Missoula Technology and Development Center's Nursery and Reforestation Programs

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The Missoula Technology and Development Center (MTDC) evaluates existing technology and develops new technology to ensure that nursery and reforestation managers have appropriate equipment, materials, and techniques for accomplishing their tasks. Projects underway at MTDC for fiscal year 1992 are described, and recent publications, journal articles, audiovisuals, and drawings are listed. Tree Planters' Notes 43(3):97-104: 1992.

For more than 20 years the Missoula Technology and Development Center has provided improved equipment, materials, and techniques in site preparation, planting, thinning, and tree improvement for resource and nursery managers. MTDC's work has improved efficiency and safety. Current work is summarized in this report. Under the leadership of Dick Hallman, program leader, the center evaluates existing technology and develops new technology. Projects are funded by the USDA Forest Service's Washington Office Timber Management Staff and priorities are set by the Forest Regeneration Committee, which is made up of representatives from various levels of the Forest Service.

Hardwood Scarifier
(project leader--Dick Karsky)

Natural regeneration of hardwood stands in the Eastern United States has become more common as Forest Service management direction has shifted towards more partial cutting. This has dictated a need for improved tools and techniques to assure timely and adequate regeneration of desired hardwoods.

Many commonly used scarification techniques do not effectively eliminate competition from undesirable vegetation. Bulldozer blades often disturb too much of the ground cover, allow soil moisture to be lost, and encourage erosion. Brush blades, on the one hand, create furrows that help hold moisture, but they do not adequately eliminate competing vegetation. MTDC worked with the Salmon National Forest in Idaho to develop a satisfactory scarifier. The Salmon blade produces a series of furrows that catch and hold moisture and seed while effectively eliminating unwanted vegetation and scattering slash. MTDC also developed an inexpensive anchor chain scarifier. This unit is a modification of the British Columbia drag scarifier developed by the BC Ministry of Forests. MTDC added heavier chain to achieve better disturbance of the soil and improved break-up of slash material.

Both pieces of equipment were tested on the Chequamegon and Nicolet National Forests and found to provide adequate scarification for natural regeneration in a partially cut hardwood canopy. Fabrication drawings are available for both scarifiers from MTDC.

Pollen Equipment
(project leader--Debbie O'Rourke)

About 30 years ago, the Forest Service launched an expanded tree improvement program. A network of genetically superior tree seed orchards was created in an effort to produce top-quality seed. Now that the trees in these orchards are in the cone-bearing stage, the problem of protecting the genetic quality of the seed is of prime importance.

Stands of timber surrounding these orchards are sources of "outside" pollen that could dilute seed quality. It is estimated that up to 40% of the seed now produced in some orchards could be the result of fertilization by this "outside" pollen. Equipment and methods to control orchard pollination are essential to the seed improvement program. MTDC is working with Forest Service Research personnel to develop equipment for mass collection of pollen and mass application of pollen to receptive female flowers.

A vacuum collection system has been developed that gives orchard managers a means of collecting

a large supply of pollen from the crown of designated trees in a quick and efficient manner. This pollen is then cleaned and stored for later application to the target trees during the optimum receptive period.

MTDC also has modified a tractor-mounted air duster that can blow collected pollen high into the crown of orchard trees.

This equipment can help protect the genetic quality of orchard seed by insuring genetically acceptable pollen and adequate pollen supplies for increased orchard productivity. Systems have been developed for Douglas-fir and loblolly pine. A final report with drawings and specifications will be prepared when the project is finished in FY 1993.

Reforestation Technical Service
(project leader--Dick Hallman)

Through this continuing project, MTDC 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 service 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, Reforestation 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. Current work includes

- ?? A new edition of the Reforestation Equipment Catalog
- ?? Improved hand-planting tools
- ?? Drawings of a seed orchard netting retrieval system
- ?? Applying global positioning system (GPS) handheld equipment for vegetation mapping in a Forest Service International Forestry project to help Sudan in its efforts to stop the desertification of its land.

Portable Power Platform
(project leader--Keith Windell)

An off-road vehicle that both transports equipment and materials and provides a lightweight power source for operating a variety of implements and hand-held tools has been assembled at MTDC. The vehicle selected for this system is the Iron Horse, manufactured in Sweden.

In a service-wide survey conducted by MTDC in 1986, Forest Service personnel placed a high priority on the need for a portable power source. They asked for an off-road vehicle capable of operating safely on a 35% grade and that could be operated by a non-riding operator, walking behind the machine, and power accessories that could be powered either by direct drive or electrical generation.

