A new way to till compacted skid trails helps restore soil productivity. Oregon State University researchers developed the tool and are offering the design to industry

Winged subsoiler tills compacted forest soil

Corvallis, Oregon

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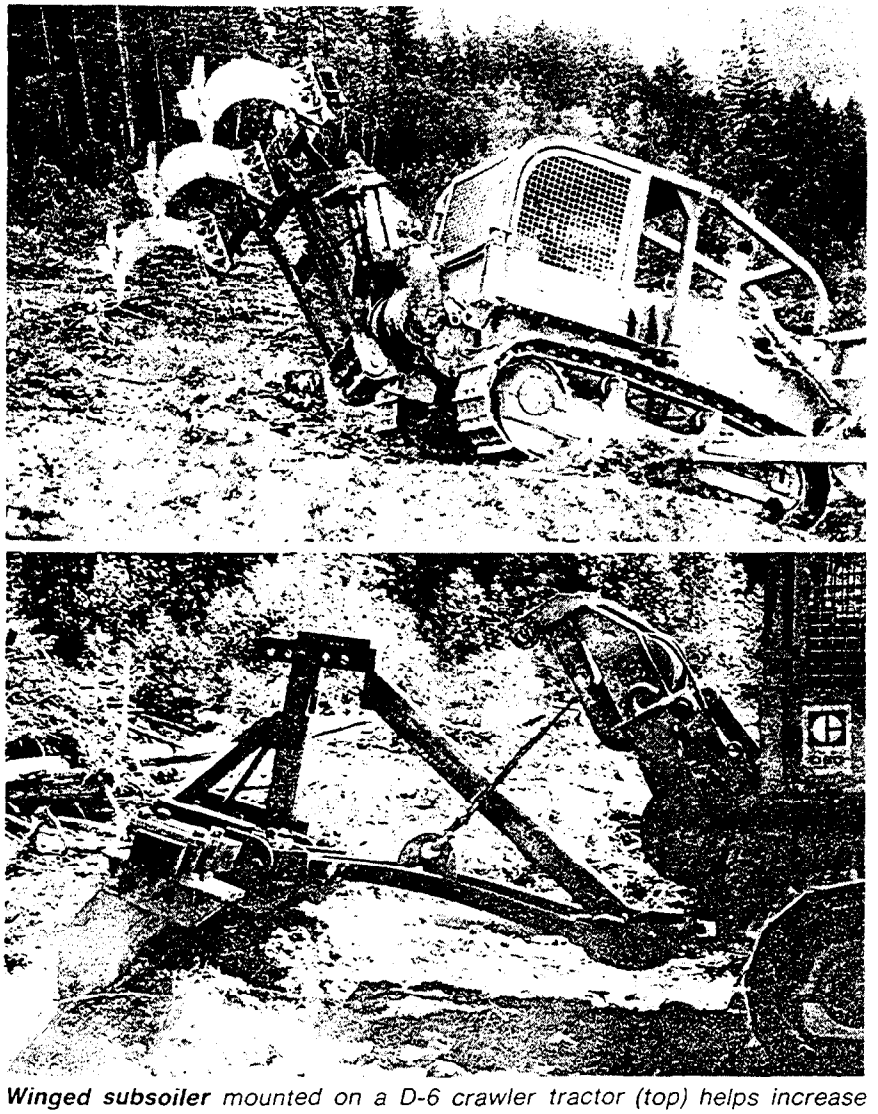
It may be mean-looking, but the winged subsoiler loosens compacted skid trails like no other tillage equipment. Developed at Oregon State University, it is designed to withstand the rigors of rocky soil, logging slash and steep slopes.

Tilling compacted skid trails helps to restore the productivity of forest soil. Studies have shown that compacted soils in and adjacent to skid trails seriously reduce seedling growth. The effect on trees has been measured in stands up to 33 years old. If the compacted layer, which commonly extends from the surface to 15 to 24 in. deep, could be loosened by some form of tillage, the growth impact could be greatly reduced. Because of this, the economy and flexibility of ground-based logging could be retained.

The question is: what is the most economical way to loosen the compacted soil so as to restore as much of its original productivity as possible?

Researchers in the Department of Forest Engineering at OSU conducted studies to answer this question. The project had three specific goals:

- Determine the cost and effectiveness of commonly available tools.
- Improve equipment, if needed, to obtain desired tillage.
- Determine the benefits in seedling growth and survival gained by tillage.



