Recent Technology and Development at the Forest Service Nurseries

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Abstract

The U.S. Department of Agriculture (USDA), Forest Service, Technology and Development (T&D) program works on a variety of projects for the reforestation, nurseries, and genetics programs. During the past few years, the T&D program has developed a tree planter pulled by a utility terrain vehicle and a seed dryer designed to dry small quantities of seed. Midmount tractors were evaluated to compare their cost and usefulness with rear- and front-mount tractors. After building a steam room for one of the USDA Forest Service nurseries, T&D developed design guidelines that could be applied to build steam rooms from new or existing facilities. Finally, the T&D program has been helping the USDA Forest Service nurseries update their data management systems. This paper was presented at a joint meeting of the Northeast Forest and Conservation Nursery Association and Southern Forest Nursery Association (Williamsburg, VA, July 21–24, 2014) and a joint meeting of the Western Forest and Conservation Nursery Association, the Intermountain Container Seedling Growers Association, and the Intertribal Nursery Council (Boise, ID, September 9–11, 2014).

Introduction

The U.S. Department of Agriculture (USDA), Forest Service, Technology and Development (T&D) program began in the 1940s to develop wildland firefighting equipment. Two facilities developed the equipment in Missoula, MT, and San Dimas, CA. Over time, the USDA Forest Service added other program areas, such as engineering, range management, recreation, forest management, reforestation, nurseries, genetics, and many more. Today, the T&D program manages specifications, develops equipment and training, and evaluates tools for many program areas internal and external to the USDA Forest Service. This article covers some recent projects completed by the Reforestation, Nurseries, and Genetics Resources T&D program.

Mid-Mount Tractor Evaluation

The purpose of the mid-mount tractor evaluation project was to purchase and evaluate two new mid-mount tractors to determine their cost effectiveness and usefulness compared with front-mount and rear-mount tractors. T&D purchased the Italian-made Mazzotti Multi 600 Tool Carrier 4x4 mid-mount tractor (Mazzotti Company, Ravenna, Italy) (figure 1). The Mazzotti has four-wheel drive and a 60 horsepower Perkins diesel engine. Wheel width adjusts from 59 to 82 in (150 to 210 cm). The span between the front wheels and the rear of the machine can be adjusted by 29 in (74 cm) to accommodate various sizes of implements.

Figure 1. Mazzotti mid-mount tractor cultivating a red oak seedling bed. (Photo by Christy Makuck, USDA Forest Service, 2012)

T&D also purchased the Saukville High Boy mid-mount tractor (this tractor is no longer manufactured or available) (figure 2), which resembles a slightly larger Model G implement carrier tractor (Allis-Chalmers Manufacturing Company, Milwaukee, WI); the Model G was an iconic piece of machinery at bare-root nurseries nationwide. The Saukville High Boy has 27 in (67 cm) of clearance. At the time of purchase, the manufacturer had just begun building units after purchasing the rights to the design. The company has since sold its equipment line, and the Saukville is no longer in production.

Specifications for each tractor are shown in table 1.

Figure 2. Saukville mid-mount tractor with cultivator. (Photo by Gary Kees, 2010)

The main advantage of a mid-mount tractor compared with front-mount and rear-mount tractors is the increased visibility of the implement and seedling row. This visibility provides the operator greater control and allows for single-person operation of mechanical in-row practices (e.g., weeding and vertical root pruning). The mid-mount option also enables the operator to perform an additional practice, such as fertilizing, by attaching a fertilizer implement behind the tractor.

Because of its smaller size, the Saukville tractor is more maneuverable than the Mazzotti tractor. The Saukville's rear, three-point lift arms were loosely constructed making it difficult to cultivate close to the row crop (both the front and rear are poorly designed). Because of the light weight of the front end, the nursery added additional forward weight on the Saukville to keep the front end from wandering.

The large, heavy size and high cost of the Mazzotti are big detractors. This tractor works well, but it is not as nimble and quick as the Saukville. In addition, the Mazzotti tractor's height makes it difficult to see smaller plants when performing treatments.

