THE BELTED SEEDLING LIFTER

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I. Background

There exists a strong need for mechanization of nursery operations today. One of the operations which will benefit greatly through mechanization is seedling lifting. Mechanizing the lifting operation can increase harvesting capacity, decrease costs and improve working conditions. In addition, mechanization can help to ease the problems of timely lifting and labor availability and reliability.

Mechanization of the lifting operation began some time ago with the development of rigid undercutting blades, i.e. belly mount wrenching blade type. The rigid undercutter has the advantages of easing the manual lifting chore and of having the lowest fixed machine costs. Although maintenance is slow, lifting with the rigid undercutters requires substantial hand labor and provides the minimum amount of soil loosening.

Agitating undercutters were developed in an attempt to further ease the lifting chore; i.e. Earl Mann type. The agitating undercutters improve soil loosening and root separation, and at a reasonably low cost, but still require a considerable labor force. In an attempt to decrease this labor requirement and improve the soil loosening and root separation, undercutting and lifting machines were developed.

The simplest undercutter and lifter is the fixed or agitating blade rod chain type, i.e. Grayco Harvester. The lifter uses the rod chain to lift the bed and agitate the mass to loosen soil and untangle the seedling roots. This lifter can also be used with a cross conveyor to elevate the seedlings into a trailer mounted bin. This lifter has the advantage of greatly easing the lifting chore and, with the cross conveyor, has the means to require much less physical labor, but the soil removal and root separation is somewhat inadequate in most soil and tree types.

The belted seedling lifter was developed in an attempt to increase the soil removal and root separation on the lifted seedlings. There are several types of belted lifters, the most common types combine a fixed or agitating undercutting blade with some type of belt pick-up device. Most belted lifters, used in the west, combine a soil removal device to loosen the soil and separate the roots and a cross conveyor to elevate the seedlings and deposit them in a trailer mounted bin. These machines offer the advantages of minimum labor requirements, increased soil removal and root separation, increased capacity and low cost per seedling harvesting.

The Ag West, Inc. belted seedling lifter is the result of several years of research and development. The original concept and machine design was developed by Weyerhaeuser Company and further developed and manufactured by J.E. Love. More recently the Weyerhaeuser Company modified the Love design to include a rod chain that lifts the seedling bed up to the belts. Ag West, Inc. was then licensed by Weyerhaeuser to refine the design and manufacture an improved seedling lifter. Significant improvements have been made to the original machine design. These design changes improve operational efficiencies, decrease maintenance costs, and allow operation in more adverse field conditions.

II. Machine Design

The Ag West lifter is a semi self-contained unit designed to be pulled by a medium horsepower tractor. The tractor i required to have either a 540 rpm or a 1000 rpm PTO and an auxiliary hydraulic quick disconnect. The PTO drives a gear increasor which in turn drives the machine's hydraulic pumps. The machine has two piston pumps and one vane pump which provide the flow to carry out the lifting operations. One pump is a hydrostatic transmission which provides infinitely variable flow to the rod chain pick-up and lifting belt hydraulic circuit. This pump can be reversed to clear lodged trash from the lifting belts if they become clogged. The second pump is a pressure and flow compensated piston pump which provides flow to operate the drive assist option. The drive assist powers the lifters gauge wheels, at a variable speed, to provide extra traction and power to move the lifter during adverse field conditions. The vane pump is piggy-back mounted to the hydrostatic pump and provides power to the soil removal and cross conveyor. The auxiliary tractor hydraulics are used to power the lifter's hydraulic cylinder circuit. The cylinder controls are contained in a remote panel which can be conveniently mounted within easy reach of the tractor operator.

The lifter has a static undercutting blade which can be controlled by the operator to vary undercutting depth uniformly across the bed width, or independently on each side of the bed, to accommodate differences in wheel path depth. The independent depth control is accomplished by the gauge wheels. The lifter has two gauge wheels that are independently raised or lowered by cylinders controlled by the operator on the tractor. In addition to the depth control cylinders, the lifter is provided with a steering cylinder attached to the lifter tongue hitch. The steering cylinder can be controlled by the operator to align the lifter with the seedling rows.