The Iron Horse met all these criteria. It is a tracked vehicle that weighs 878 pounds when an empty steel cargo carrying platform is attached. It is powered by a four-stroke 5-horsepower Honda gasoline engine and is operated from a non-riding position by means of a steering arm. The basic unit is rated to carry 1,100 pounds.

MTDC conducted an evaluation of the Iron Horse that focused primarily on its load carrying and terrain capabilities and the safety aspects of its field operations. The unit proved to be safe and maneuverable. MTDC designed a bulk load carrying platform and a multi-purpose hydraulic power pack and tested them in FY 1990. The hydraulic unit is powered by an 18-horsepower gasoline engine. A variety of tools for pruning, thinning, and chipping have been tested with the unit. MTDC is working with a prototype spot-site scarifier that mounts on the power platform. This scarifier was tested on two sites in spring 1992 and drawings will be available in early 1993.

Bracke Scarifier
(project leader--Dick Karsky)

MTDC was asked to modify the Bracke scarifier seeder to improve its performance when direct seeding sand pine. A pneumatic seeder and visual seed-monitoring system were added to the unit. The seeder distributed the seed out along the scalp and delivered 8 to 10 seeds per scalp. Drag chains were added for better seed coverage along with a packing wheel designed to firm up the soil over the seeds. Early indications are that the improvements can substantially increase seed germination and improve stocking distribution.

MTDC also modified the British Columbia drag chain scarifier as an alternative to the Bracke scarifier/ seeder for seeding sand pine. This piece

of equipment was configured with three equally spaced anchor chain segments of five links each and a gravity-drop tube seeder.

Both the Bracke and the BC drag chain scarifier/ seeders are currently in use on the Ocala National Forest in Florida.

Field Storage
(project leader--Diane Herzberg)

A long-standing problem in reforestation has been the lack of adequate seedling storage facilities. A proper facility must be able to keep a good supply of fall seedlings at a cool temperature to maintain their dormancy. To be especially useful, this facility should be portable, and in some cases have its own power supply. MTDC was assigned the task of coordinating development of a temperature controlled portable storage facility that could be easily moved to field locations. Two pickup truck-sized transportable refrigeration storage units are the result of this effort.

Polar Products of Torrance, California, offers a portable pickup-sized temperature-controlled unit for use as a seedling cooler. The 12-V refrigeration system operates from the vehicle's electrical supply or a photovoltaic array with a backup battery. The system can also be run on 110-V ac through a battery charger.

MTDC has developed a slide-in pickup-sized storage unit that relies on standard commercially available refrigeration components and operates on a 110-V ac current. This unit was designed to complement the 12-V dc Polar Products system.

Seedling Protection
(project leader--Keith Windell)

MTDC has been working with Southern Region Timber Management to evaluate commercially available devices that can be used to protect seedlings from animal damage and promote growth (figure 1). Tree shelters, which were developed in England, are tall plastic tubes used to increase seedling growth and survival rates. They protect seedlings from animal browsing and enhance the microclimate around the seedlings. With current increased emphasis on ensuring the survival of selected hardwood species, tree shelters may be helpful in maintaining and re-establishing hardwoods on difficult planting sites. Tree shelters are currently being used at scattered locations throughout the United States, mostly on an experimental

Figure 1—*Seeding protectors promote new growth.*

basis. Long-term benefits have yet to be determined. MTDC has examined field requirements, costs, and logistical problems. An extensive literature search has been completed and a publication documenting this preliminary work is available on request.

Steep Slope Site Preparation
(project leader--Dick Karsky)

At present, mechanical site preparation equipment is generally restricted to slopes of less than 35%. With the emphasis on "ecosystem management" in the Forest Service, more residual material is being left after timber harvests. New methods are needed to adequately treat brush and logging debris and to prepare planting sites on slopes of more than 35% with heavy slash.

In late FY 1991, a guidance group from the Forest Service's Northern, Pacific Southwest, and Pacific Northwest Regions met with MTDC engineers to develop a strategy to solve this problem. MTDC

has conducted a market and literature search seeking equipment and techniques currently available for steep slope work, and a report is being prepared. All applicable equipment from large excavators to small 4-wheel-drive ATV's will be considered for Forest Service tasks. MTDC will continue to monitor activities in steep-slope site preparation.

Mulch For Seedlings
(project leader--Keith Windell)

Ground mulch is commonly used in the ornamental and landscape business to reduce vegetative competition and improve soil moisture around newly planted trees and shrubs. A preliminary investigation by Forest Service researchers indicates that ground mulch can significantly improve survival and promote the early growth of seedlings on National Forest System lands.

