AUTO-STEER OPPORTUNITIES FOR CROP MANAGEMENT

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Introduction

Guidance systems have played a major role the in development of mechanized agriculture. Disk markers are a technology almost as old as mechanized planting. Knotted wire was a key part of the cross-check corn planting system that improved mechanical weed control for corn in the early 20th century. Foam markers were crucial to improving chemical weed control accuracy in the late 20th century. Global Positioning System (GPS) light bars were introduced for ground-based equipment in the late 1990s and quickly became standard practice for many farmers and custom operators. GPS auto guidance is the next step in this process.

GPS auto guidance goes one step beyond light bars to entirely take over steering within the pass. Equipment operators still need to turn at the ends. GPS auto guidance is widely used for furrow and drip irrigated crops in California's Central Valley, and for controlled traffic in wheat, canola, and other broad acreage crops in Australia. Auto guidance manufacturers are now ramping up to sell their products in the Corn Belt. This article summarizes a study recently completed at Purdue University that looks at which Corn Belt farmers are likely to benefit from this technology.

Like other precision agriculture technologies, the profitability of GPS auto guidance depends on reducing costs or increasing yields. In California's Central Valley, the fact that auto guidance gives growers greater flexibility in hiring labor has been key to profitability. For example, in the past only a few skilled drivers could operate the listers to create the straight, evenly spaced ridges for furrow irrigation. Those skilled drivers command high wages and are not always available. With auto guidance California growers can chose from a wider range of drivers, without reducing the quality of the work. In addition, with auto guidance drivers can work longer hours, at night, and in fog.

In Australia, the economics of auto guidance seem to be driven by controlled traffic. Because many of their soils are prone to compaction and because most of Australian cropland does not experience freezing and thawing, compaction is a key issue. Australian farmers and researchers report that wheat and canola yields increase up to 100% when wheel traffic is limited to pre-established lanes. For years, manual "tram-lining" has controlled traffic. Auto guidance can limit traffic to an even smaller portion of the field than tram-lining, with year-to-year consistency, and with less operator stress and fatigue. Australians are also using GPS auto guidance to facilitate mechanical weed control in chickpeas and other row crops.

While some Corn Belt soils are susceptible to compaction, there are other "spatially sensitive" practices that might benefit from greater driving accuracy and repeatability (e.g., the ability to return to the same place for subsequent operations and from year-to-year). In the Corn Belt those spatially sensitive practices might include: strip tillage, sidedress nitrogen application, and mechanical weed control. This study used controlled traffic as an example of

a spatially sensitive practice that Corn Belt farmers might use.

Technology on the Market

Auto guidance technology is on the market with two accuracy levels: differential corrected GPS (DGPS), which has about a 4 inch (10 centimeter) accuracy, and real time kinematic (RTK) GPS, which has about a 1 inch (2 centimeter) accuracy. The major providers of auto guidance for farm equipment are John Deere, IntegriNautics, Trimble, and Beeline. Deere, Trimble, and Beeline offer, or are planning to offer, both DGPS and RTK systems, while Integrinautics sells only RTK systems. IntegriNautics and Trimble are strictly after-market suppliers. The Beeline technology is available, factory installed, on AGCO Challenger tractors and as a retrofit on other equipment makes. Most agricultural auto guidance is currently installed on tractors, but technology for sprayers, fertilizer applicators, combines, and other equipment is being developed.

Depending on the GPS technology the grower already has and the level of accuracy desired, costs range from $10,000 for entry-level DGPS technology to almost $60,000 for a top-of-the-line RTK system. The Deere product utilizes its Greenstar system and Starfire position receiver. Upgrading the tractor with the Greenstar already installed includes an AutoTrac keycard and a vehicle steering control kit. A major part of the RTK system cost is the base station, which can be fixed or mobile. Ideas for reducing RTK system cost include developing wireless Local Area Networks (LANs) through which several farmers could share an RTK correction signal.

The economics of both light bars and auto guidance are different from most other GPS-based technologies because their benefits do not depend on information analysis and changing agronomic practices. To benefit from auto guidance, equipment must be driven more accurately, more consistently, and/or for longer periods every day. GPS guidance is an information technology in the sense that it depends on digital information and computerized data processing, but in many ways it has more in common with traditional farm mechanization than with yield monitors, variable rate application, and other precision agriculture technologies.

GPS guidance scenarios

The profitability of auto guidance depends on farm size and cropping practices. The Purdue study looked at three auto-guidance scenarios:

1. Improving field efficiency, and reducing skip and overlap on an 1800 acre farm.
2. Using auto guidance to work longer hours and expand farm size with the same set of equipment.
3. Controlled traffic on an 1800 acre farm.

The 1800 acre farm on a 50/50 corn-soybean rotation was chosen as a typical size crop operation in west central Indiana using a 12 row planter. The estimates assume that planter size is the limiting factor in getting field work done and that with current technology a 12 row is the largest workable planter given field size and shape, and rolling topography. For farmers who can use larger equipment (e.g., 16 row, 24 row), the benefits of GPS auto guidance would

be greater than those estimated here because the cost of auto guidance is the same regardless of equipment size.

The estimates assume the grower currently uses disk markers for planting and foam markers for spraying. Three GPS guidance alternatives are considered: (1) light bars, 2) DGPS auto guidance, and 3) RTK auto guidance. The study assumes that the foam markers would be eliminated if any GPS guidance is used, but disk markers would be retained as a stand by technology on the planter. The estimates are based on technology prices of: light bar, $4050; DGPS auto guidance, $15,000; and RTK auto guidance, $50,000. The DGPS annual subscription cost is $800.