The undercutting blade is directly followed by the rod chain pickup unit. The rod chain unit serves to raise and position the seedling bed for pickup by the lifting belts. The rod chain also begins to loosen the soil attached to the roots. The seedling rows are gently but firmly grasped between opposing pickup belts and gradually lifted and conveyed over the soil removal device.

The soil removal device consists of a series of balanced oscillating impactors. The impactors impact the root mass just below the root collar, at a height which is controlled by the operator. The speed of the soil removal device may be varied so as to provide optimum soil removal under different soil types and different moisture levels. The impactors effectively remove the attached soil from the seedling roots and help to untangle the root mass with a minimum amount of seedling damage.

The lifting belts further elevate the seedlings and deposit them onto a cross conveyor at the rear of the machine. The cross conveyor is equipped with lift cylinders to raise the extended portion of the conveyor to allow quick changing of the loading bins mounted on a trailer traveling alongside of the lifter. The cross conveyor is variable speed and features a cleated wire belting which minimizes the amount of soil accumulating on the belt and being deposited into the bin.

III. Machine Capacity

The Ag West, Inc. Belt Lifter has been designed to operate at speeds from 0 to 60 feet per minute with a fully adjustable speed control. The power assist option offers more than adequate power to overcome even the worst field conditions.

The Lifter has been used to harvest a great variety of nursery stock. Harvested species include Sitka Spruce, Douglas Fir, Noble Fir, Loblolly Pine and Ponderosa Pine. The lifter has successfully harvested 2-0 stock and 2-1 transplants and can easily be converted from an 8 row to a 6 row machine. The machine can also be used in plug-1 and 1-1 transplants. Harvested seedling densities have ranged from 27 to 164 trees per lineal foot of bed.

The harvesting rate of the lifter will depend upon its forward speed and the seedling density being harvested. Although the lifter has the capacity of 60 F.P.M., a conservative average speed for various field conditions would be around 20 F.P.M. At 20 F.P.M. speed, the theoretical harvesting capacity for 8 hours of operation would be 259,200 trees at 27 trees per lineal foot, 902,400 trees at 94 trees per lineal foot and 1,574,400 at 164 trees per lineal foot. The actual in field harvesting rate for an 8 hour day must be figured by adjusted the theoretical values for field efficiencies.

The majority of the time lost in the field is caused by employee breaks, turning and idle travel, cleaning clogged equipment, machine adjustment, maintenance service (other than at the end of the day), and waiting for bin trailers or other machines. Employee breaks will usually account for about 1 hour per day and the efficiency of the other operations will ordinarily range from 70 to 90% depending upon field conditions and the supply of bins and trailers. Using an average of 80% overall field efficiency and accounting for break tine, the infield capacity would run

181,440 trees per day at 27 trees per lineal foot, 631,680 trees per day at 94 trees per lineal foot, and 1,102,080 trees per day at 164 trees per lineal foot of bed. Normal operation of the lifter requires 5 people, one to operate the tractor and the lifter controls, one behind the machine to insure proper machine adjustment, two to fill and align the seedlings in the bins and one person to drive the bin trailer tractor. This labor requirement would result in a harvesting rate of 6,480 trees per manhour for 27 trees per lineal foot of bed, 22,560 trees per manhour for 94 trees per lineal foot of bed and 39,360 trees per manhour for 164 trees per lineal foot of bed. It is easy to see the labor cost savings this machine can produce in just one season. Ordinarily the only change needed in the nursery operations is to be sure there is an adequate supply of bins for storage and that the nursery beds are maintained in reasonably good shape.

IV. Future Trends

Ag West, Inc. is determined to continue to produce, develop, and refine the belted seedling lifter. There are plans on the drawing board for an improved, self-propelled lifter. This machine will incorporate the newest developments in seedling harvesting technology. The machine will be self-propelled, eliminating the need for tractor hookup. The machine design will incorporate improvements in the belt design life and improvements in the soil removal system.

The self propelled unit will also be designed to be a multiple purpose implement. The harvesting unit will be removable and replaceable with several other implements. Other implements will be designed to operate on the machine, such as, bed preparation and shaping equipment, precision planters and spraying equipment.