MTDC personnel met in early FY 1992 with a guidance group of Forest Service timber management experts to determine the course of this investigation. Data on various types of mulch material, current techniques, and equipment for placing and stabilizing the material around newly planted trees is being collected. Preliminary information should be gathered and presented to the guidance group in December 1992.

People In Tree Tops
(project leader--Tony Jasumback)

Timber Management personnel have for many years expressed the need to gain access to the top portions of trees for various cultural works such as pollination, cone collection, and insect and disease surveys. The tree climbing equipment commonly used is dangerous and provides only limited access to the entire crown. Mechanical equipment such as lifts require frequent moving to reach all sections of a tree crown and are limited in the heights they can reach.

MTDC personnel have begun an investigation of available equipment and techniques that may be applicable to tree crown work. Lighter-than-air craft and new highly mobile lifts (figure 2) are two possibilities that will be examined. MTDC is working with Southern Region Timber Management personnel to develop an approach to this problem.

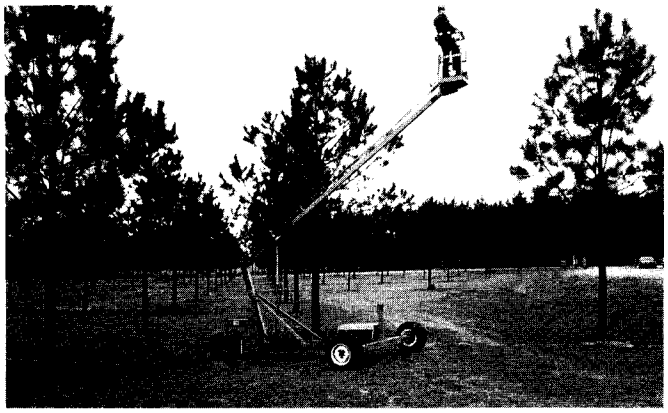

Figure 2—*Highly mobile lifts make tree crown work more convenient and safer.*

Seedling Counter
(project leader--Dave Gasvoda)

To meet the demand for seedlings for national reforestation efforts, Forest Service nursery managers need accurate cultural and inventory data. Most data can be collected only by employing crews of counters to sample each bed in a nursery and statistically determine the quantity of seedlings.

MTDC was asked to develop a method of inventorying nursery seedlings without resorting to costly hand counting. An automated tree seedling counter was developed. This counter uses an infrared light beam to detect and count seedlings as the unit is moved along a planted row in the nursery. All components of the counter are mounted on a steel frame that attaches to a tractor with a category 1 three-point hitch.

A transmitter emits a beam of light across and through the seedling row to a receiver. The beam 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 plane of light and not register as a count. Because stems are not always 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. In tests conducted at eight Forest Service nurseries, the MTDC seedling counter worked well, with the majority of species. Count accuracies are well within the design criteria of ± 10%. Most counts have been within ± 5%.

Two seedling counters are now in use at Forest Service nurseries. Since a commercial source has not yet been established, six additional units have been fabricated at MTDC shops in FY 1992 and installed in Federal nurseries.

Machine Vision
(project leader--Dave Gasvoda)

Forest Service tree nurseries tailor their seedlings to the specific needs of national forests and ranger districts. In doing so, these nurseries must have effective quality control. Currently, lifted seedlings are delivered to packing sheds for grading and packing. In this process, graders sort seedlings by hand, cull the unacceptable plants, and sort the others by stem diameter, top length, root area, and overall quality. They then place the acceptable seedlings on a packing belt for final processing and packaging. Quality control checkers further monitor this operation by picking samples and overseeing grader performance. This is a labor-intensive, expensive process.

MTDC was asked to automate the quality control and grading in an effort to reduce costs. Under contract to MTDC, Oklahoma State University investigated the feasibility of using machine vision in grading and quality control operations. Machine vision and image processing were used to measure morphological properties of seedlings. A grading program was integrated into the computer software to accept or cull each seedling according to the morphological criteria. This system proved itself in initial testing. Oklahoma State University is working with Oklahoma and Oregon State nurseries and the Forest Service to further refine this technology.

A machine vision system utilizing a "line scan" system is now being developed by Oklahoma State University to measure and record seedling morphological characteristics (figure 3). This system promises increased efficiency in quality control for the Forest Service nursery manager. This system was successfully demonstrated at the Elkton State Nursery, Oregon. Plans for developing a production model are being made.