***Winged subsoiler** mounted on a D-6 crawler tractor (top) helps increase productivity of soils; shoes here (bottom) were set at a 20-in. depth.*

Available tools

Brush rakes, different conventional rock subsoilers, and two sizes of disk harrows were examined first.

Chip Andrus, a forest engineering graduate student, studied costs and effectiveness of these tools. Costs of tillage were not unreasonable, but the quality and extent of tillage were disappointingly low. Of course, none of these tools was designed for tilling compacted forest soil.

Brush rakes shattered only 38% of the compacted soil mass, and some recompaction took place as the machine traveled behind on the loosened soil.

Rock rippers had highly variable success, fracturing from 18% to 43% of the compacted layer. Straight tines typically created narrow V-shaped trenches.

The smaller disk harrows (six 32-in. blades) were too light to penetrate and generally tilled only 3 to 6 in. deep. Larger disks (16 or 24 36-in. blades) loosened soil 6 to 8 in. deep.

Multiple passes with the three types of machines could increase the percentage of soil tilled. However, cost increases would be almost proportional to number of passes, and in some cases all the compacted soil would still not be tilled.

For purposes of comparison, tillage costs were computed on the basis of measured productivity, including minor delay time, and standard rates for machine and operator. Move-in and overhead costs were not included.

Ripper costs ranged from $42 per mile for the smallest (63-hp) ripper unit with two shanks (single pass per trail) to $135 per mile for the 140-hp tractor equipped with a five-shank ripper (sin-

gle pass), tests showed.

Tilling with a brush blade mounted on a 230-hp tractor cost $200 per mile. The small disks, towed by a 140-hp tractor, cost $103 per mile.

Some improvement in tillage effectiveness is clearly required if productivity is to be fully restored. We concluded that the ideal tilling tool would include the following features:

- Be capable of tilling the full width of a trail (about 11 ft) in a single pass.
- Be capable of tilling to a 24-in. depth when required.
- Fracture at least 80% of the compacted layer.
- Be rugged enough to withstand tilling through stony soils, large roots and heavily compacted soils.
- Allow large quantities of debris to pass between shanks.
- Be easily attached to any logging tractor with a drawbar hitch and winch line.

Developing the winged subsoiler

Very large subsoilers are used in agriculture to loosen soils to depths of 3 ft or more and are also rugged enough to offer some possibility for use in the woods. Rome Industries (Cedartown, Ga.) supplied, for testing, two 48-in. curved subsoiler shanks with replaceable winged shoes and unique chisel-shaped shoes. The winged shoes were 19 in. wide and provided a lift of 2¼ in.

The shanks did not fit any existing rock-ripper tool bar, so a suitable test frame was developed. Radke's Repair and Iron (Corvallis, Ore.) built a prototype frame that allowed us to test individual subsoiler tines with the winged shoes verses chisel-shaped shoes.