Knife Cultivator

The T&D program built a new knife cultivator from old technology (figure 3) to address the need for cultivating around small forbs and grass seedlings without disrupting the soil. A lightweight knife blade, designed similar to the old push cultivator used in a small garden plot, was attached to a cultivator bar mounted under a tractor. The knives are very thin and sharp. The cultivator is designed to cut weeds without disturbing the soil. This process limits the risk of tearing out big clods along with the native plants. The T&D knife cultivator has a set of gauge wheels and the tool standards are spring loaded to protect the knife if they hit rocks. The knife cultivator worked very well unless the weeds became larger than approximately 6 in (15 cm) tall. Taller, wet weeds tended to plug up in the knife blade supports. In addition, very hard ground wore the knives quickly. In soft and loamy ground, such as at the USDA Forest Service Bessey Nursery (Halsey, NE), the weeds would not cut, and they collected on the knife blades.

T&D tested a similarly designed cultivator, commercially available from Buckeye Tractor Co (Columbus Grove, OH). The Buckeye Tractor cultivator proved to function as well as the T&D cultivator. Both knife cultivators are designed so that the spacing among knives can be adjusted as needed.

Table 1. Specifications for the two mid-mount tractors evaluated by MTDC.

Specifications	Saukville High Boy	Mazzotti Multi 600 Tool Carrier 4x4
Hitch	Three-point category one, middle and rear, rear drawbar	Three-point category two, middle (2,200 lb [4,840 kg] lift) and rear (3,300 lb [7,260 kg] lift), rear drawbar
Engine	37 hp Cummins diesel	60 hp Perkins diesel, four cylinder
Transmission/drive	Variable speed hydrostatic Sauer-Danfoss transaxle with hi-low range, two-wheel drive	Two variable speed ranges, four-wheel hydraulic
PTO	Mid-mounted hydraulic, 540 rpm	Mid-mounted hydraulic, 540 rpm
Brakes	Rear separate discs	Four-wheel hydraulic
Tires	Front: 5.00 -12; rear: 8.30 -24	Front: 7.5 R18; rear: 9.5 R32
Wheel width adjustment	Front: 56 to 72 in (142 to 183 cm); rear: 48 to 68 in (122 to 173 cm)	Front and rear: 59 to 82 in (150 to 210 cm)
Wheelbase length	Variable 105 in (267 cm); overall variable 161 in (409 cm)	Variable 101 to 130 in (256 to 330 cm); overall variable 153 to 182 in (389 to 462 cm)
Weight	3,500 lb (7,700 kg)	5,290 lb (11,638 kg)
Fuel capacity	12 gal (45.4 L)	12.5 gal (47 L)
MTDC purchase price in 2013	$24,490	$85,000
Contact information	No longer being commercially manufactured	Bartschi-Fobro, Inc., Grand Haven, MI

hp = horsepower. MTDC = Missoula Technology and Development Center. PTO = power take off. rpm = revolutions per minute.

Figure 3. Technology and Development program knife cultivator mounted on the Mazzotti mid-mount tractor. (Photo by Gary Kees, 2012)

Small Lot Seed Dryer

The small lot seed dryer (figure 4) was built at the request of the USDA Forest Service Lucky Peak Nursery (Boise, ID) based on an idea demonstrated by Bob Karrfalt at the USDA Forest Service, National Seed Laboratory (Dry Branch, GA). Karrfalt presented his idea at the annual Western Forest and Conservation Nursery Association meeting in Bend, OR, in 2012 and later published his design (Karrfalt 2014). The T&D program took Karrfalt's idea and created a slightly more robust unit using seed trays that the Lucky Peak Nursery was already using. The T&D-developed dryer has a base with a fan and heating element. A plenum sits on top of the base and houses five seed trays (17 by 17 by 2.25 in [43 by 43 by 5.70 cm]). Air is blown up through the plenum and across the trays, exiting in the front. The user can control both fan speed and temperature. The unit is designed to provide airflow ranging from 5.6 to 37.0 cfm (9.5 to 62.9 m^3/hr) at 100.0 °F (37.8 °C). The plenum is designed to ensure the same airflow across all five trays.