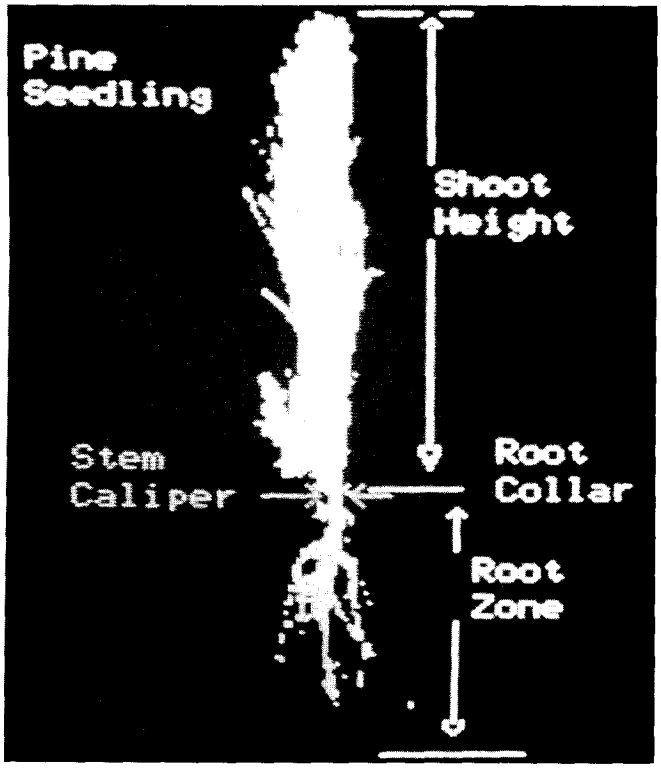

Figure 3—*Machine vision images measure morphological properties of seedlings.*

***Isozyme* Laboratory**
(project leader--Debbie O'Rourke)

The National Forest Genetics Electrophoresis Laboratory (NFGEL) was established by the Forest Service in 1988 for starch gel testing of forest plant material. Because 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 effective system for production rather than research.

MTDC engineers with the help of NFGEL geneticists clarified the problems and designed an integrated system of equipment that included grinding blocks, wick combs, and jigs for sample preparation; buffer trays and gel molds for enzyme separation; and a gel slicer to slice the gel. Prototypes were built and test runs with the system were successful. NFGEL has found the greatest advantage in the gel molds and buffer tray. As a result of the MTDC designs, test results are clearer and preparation time has been greatly reduced. Use of this equipment has helped the lab to double its production.

The development of this equipment has increased both the quality and efficiency of the starch gel testing operation. The test project was completed in FY 1991. MTDC has fabricated twelve additional trays and molds in FY 1992.

Progeny Test Seeder
(project leader--Diane Herzberg)

Forest Service nurseries sow beds with highvalue tree improvement seed to meet special requirements of geneticists. Spacing and sowing specifications have dictated a hand planting operation for the exact placement of these seeds.

The progeny test seeder was developed at MTDC to place progeny tree seed in exact sowing patterns in bareroot nurseries. This seeder is an alternative to the labor-intensive plywood board sowing method currently used. The seeder is a four-wheel operator-propelled (pedal-powered) vehicle that can be used either indoors or out of doors.

The machine was designed to straddle a 48-inch-wide nursery bed. It is an 8-row sowing machine with 12 drop tubes in each row. This allows the seeder to sow 96 seeds simultaneously. The seeds are released from pre-filled shutterlike seed trays to drop down a set of tubes to the nursery bed below. This allows the operator to accurately position the seed in the desired plot. Seed covering was not designed into the unit, however. The seeds must be covered with dirt or grit by hand or with a spreader.

Root Pruner
(project leader--Debbie O'Rourke)

Tree seedlings are pruned in the packing shed to provide seedlings with a uniform root length. This is currently done with hand-operated office-type paper cutters. This system has a number of problems. The hand cutting is difficult, and workers tire quickly. They are subject to carpal tunnel injury and finger lacerations. The work goes slowly and typically, additional personnel and equipment are required to keep up with production. Also, contractors have difficulty meeting Forest Service root length specifications.

MTDC was asked to develop a root pruner prototype that would automate this process and increase packing shed safety and efficiency. Early in developing the prototype, MTDC engineers decided that a small conveyor, separate from the grading line, would be used to present the tree bundles to the cutter. This would keep the operator a safe distance from the blade. The small conveyor would also be more easily adapted to most existing packing sheds.

The next design consideration was to select the method of cutting the roots. Lasers and high-pressure water jets were cost prohibitive and rotary saws were noisy and shattered the root ends. The solution was found in a pneumatic shear. The power source, compressed air, was readily available in the packing shed. The quality of the cut was excellent, and simple electric controls would allow the remote activation desired for improved safety.

