, through a battery charger. This unit was tested in the Pacific Northwest Region during spring planting. Suggested improvements such as weight reduction, increased tree hauling capacity, and a simplified AC battery hookup are being evaluated.

MTDC is developing a slide-in pickup-sized 110 VAC storage unit that relies on standard commercially available refrigeration components. This unit was designed to require minimum maintenance and complement the 12-volt Polar Products system. The 110 VAC storage unit is being manufactured by Isoloc Manufacturing of Vancouver, Washington, and will be available for the 1992 field season.

Pollen Equipment

The goal of this project is to develop equipment and techniques to collect and apply pollen. The pollen collection and dispenser project actually consists of two efforts--one to develop equipment to collect pollen from orchard trees and the other to develop equipment to apply the collected pollen.

MTDC is working in conjunction with the Pacific Northwest Forestry Sciences Laboratory in Corvallis, Oregon, and the Southern Forestry Sciences Laboratory in Raleigh, North Carolina, on both collection and application equipment. Equipment compatible with both Western Douglas-fir and Eastern Loblolly pine is being developed and tested.

Several devices for collecting pollen were considered including enclosing the lower two-thirds of the tree with canvas and shaking the tree; blowing through the tree and collecting on the opposite side; and vacuuming the tree and collecting electrostatically. A cyclone separator was selected as the best device to vacuum pollen from both Douglas-fir and Loblolly pine. By using light-weight flexible hose, extension poles, and a collection head, pollen can he collected to a height of 25 feet above the ground. A four-person crew can collect approximately 5 liters of pollen per hour with the cyclone separator.

Work is now underway to develop controlled pollination equipment that will allow workers to apply pollen to an entire crown, which will provide mass supplemental pollination of both Douglas-fir and Loblolly pine.

Bracke Scarifier

The Ocala National Forest asked MTDC to improve the Bracke-Scarifier/Seeder to obtain better results for direct seeding of sand pine.

MTDC modified one of the Forest's Bracke machines by adding a pneumatic seeder and a visual seed monitoring system. Drag chains were added to cover seeds placed in the scarified spots. The pneumatic seeder distributed the seeds out along the scalp and delivered 8 to 10 seeds per scalp. The Ocala Forest seeded 400 acres with this modified unit with no mechanical problems.

Early indications are that the improvements can substantially increase seed germination and improve stocking distribution. Additional testing as well as placing a packing wheel to firm up the soil over the seeds are planned for 1992.

The Ocala National Forest also considered a British Columbia drag chain scarifier as an alternative to the Bracke Scarifier/Seeder. The BC scarifier was assembled with various anchor chain configurations and used with both a drop tube seeder and a cyclone broadcast seeder. Test results have shown that a configuration with three equally-spaced anchor-chain segments of five links each and the gravity drop tube seeder produced the best results. Further modifications will be tested in FY 1992.

Nursery Technical Services

This project allows MTDC to provide technical services to Forest Service nurseries and to respond to requests from State and Private personnel. Recent work accomplished includes: modifying and rebuilding small root growth chambers for Forest Service Research laboratories (these items are now being used by nurseries); designing and building electrical surge protection for 43 Forest Service weather stations as part of the Reforestation Improvement Program; drawings of the gravity table modification designed and built at the California Division of Forestry, L.A. Moran Regeneration

Center in Davis. Drawings of a mulch spreader, designed and built at J. Herbert Stone Nursery are underway at MTDC and will be completed in 1991.

New applicable technology is continually monitored under this project. It also allows Center personnel to attend meetings and participate in symposiums. Drawings of nursery equipment are available on request. A list of drawings, publications, and articles appears in this report and is published in Tree Planters' Notes periodically.

An update of the Nursery Equipment Catalog, originally published in 1975, is being prepared.

Isozome Laboratory

A National Forest Genetics Electrophoresis Laboratory (NFGEL) was founded by the Forest Service in 1988 for testing starch gel in forest plant material. Since existing equipment was not designed for use on a production basis, problems with efficiency were immediately evident. MTDC was asked to identify the problems and design an efficient system for producers rather than researchers.

