Lasers and Moles Make a Pipe Dream Come True

JAMES L. FOUSS and RONALD C. REEVE

The laser and a mole have teamed up with flexible plastic pipe to cut food costs. This unusual combination works largely underground, but it's very much on the level.

A down-to-earth problem was involved—how to reduce the expense of draining farmland and thus cut food production costs. Agricultural research came up with the answer.

That discovery of the space age, the laser, was put to work down on the farm. This was accomplished by Agricultural Research Service engineers working cooperatively with Ohio State University.

Here's how the system goes—laser, mole, and flexible pipe tubing:

A laser beam is projected to automatically control the digging depth of a mole plow, which is pulled by a large crawler tractor. A torpedo-shaped object—the "mole"—attached to a narrow vertical shank, forms an underground channel (without digging a trench) as it is drawn through the soil. An attachment on the mole plow feeds a continuous length of flexible plastic drain tubing into the ground at a consistent level controlled by the laser beam. As the tubing goes down, so too do farm drainage costs and food costs as well.

Before this intriguing development, tile drainage installation and materials had changed little from the middle 1800's. Laying short segments of drain tile end-to-end in a trench is still the common method of field drainage.

Mechanical trenching machines have been used since the early 1900's to replace hand excavation. Trenching machines are slow and have been changed little, but laborsaving methods have been developed for handling and placing the tile. Despite these improvements, installation costs remain relatively high.

Introduction of coilable, corrugated-wall plastic drain tubing during the mid-1960's permitted a greater reduction in labor requirements. The tonnage of drainage materials that needs to be handled has also been drastically cut. A 300-foot coil of 4-inch diameter corrugated plastic drainpipe weighs about 80 pounds and can be handled by one man. By comparison, 300 feet of clay or concrete drain tile weighs slightly more than a ton.

Corrugations in the wall of the plastic drain give the pipe its needed strength and provide longitudinal flexibility, making it coilable and easy to handle. Compared to smooth-walled plastic pipe, the corrugated tube is much lighter and lower in cost.

Corrugated plastic pipe can be rapidly installed with newly developed

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Basic elements of laser-controlled system for laying drainpipe. Laser projector is set up on tripod directly in front or behind mole plow.

mole plow drainage equipment pulled by a tractor. A tube-feeding attachment to the plow eliminates the time-consuming task of ditch excavation and backfilling required in conventional tile drainage. The plastic drainpipe can be installed at speeds up to 125 feet a minute with this machine. Under many field conditions, at least 2,000 feet of corrugated plastic drain can be put in per hour. This compares with about 4 hours needed to install the same amount of draintile with a conventional trenching machine.

To function properly, subsurface drains must be laid on a uniform slope or grade. The high-speed equipment for installing plastic drainpipe requires more accurate and responsive grade control devices than those presently used on trenching machines. Conventional line-of-sight grade control methods require continual resetting of many sight-bar stakes or the stretching of gradeline reference wires—time-consuming operations which involve high labor costs.

With the laser system, aiming the laser beam is all that’s needed to establish the grading guideline reference. An electronic sensor on the machine receives the laser light and automatically controls the hydraulic mechanism which regulates the installation depth. Although the automatic system was developed especially for high-speed equipment, it can be used equally well on low-speed machinery.

The new system uses a low-power gas laser that emits a small nondivergent beam of light. The beam projection unit is tripod mounted, lightweight, and portable. It is battery-powered for field use. The laser beam is projected from a remote location in the field, toward the drainage machine, on a line parallel to the slope desired for laying the drainpipe.

The machine-mounted electronic sensor includes phototubes for receiving the laser beam.

During the machine's forward motion, the automatic system continuously keeps the electronic sensor unit at an elevation so that the laser beam is centered on the phototubes. When the machine's digging depth varies from that established by the laser beam reference, the phototubes put out a signal. This causes the digging depth to be automatically adjusted by a hydraulic cylinder mechanism, thereby compensating for ground surface irregularities. Thus, the drainpipe is laid at both the desired depth and grade.

The automatic system typically corrects the digging depth within three-eighths of an inch or less over distances up to 1,500 feet. All the machine operator has to do is see that the plastic pipe feeds properly into the installation implement and steer the tractor in a fairly straight line toward the laser beam unit. Operator fatigue and carelessness that now cause gross inaccuracies in draintile installation are eliminated by the laser system.

The laser system can be adapted for
Laser beam detector is in rectangular box above tractor treads on drainage machine, top. Detector picks up laser signals and automatically controls digging depth. Photo at lower left shows how flexible plastic drain tubing enters mole plow at top and is fed out at bottom. Lower right, Agricultural Engineer James L. Fouss aims laser beam projection unit.
automatic grade control on other types of drainage or earth-moving machines. Automatic control of the cutting depth might be used on scrapers, graders, bulldozers, shovels, draglines, and other machines used in land leveling, dredging, and construction of open ditches and terraces.

This would greatly reduce labor requirements, increase operating efficiency, and reduce costs.

Savings can also result from its use in constructing roads, highways, airports, dams, sewers, and in many surveying operations.

While the original laser projected a small straight-line beam, a laser projection unit has now been devised that emits a "fan"-type light beam optically spread into a horizontal plane. This permits construction machines to operate in any direction in the field. It also enables several machines to operate simultaneously in the same area from one laser beam reference unit.

The role of the laser beam elevation and guidance control system is still in its infancy. Through research, new uses in many fields are sure to follow. Farming will become more efficient as this system is put to use both for drainage and for solving other farm operational problems. As this occurs, we may rightly expect to see the "pipe dream" of lower food production costs come true.

The Tricky Chemistry of a Blade of Grass
MAX B. HEPPNER

Grass is to the farmer as clothing fiber is to the shirmer. The shirmer must know the strength of rayon compared to cotton to make sure your shirt doesn't rip when he changes fiber. The farmer must know the feeding value of bromegrass compared to alfalfa to make sure a cow's production doesn't slip when he changes feed.

In this respect, the shirmer has it all over the farmer. The factory supplies the chemical specifications of rayon, whereas Mother Nature has been extremely guarded about revealing the feeding value of alfalfa.

For more than 100 years, animal nutritionists have been on the track of a blade of grass without complete success. They split the feed value of grass into basic fractions: Energy, protein, and minerals. Then, in the 1930's and early 1940's, they started discovering one vitamin after another.

By 1945, when they had worked through the alphabet from vitamins A through K, nutritionists came up with yet another unidentified feed factor. They noted that cows invariably responded with an increase in milk production of up to 9 or 10 percent after part of their alfalfa ration had been replaced by a portion of corn with equal energy value.

At that time, Dr. Lane A. Moore, a nutritionist with extensive research experience at Michigan State University and the University of Maryland, was just setting up shop at the U.S. Department of Agriculture's research center in Beltsville, Md. He had been working on the effect of vitamin A deficiency in dairy cattle. And—like his colleagues—he believed that nu-