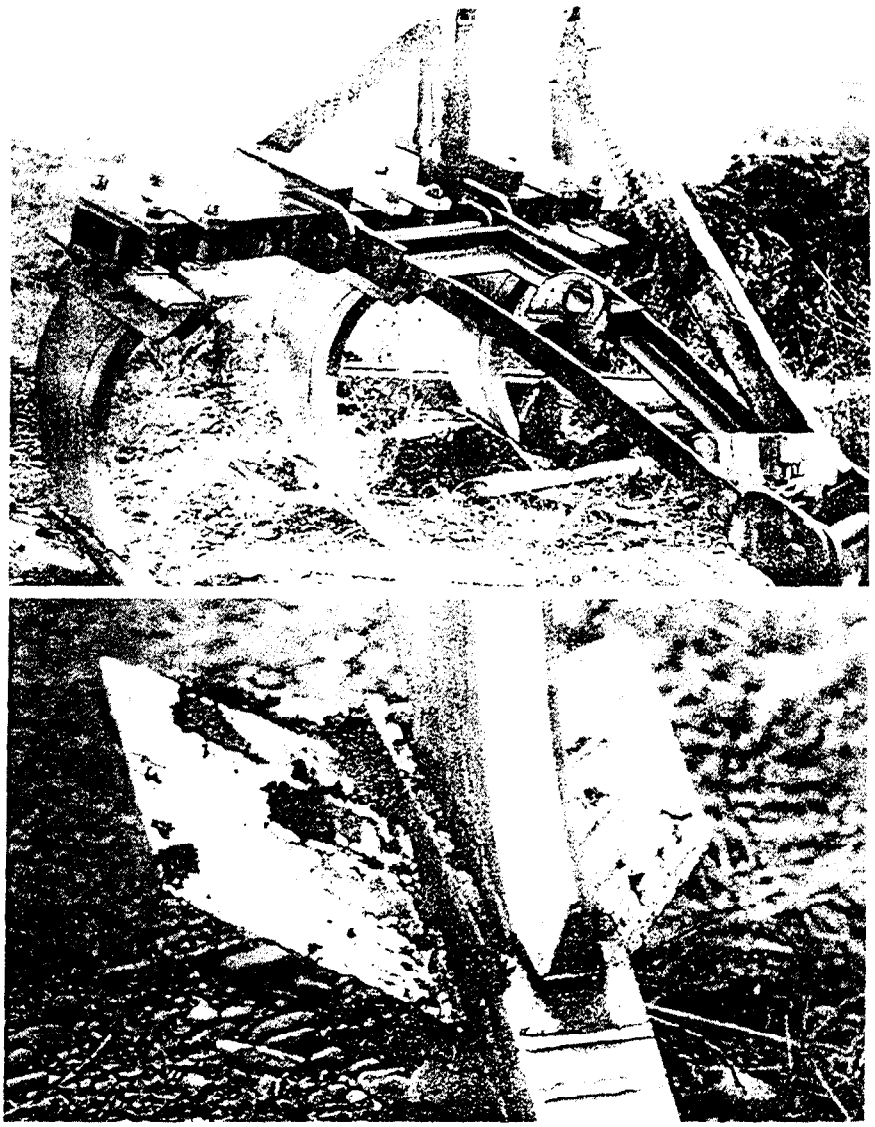
When we compared subsoiling with winged and with chisel-shaped shoes, we found the former to increase amount of soil shattered per shank by 30% in stony soil and 64% in clayey soil.

The wings did not appear to increase draft (power requirements) on the tractor. A third shank was added and the frame modified to make it more adaptable to a wide range of tractors. The tool was tested operationally on two sites administered by the Bureau of Land Management in southwest Oregon. The test sites were clearcut units for which ripping of skid trails was required in the timber sale contract. The tool pulled easily behind the D-6 crawler tractor, fracturing 81% of the compacted layer on one site and 88% on the other.

About 5½ miles of skid trails were tilled on the two sites. Cost of tillage calculated on the same basis as the previous test were $176 per mile of trail.

Performance of the subsoiler

The winged subsoiler with its three curved shanks moves easily through the soil behind a D-6 crawler. Most debris is able to pass through the widely spaced shanks, though occasional lifting is still required to clear large slash from them. The shanks are also lifted to avoid large stumps, roots, and rocks.



***Prototype frame** for the subsoiler (top) was built for tests to compare winged shoes with chisel-shaped shoes; closeup of winged subsoiler shoe (bottom).*

Steep, uphill tilling requires a larger tractor, while skid trails can be tilled downhill on slopes up to 50%. Gradients across skid trails can be up to 15%.

Compacted soils that are high in clay do not respond well to most tillage, including the winged subsoiler. When wet, such soils tend to mold instead of loosen; when dry, they tend to break into persistent clods. Soils other than clay respond to tillage best when dry to slightly moist.

How tillage of skid trails affects tree growth is being evaluated by the OSU Department of Forest Engineering. A recent greenhouse study has shown a significant increase in seedling growth when compacted skid trails are tilled. Preliminary results from an on-going field test also indicate positive growth response from tillage.

Contractors using the prototype of the OSU winged subsoiler have been enthusiastic about how well it works, but they have had many suggestions for design improvements, including a more stable two-point hitch, a hydraulically controlled tool bar lift, and individually sprung shanks that will release when encountering large obstructions. It has also been suggested that the amount of soil fractured by conventional rock rippers can be substantially increased by adding winged shoes to the shanks.

The winged subsoiler prototype has tilled over 100 miles of compacted skid trails more effectively than currently available tillage equipment. It has met with the approval of logging contractors and professional land managers.

OSU hopes that improved models will be manufactured by private industry. The prototype is now available through Papé Bros. Inc., a Caterpillar dealer headquartered in Eugene, Ore. ■

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