In 1989, MTDC engineers and NFGEL geneticists clarified the problems and explored possible solutions. MTDC designed and built buffer trays and gel molds, a gel slicer, a grinding block, wick combs, and a jig. Each piece of equipment is part of an integrated system that should eliminate much of the hand work and provide consistent results. Prototypes of the equipment were designed, built, and tested by MTDC with good results. NFGEL is now using the equipment. Design of the die punch mechanism will be completed in 1991.

Seedling Counter

To meet the demand for seedlings for national reforestation efforts, Forest Service nursery managers must have accurate cultural and inventory data. Much of this information is obtained by counting seedlings. Such counts are labor-intensive and expensive.

An automated tree seedling counter was developed by MTDC through two contracts with Dr. Glenn Kranzler of Oklahoma State University.

The MTDC counter consists of transmitter and receiver circuitry housed in sealed aluminum enclosures and mounted on a skid, a magnetic pickup for determining distance traveled and a stem diameter reference, and a computer for data storage and retrieval that interfaces with a personal computer and provides a permanent data base. These components are transported on a steel frame that attaches to a tractor with a category 2 three-point hitch.

The counter's optoelectronic detector uses an invisible infrared light beam to detect and count seedlings. A transmitter emits a beam of light across and through the seedling row to a receiver. The bean shape--a vertical plane of light-- makes it possible to distinguish seedling stems from branches. Nearly vertical stems will block the beam, while branches crossing at an angle will block only a portion of the beam and not register as a count.

Because stems are not always perfectly vertical, and branches or needle masses sometimes are large, beam height and width must be selected carefully for the species and size class to obtain optimum accuracy.

Drawings, an operating manual, and a video, The Seedling Counter, are available on request from MTDC. A commercial manufacturer expects to have production units available this year.

Progeny Test Seeder

Forest Service nurseries sow nursery beds with High-value tree-improvement seed to meet special specifications for geneticists. Spacing and sowing requirements dictate labor intensive methods.

MTDC was asked to investigate the possibilities of mechanizing and simplifying these operations. A seeder for exact placement of tree seeds for progeny testing was developed by MTDC and field tested during FY 1989 at the Wind River Nursery in Carson, Washington.

The seeder is an operator-propelled vehicle that can accurately position itself over the designated plot and drop seeds from a pre-filled, shutter-type seed tray into the proper soil impressions through a system of drop tubes and releases.

A second prototype that incorporates design improvements suggested from the initial field trial will be tested at the Ashe Nursery in Brooklyn, Mississippi, and the Bend Pine Nursery in Bend, Oregon, in March. Complete drawings and an operators manual will be available from MTDC in 1991.

Hardwoods Scarifier

Natural regeneration of hardwood stands in the eastern United States is becoming more common as Forest Service management direction shifts toward partial cutting. With this new emphasis, comes the need for improved tools and techniques to assure timely and adequate regeneration of desired species. After a site visit to the Nicolet National Forest in Wisconsin, in May 1990, it appeared that a blade such as the Salmon Blade may produce the desired results. A Salmon Blade, a 3-point hitch, and a mounted disk have been purchased and will be mounted on a Nicolet National Forest prime mover. Field tests started in April

1991. Various treatments using only the Salmon Blade, only the disk, and a combination of the two implements will be evaluated.

Seedling Protection

MTDC personnel are providing engineering support to Eastern Region Timber Management by exploring the concept of sheltering newly outplanted seedlings on National Forest land. Experiments are underway to determine if placing double-walled tubes over the seedlings can promote growth and reduce animal damage. Early results are encouraging, but cost, logistic, and durability problems must be addressed.

As field growth and survival studies continue with currently available commercial products, our engineers will be looking for new material and improved techniques to further the concept.

