



Researchers Fouss and Fausey Develop Laser Grade-Control System That Transforms Drainage and Irrigation Technology



Figure 1A (above) Research prototype laser-controlled drainage plow. 1B. (inset) Laser transmitter with shielding removed to show telescope and chopper blade.



Although hills, slopes, and folds in the earth are interesting visually, in cultivated fields these features can be problematic for farmers. Uneven land surfaces, bound by the laws of gravity, often pull water away from where it's needed most. As a result, some crops languish from excess water, others shrivel for a lack of it, and runoff and erosion are commonplace.

James E. Fouss (currently a supervisory agricultural engineer and research leader at the Agricultural

Research Service [ARS] Soil and Water Research Unit in Baton Rouge, Louisiana) and Norman R.

Fausey (currently a supervisory soil scientist and research leader at the ARS Soil Drainage Research Unit in Columbus, Ohio) found a way, almost three decades ago, to use emerging technology to solve the problem of uneven field surfaces associated with installing subsurface drainage on agricultural lands. Their creation—the

laser beam automatic grade-control system—has provided the most efficient way to install drain tubing in agricultural fields rapidly and accurately with modern equipment. About a decade later, other ARS researchers spearheaded studies to apply the commercialized “laserplane” system technology to the field of agricultural

In recent months, a CAST committee made up of five members of the Board of Directors and chaired by Dr. William Sandine has identified a number of “research success stories” that succinctly convey the value of agricultural research to our readers. The first story appears here; others will follow in subsequent issues of NewsCAST.



Figure 2. Laser-controlled ARS draitube plow.

cropland leveling and surface irrigation (see Textbox 1).

Why Use Lasers for Drainage?

The idea for a laser beam-controlled plow came to Fouss and Fausey while they were employed in the Agricultural Engineering Department at the Ohio State University, Columbus, in 1964–1965 testing the installation of subsurface drains with experimental plow-type equipment. They were using ARS-developed lightweight corrugated plastic drainage tubing that had replaced the heavy, rigid drain tile materials of clay and concrete. But they saw quickly that drainage machine operators would not be able to control accurately the depth and grade for installing tubing at the plow’s speeds of 100–150 feet per minute. The solution? Some form of automated depth and grade control. Traditionally, operators just “eye-

balled” the sighting bar to bring it in line with crossbars aligned across the field to determine whether to raise or lower the digging mechanism. Requiring the constant attention of the operator, this practice could control trenching machines effectively, but only at speeds of 10–30 feet per minute.

The research prototype laser beam system was designed and developed to meet the specific needs of high-speed drainage plow equipment used to install corrugated plastic draitubing (Figure 1A). The prototype system, assembled and

tested between 1965 and 1967 by Fouss and Fausey, consisted of a transmitter—a 0.3-milliwatt-output helium–neon gas laser, a 10-power telescope to expand and collimate the small-diameter laser beam to about 1/2-inch diameter, and an electric motor-driven slotted disc to

Textbox 1. Additional Early Researchers

- T. W. Edminister, Administrator, USDA–ARS (deceased)
- Cecil H. Wadleigh, Director, Soil and Water Conservation Research Division, USDA–ARS (deceased)
- Jan van Schilfgaarde, Director, Soil and Water Conservation Research Division, USDA–ARS (retired)
- Ronald C. Reeve, Research Investigations Leader, Soil and Water, USDA–ARS (retired)
- Glenn O. Schwab, Professor, Agricultural Engineering Department, The Ohio State University (deceased)
- Cornelius A. Van Doren, Chief, Corn Belt Branch, USDA–ARS (retired)
- Ted L. Teach, President, Laserplane Corporation (retired)

“chop” the beam at a frequency of 150 times per second (Figure 1B). This battery-powered laser transmitter was mounted on a tripod at the upgrade end of the proposed drain line. The desired grade or slope was set into the transmitter, projecting the laser beam parallel to and above the proposed drainpipe.

As the laser beam-adapted plow moved forward, any deviation from the desired grade caused the receiver unit mounted on the plow’s frame to move up or down, which then would cause an imbalance in the electrical bridge circuit. Once the imbalance reached a preset level, a control circuit activated an electric valve to hydraulically move the plow’s hitch-point up, or down, until the laser receiver was again “on grade.” According to field tests, the laser receiver could be maintained within about 3/4 inch of the desired grade line, at ground speeds up to 100 feet per minute.

Going to the Marketplace

Following a 1967 demonstration of the ARS prototype laser beam automatic

Textbox 2. Uses of the Laser Grade-Control System

- Land surveying and grading
- Increased water conservation
- Erosion control
- Overall farm efficiency for irrigated agriculture
- Highway and building construction and alignment
- Tunnel and open ditch excavation
- Rice paddy and levee construction
- Pipeline construction
- Military applications

grade-control system to Ohio land drainage contractors, Fouss met with individuals who, soon afterward, became founders of the Laserplane Corporation, located in Dayton, Ohio. Many of the concepts for the laser beam control, developed and tested by the ARS, were adopted for use in the development of a commercial version of the laserplane system for drainage

equipment.

At the 1968 Ohio State Farm Science Review in Columbus, Ohio, the first commercially available Laserplane Grade-Control System was revealed in field trials and demonstrations. These trials were conducted cooperatively by ARS researchers and Laserplane engineers. Here, a few thousand farmers and as many as 100 drainage contractors

Figure 3. Visitors to the 1971 Ohio State Farm Science Review.



viewed the system's performance on a wheel-type tile trenching machine installing corrugated plastic drain tubing. By the fall of 1970, many farmers in the Midwest were demanding the laser beam-controlled machine to install their drainage systems. And by early 1971, many tile trenching machines were equipped with laserplane grade control.

Making a Good Thing Even Better

Researchers at the ARS designed a larger drainage plow and tested its capability and grade-control accuracy for installing corrugated plastic drains. This larger plow was equipped with the commercial Laserplane Grade-Control System and was demonstrated at field shows in Illinois and Ohio in 1971 (Figure 2). A new drainage plow imported from England—equipped with laserplane control—also was seen at the Ohio State Farm Science Review that year (Figure 3). Even larger crowds attended these events.

Testing of this larger plow allowed ARS researchers to ascertain the

accuracy of the grade control and to confirm the optimum mounting position for the laser receiver on the drainage plow frame. Fouss and Fausey also found that ground speeds for the plow—of up to 100 feet per minute—provided the best grade-control accuracy. These findings soon became important guidelines for the industry.

After 1971, all plows and nearly all high-speed trenchers sold in the United States were equipped with laser automatic grade control as standard equipment. By the early 1970s, the laserplane grade-control system was adopted for most drainage machines—both trenchers and plows—in several European countries.

Worldwide Use Nets Big Dividends

Since its inception and development, the laserplane system has been adopted by agriculture and industry worldwide to improve land-grading operations for surface irrigation (see Textbox 2). The adoption of this technology has led to significant increases in surface irrigation

efficiency and a great decrease in irrigation costs through savings in the volume of water needed to be pumped and the cost of energy needed for pumping. Nighttime operation of the laser system allows operators to take advantage of good weather conditions and lower temperatures, both of which can improve grade-control accuracy (Figure 4). Improved surface irrigation also has brought about increased crop productivity and uniformity on irrigated lands.

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Figure 4. Nighttime laser-controlled land leveling.