Figure 4. Small lot seed dryer developed by the Technology and Development program. (Photo by Gary Kees, 2014)

UTV-Pulled Tree Planter

Lucky Peak Nursery submitted a proposal to the T&D program to locate or develop a mechanical tree planter that could be towed by an all-terrain vehicle (ATV). It is much easier to train personnel to operate an ATV or utility terrain vehicle (UTV) than a tractor. This type of planter would also be able to plant seedlings in wetlands and areas not accessible with a tractor. The planter had to be capable of planting 2-year-old tree stock. It had to be maneuverable and the coulter blade and planting shoe had to be capable of being lifted out of the ground for turning. It was desirable to have both the ATV and planter fit on a small trailer or in the back of a pickup truck.

A wagon-like cart was designed to carry the planter and its operator (figure 5). The coulter blade and shoe were designed with a parallel link that keeps the planting shoe level at all depths. This design allows the operator and packing wheels to stay on the ground; only the coulter and trencher are raised when making corners. The design includes a 12-volt, electrically activated hydraulic pump and cylinder for raising the

Figure 5. The utility terrain vehicle (UTV) tree planter for planting seedlings at the Lucky Peak Nursery. (Photo by Clark Fleege, USDA Forest Service, 2014)

coulter blade and planting shoe. The seats, packing wheels, and plant boxes are made by the Holland Transplanter Company (Holland, MI).

Initial testing of the tree planter proved that an ATV would not be able to pull the planter so the project focus was changed to develop a UTV-pulled mechanical tree seedling planter. A diesel John Deere Gator UTV was used for this project (Deere & Company, Moline, IL). The power and weight of the Gator is marginally adequate. The biggest issue is maintaining traction in difficult soil conditions. Initial tests were conducted at the Lucky Peak Nursery in the summer when the ground was hard. At times, lowering the coulter and shoe lifted the transplanter wheels off the ground. In softer soil, however, the shoe developed an adequate slot and was able to plant some stock that Lucky Peak had available.

It is expected that pulling the UTV tree planter in softer soil conditions during typical spring planting conditions should work. While the UTV tree planter can be towed in the field at lower speeds, it is not designed to be towed at highway speeds. The UTV tree planter fits in the back of a pickup truck or small trailer but not with the UTV. The UTV planter can easily be towed by a pickup truck or jeep. A complete set of drawings for the UTV-pulled mechanical tree planter is available from T&D (drawing MTDC-1104).

Steam Room Design Guidelines

The USDA Forest Service Toumey Nursery (Watersmeet, MI) and the USDA Forest Service Bessey Nursery asked T&D to develop "Steam Room Design Guidelines" for construction of steam rooms at their facilities. In 2004, the T&D program developed a steam room (figure 6) to sterilize large lots of polystyrene seedling blocks for the Lucky Peak Nursery by converting a walkin cooler using a steam boiler and some piping (Trent et al. 2005). The steam room greatly decreases the labor and time required to sterilize seedling blocks. Rather than specifying a one-off design, the T&D program developed design guidelines to enable nursery managers to specify requirements for the steam boiler. The guidelines direct the nursery manager through a series of questions and recommendations to collect data required for a boiler company to properly size the boiler. A properly sized boiler is capable of heating the room to 160 °F (71 °C) within an acceptable amount of time. The Lucky Peak Nursery starts its boiler at around 6:30 a.m. At approximately 5:00 p.m., the room reaches 160 °F (71 °C) and they shut the boiler off. The steam room doors remain closed overnight and are opened in the morning.

Figure 6. Interior of the Lucky Peak Nursery steam room. (Photo by Clark Fleege, USDA Forest Service, 2013)

Nursery Management Information System

The Nursery Management Information System (NMIS) is a database system that the USDA Forest Service nurseries use to track inventories (seed and seedlings), process sowing requests, and prepare billing statements. Two systems are currently in use: an Access database and an Oracle database. Each database has different functionality. The T&D program is working with the nurseries to combine the two databases and improve the system. We are investigating hosting and maintenance solutions to ensure future viability of the databases.

Conclusion

The T&D program receives project ideas from people all over the country. Anyone interested in submitting an idea can contact the T&D program at 909–599–1267 or 406–329–3900. Additional information about the projects described in this article and other projects completed by the T&D program are available on our Web site: http://www.fs.fed.us/t-d/.

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