Machine Vision

Tree seedlings are grown in Forest Service bare-root nurseries tailored to specific Forest and District needs. After lifting, seedlings are delivered to packing sheds for grading and packing. Each Forest Service nursery has quality control standards for the seedlings they deliver to field units for outplanting.

The current quality control and grading process is unacceptably labor-intensive and expensive. The graders cull seedlings that do not meet field specifications, count seedlings that do meet specifications, and place acceptable seedlings on a packing belt for final processing and packaging. The grader sorts the seedlings by stem diameter, top length, root area, and overall quality. Quality control is maintained by checkers who sample grade seedlings and monitor grader performance.

MTDC was asked to automate the quality control and grading process in an effort to reduce costs.

Under contract, Oklahoma State University investigated the feasibility of using machine vision for grading and quality control in seedling operations.

Machine vision and image processing were used to measure morphological properties of seedlings. A grading scheme was integrated into the software to accept or cull each seedling depending on morphological characteristics.

OSU's study proved that machine vision can measure morphological features more consistently then current methods. As a result, MTDC is pursuing this technology through cooperative agreements with Oklahoma State and Oregon State Universities, and the state of Oklahoma.

Results will be reported in 1991.

Root Pruner

Tree seedlings are pruned in the packing shed to provide tree planters seedlings with a uniform root length. Hand-operated paper cutters require additional personnel, are unsafe, and often cause bottlenecks. MTDC was asked to develop a root pruner prototype that would automate this process and increase packing shed safety and efficiency.

A prototype utilizing a conveyor system with wire baskets that close around seedling roots and present them to the cutter was developed. This design is being refined to incorporate a pneumatic shear and a simplified clamping mechanism to reduce maintenance and down time. The modified root pruner will be tested in 1991.

Publications and Journal Articles

Feasibility of Machine Vision for Tree Seedling Grading and Root Growth Measurement, Oklahoma State University Contract Report, Lowman, June 1990, Pub. No. 9024-2814-MTDC.

MTDC Seedling Counter Operators Manual, Gasvoda, June 1990, Pub. No. 9024-2816-TDC.

Mechanized Application of Bird Netting To Protect Germinating Seeds, Lowman, Tree Planters Notes, Fall 1989.

The Nursery Program at MTDC, Lowman, Symposium Paper presented at Southern Nurserymen's Conference and Western Nurserymen's Conference, August 1990.

A Precision Seed Sower for Longleaf Pine Bareroot Nursery Seedlings, Cordell, Gramling, and Lowman. Tree Planters Notes, Fall 1990.

The Nursery Equipment Catalog is planned for publication in FY 1992.

Audiovisuals

Natural Regeneration of Douglas-fir and Other Conifers, video, 1989.

Predicting and Manipulating Tree Growth, Slide Tape, 1989.

The Seedling Counter, video, 1990.

Drawings

MTDC-850 Box Lifter
MTDC-849 Isozome Accessories
MTDC-848 Pollen Applicator
MTDC-844 Isozome Laboratory Gel Slicer
MTDC-842 Isozome Laboratory Tray
MTDC-841 Sandia Cone Cutter
LARME-1 Gravity Table Modification

Current Projects

TE02E11 Tech Services--Reforestation, Hallman
TEO2E12 Tech Services--Nurseries, Lowman
0E02E33 Isozome Lab, 0'Rourke
0E02E39 Hardwoods Scarifier, Karsky
1E12L88 Seedling Protection, Windell
5E52E28 Seedling Counter, Gasvoda
6362E11 Field Storage, Herzberg
8E82E18 Pollen Equipment, Jasumback
9E92E19 Machine Vision, Gasvoda
9E92E20 Root Pruner, O'Rourke
9E92E18 Bracke Scarifier, Karsky
7E72E27 Progeny Test Seeder, Herzberg

Publications and drawings may be ordered in single copies. The videos and slide tape may be borrowed.

If you need additional information, contact:

USDA Forest Service
Missoula Technology & Development Center
Bldg. 1, Fort Missoula
Missoula, MT 59801