The estimates assume a corn price of $2.23/bu. and a soybean price of $5.49/bu. Variable crop production costs were taken from the 2003 *Purdue Crop Cost and Return Guide*. Harvesting was assumed to be a custom operator at $21/acre. Rent was set at the Indiana average of $116/acre. Labor was valued at $8.29/hour. Returns to management were calculated using a spreadsheet farm model.

The 1800 acre farm

The results indicate that the light bar technology is the most profitable option for the farmer who is not expanding and who does not use any "spatially sensitive" technologies (Table 1). In this case, the benefit of any GPS guidance is that it reduced skip and overlap, as well as increased field speeds. The estimates indicate that light bars allow a 13 percent increase in field speed and auto guidance allows a 20 percent increase. Most of the reduction in skip and overlap is achieved with the low-cost light bar technology. The additional reduction in skip and overlap due to auto guidance is small relative to the substantially higher cost of auto guidance.

While estimates indicate that auto guidance is not the most profitable technology for the 1800 acre scenario, it does result in some time savings. The estimated field time for the base case is about 496 hours per season, not counting harvest. The time with light bar technology is about 11 percent less, or 439 hours. With either DGPS or RTK auto guidance the time is cut another 6 percent, to about 411 hours. These time savings may mean greater timeliness in field operations or more leisure.

Scenario	Light Bar	DGPS Auto Guidance	RTK Auto Guidance
1800 Acre Farm	$1.95	-$0.26	-$7.13
Expanding Operation	$6.93	$7.36	$3.41
Controlled Traffic, 1800 a. Moderate Compaction	$22.07	$24.49	$18.84

Table 1. Increased Returns to Management Under Three GPS Guidance Scenarios[1]

[1]Compared to management returns on a farm using foam and disk markers.

Farm Expansion

Estimates indicate that light bar guidance would allow the 1800 acre operation to expand to about 2600 acres with the same 12 row planter and other equipment, while maintaining operation timeliness. GPS auto guidance would allow that grower to expand to about 3100 acres with the same set of equipment. The base case assumes a 14-hour workday. With a light bar. this is increased to 18 hours per day and with auto guidance, 20 hours per day. The ability to farm more acres with the same equipment is the combined effect of more work hours per day, higher field speeds and reduced overlap.

For the expanding farm operation DGPS auto guidance is slightly more profitable that the light bar option (Table 1) because it allows the grower to farm substantially more acreage with the same equipment. In this case RTK auto guidance is more profitable than the base case (foam and disk markers), but less profitable than the light bar or DGPS auto guidance.

Because the farm operation is expanding it is important to look at whole farm profits. The DGPS auto guidance allows the farm to increase returns to management by about $9700. The light bar technology increases returns to management by $5,800 and the RTK auto guidance by $4,500. If farm family members are supplying labor, the labor income from those added acres would also increase family income.

One of the key assumptions of this farm expansion analysis is that light bar and DGPS guidance is good enough for corn planting. If all fertilizer is applied pre-plant and all weed control is chemical, a 4-inch wobble in the row may not be any problem. If there is sidedress nitrogen, mechanical weed control, or other spatially sensitive practices, the 4-inch accuracy of light bars and DGPS auto guidance may not be good enough. In that case, RTK auto guidance would provide some benefits over the foam and disk marker technology.

Controlled traffic

The controlled traffic example used estimates of compaction effects on yields from northern Ohio. It assumes that in soils moderately susceptible to compaction, average corn yields would be 150 bu./acre in non-compacted soils, and 139 bu./acre in compacted soils. Soybean yields would be 46 bu./acre in compacted soils and 49 bu./acre in non-compacted soils. With traditional random traffic, about 90 percent of the soil surface receives wheel traffic every year. The estimates assume that, with light bar controlled traffic, this can be cut to 30 percent: with DGPS auto guidance to 20 percent; and with RTK GPS to 15 percent. The estimates are long run in the sense that they assume that all equipment matches the width required for controlled traffic. This study did not deal with the transition costs of moving from random to controlled traffic.

On the 1800 acre base case farm with controlled traffic on soils moderately susceptible to compaction, the DGPS auto guidance is the most profitable guidance technology. The light bar follows close behind. The RTK auto guidance is more profitable than random traffic, but not as profitable as the other options. With soils highly susceptible to compaction, both auto guidance technologies show more benefit and the profitability gap between

DGPS and RTK auto guidance narrows to about $2/acre. If manual tram-lining were able to reduce traffic to 50 percent of the surface, the increase in the return to management would be about $15/acre.

Auto guidance is a new technology and the price is relatively high. As the auto guidance market matures, many observers expect the price of the technology to drop. If the price of auto guidance technology were to drop by 50 percent, RTK auto guidance becomes the preferred choice for controlled traffic on soils highly susceptible to compaction.

Conclusions:

The Purdue GPS auto guidance study leads to the conclusion that DGPS auto guidance will be profitable for a substantial group of Corn Belt farmers in the next few years. This will primarily be growers who are now farming as many acres as they can with a given set of equipment. The initial benefit for many growers will come from being able to expand farm size with the same equipment set. A $15,000 investment in DGPS auto guidance is a relatively inexpensive way to expand equipment capacity by several hundred acres.

In the longer run, as farmers become more comfortable with auto guidance technology they will probably find a variety of spatially sensitive practices that could benefit from greater driving accuracy and repeatability. This study used controlled traffic as an example of a spatially sensitive practice, but in the Corn Belt, strip tillage, sidedressing nitrogen, or mechanical weed control may also show benefits. As with other precision agriculture technologies, the benefits of fine tuning operations will be higher value crops.

At current equipment prices, RTK auto guidance is more profitable than foam and disk marker systems for expanding farm operations and for those with soils subject to compaction, but it is not as profitable as light bars or DGPS auto guidance. If the price of auto guidance drops as the market matures, RTK auto guidance will become a competitive technology.

For More Information

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