The prototype MTDC developed accommodates up to an 8-inch diameter seedling bundle and carries them to the cutting area on plastic conveyor chain (figure 4). When these bundles enter the cutting area, the shear is activated and the seedlings are pruned to the correct length. The bundles are then transported to the end of the unit and packed in boxes. The cutting area is completely enclosed with a Lexan guard, which provides a barrier between the operator and the cutting mechanism, yet still allows the necessary visibility.

Initial testing has been promising. The pneumatic shear produces a clean cut. The conveyor is simple to operate, and output easily matches grading line production. Further refinements will be made and the project is scheduled for completion in FY 1993.

Figure 4—*Prototype root pruner has been tested at the Forest Service's Coeur d'Alene Nursery.*

Seedling Box Lifter
(project leader--Dick Karsky)

A 1984 survey of Forest Service nursery managers indicated that an improved method of lifting

seedling boxes from the ground to transport trailers was of a high priority. They cited the problems of labor costs and the high probability of back injuries. A prototype was designed and built by MTDC engineers. Initial tests were conducted at the Coeur d'Alene, Lucky Peak, and J. Herbert Stone Nurseries.

The seedling box lifter is adaptable to either side of a standard farm tractor. It attaches to the tractor's three-point hitch and allows the tractor to also pull the transport trailer.

A frame mounted on the side of the tractor with a lift cylinder attached raises and lowers the front of the pickup unit. The pickup unit grabs the boxes and positions them on the elevator chain. This elevator chain raises the boxes to a height of 3 to 4 feet above the trailer bed and delivers them to an inclined gravity conveyor which then moves them to the center of the trailer. Stackers or box handlers then stack the boxes in the appropriate place on the trailer. The belt/chain assembly can be adjusted to pick up boxes from 14 to 19 inches wide. It can typically deliver 10 to 12 boxes per minute to the trailer and does an excellent job with both plastic and corrugated boxes.

This project has been terminated. To develop a complete pickup system that integrates a trailer/ transport system into the box lifter operation requires further work, which would require further funding.

Smart Toolbar
(project leader--Ben Lowman)

Nursery equipment operators have experienced problems in maintaining toolbar height at a consistent level above the seedbed while doing various cultural operations. This capability is essential for such tasks as root wrenching, root culturing, and top pruning. With current technology, it is possible to design a system that can automatically sense toolbar height above the seedbed and simultaneously adjust a toolbar to maintain whatever level is desired. Essentially, the goal of this project is to test various distance sensing devices, determine the most applicable device, and design a toolbar system for automatic height control. Initially this idea originated at the J. Herbert Stone Nursery and MTDC will be working with them on this project. The project began in October 1991. Ultrasonic measuring devices were tested in FY 1992 and results showed problem areas; modifications were made and retested. Further testing is planned.

Seed Separator
(project leader--Ben Lowman)

Forest Service nurseries are currently reporting difficulties in separating pitch from tree seed. This is especially true with white pine and western larch seed. Many seed separation devices used in agriculture are not presently being used in tree seed cleaning operations. Initial testing and consultation with Bob Karrfalt, Director of the National Tree Seed Laboratory in Macon, Georgia, revealed that a vibratory separator showed the most promising capability of separating pitch from seed. MTDC has purchased a small vibratory separator and tested it at Coeur d'Alene and Lucky Peak Nurseries. Further tests and demonstrations are planned.

Nursery Technical Services
(project leader--Dick Hallman)

In the past, this project has allowed MTDC to provide technical services to Forest Service nurseries. A newly funded aspect now also allows MTDC to provide limited engineering consultation services to State and private non-industrial organizations that produce forest tree seedlings for reforestation. New applicable technology is continually monitored under this project and MTDC personnel disseminate this information by presenting papers at professional meetings and symposia. They also answer inquiries from Forest Service field personnel, visit various Forest Service Nurseries, and provide drawings and publications on request.

Recent accomplishments

1. Modification and fabrication of small root growth chambers for Forest Service Research laboratories and nurseries.
2. Production of fabrication drawings for the gravity table for reverse flow designed by the L.A. Moran Regeneration Center (California Division of Forestry) at Davis.
3. Production of fabrication drawings for a new mulch spreader designed and built by the Forest Service's J. Herbert Stone Nursery at Medford, Oregon.
4. Modification of a Fobro tree harvesting combine for the Forest Service's Wind River Nursery to reduce downtime and increase efficiency.
5. Production of the Nursery Equipment Catalog.