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Choose a GPS Guidance System Based on Farm Needs

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Current precision farming activities are based on global positioning system (GPS) coordinates, so choosing the right GPS for a specific operation is important. Farmers who access a GPS signal through a guidance system usually find the choice relatively simple and base purchasing decisions on price. This publications is intended to simplify the decision for buyers who need to investigate which system best benefits a specific operation.

Types of GPS

A basic recreational GPS is rated for 15 feet or less accuracy and is suitable only for soil sampling. Agricultural guidance systems contain more accurate GPS units, filtering techniques, and update cycles to make them usable for agricultural guidance. The three main types of guidance systems based on correction type are: Wide Area Augmentation System (WAAS), also known as satellite based augmentation system (SBAS); OmniSTAR; and real-time kinematic (RTK) systems. Technology used in John Deere equipment (SFI, SFII, and RTK) mimics these systems in scope and accuracy.

• **WAAS** is a system supplied by the Federal Aviation Administration at no cost to users. Most GPS receivers made since 2000 are programmed to receive this signal. Typical accuracy ranges from 12 to 15 inches or better, but year-to-year accuracy can vary by as much as 6 to 15 feet.

The WAAS signal provides 100 percent coverage almost constantly. WAAS technology concerns in Kansas include the lack of signal in certain fields due to obstructions, magnetic interference, inadequate software setup (system jumping between WAAS correction satellites during turns, for example) or other electrical noise, and "waviness" in some situations when applied to row crops. Units have been found to be beneficial for spraying, planting wheat day or night, and general tillage operations.

SiRF technology is a special chip set that uses less power with better urban canyon performance. This system is available in some hand-held units and has accuracy ratings similar to the WAAS system.

• **OmniSTAR** is a subscription correction service that uses additional GPS techniques (L-band) to increase accuracy. The company offers three services for agriculture: virtual base station (VBS) with sub-meter accuracy, XP with 6 to 8 inches pass-to-pass, and high performance (HP) with 4- to 6-inch pass-to-pass. Absolute accuracy ratings (year-to-year) are similar to the pass-to-pass ratings. The system can be used for strip tillage and controlled traffic routes. Subscriptions range from $800 to $1,500 per year. VBS is not common in U.S. agriculture because its performance is similar to the free WAAS system, but it is important in parts of the world where such systems do not exist. Problems reported in Kansas include a 6-inch offset when around power lines and other obstacles, but systems are reported to work well in most applications.

• **RTK** systems are considered the top line among guidance and GPS systems, with antenna accuracies in the +/- 1-inch range. In guidance applications, the actual accuracies of an RTK system can vary as much as 4 to 6 inches when factoring in tractor steering and the dynamics of a moving vehicle. These systems usually cost more than other systems because they require a base station less than 30 miles away from the rover unit, as well as a radio link between the units. RTK systems typically cost $12,000 to $25,000 and require

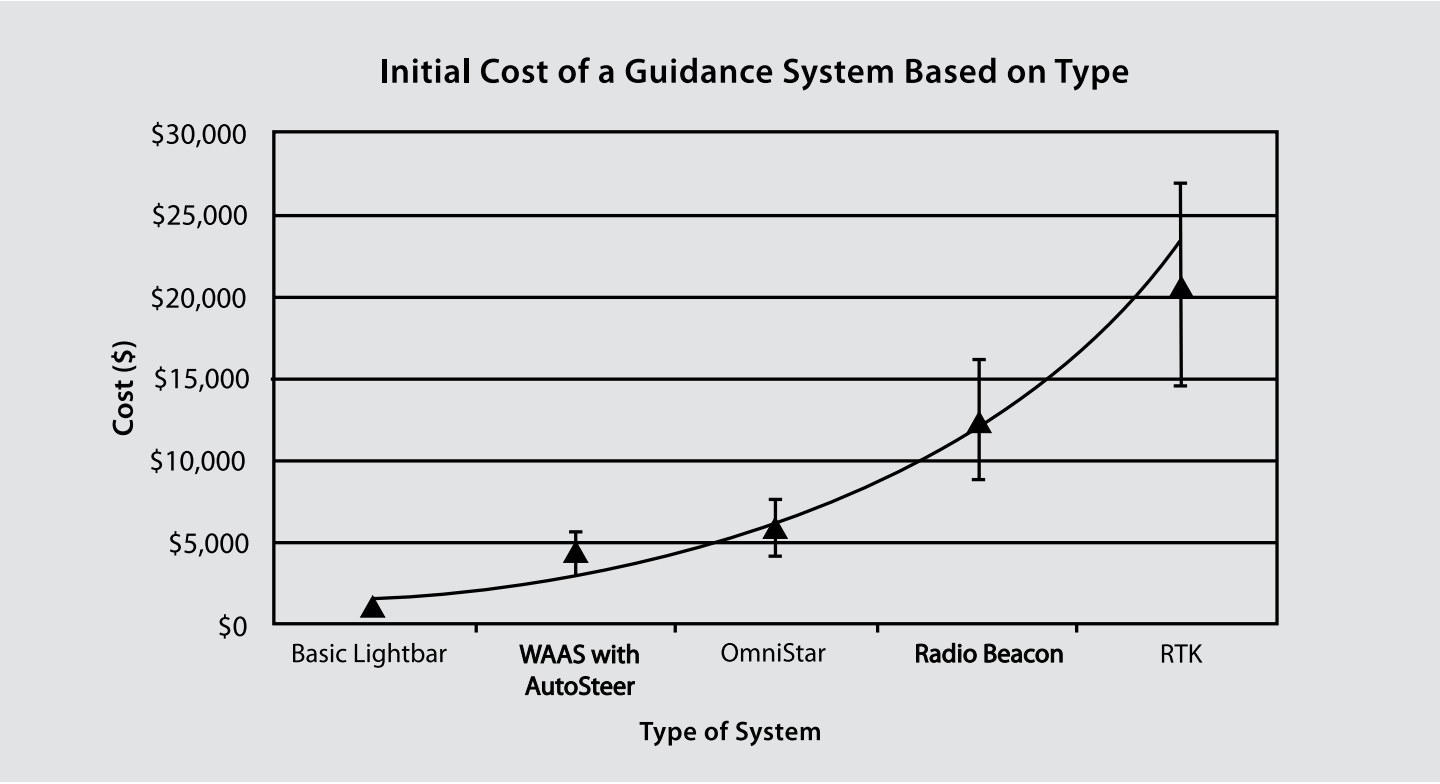

Figure 1. Typical cost for guidance equipment based on correction type.

either a subscription service to a local base station ($750 to $1,500 per year) or the purchase of a portable base station ($5,000 to $15,000), which must be within 3 to 5 miles line-of-sight from the rover unit. Reported problems with these systems include loss of signal near tree lines or around other obstacles, causing the system to re-boot and requiring a 10- to 15-minute waiting period to re-initialize. Some newer systems avoid this problem by adding an inertial mass unit (IMU) to provide guidance for a few minutes without a GPS or RTK signal, and others offer ways to avoid these problems. These systems are considered the best and most advantageous for all agricultural uses.

The U.S. Coast Guard beacon, using LORAN C, offers a fourth type of differential correction, but the WAAS system is generally replacing it.

Initial equipment cost of the different systems is shown in Figure 1. Basic WAAS light bars offer the lowest cost, with auto-steer RTK units the highest. Most units offer a payoff at some point, depending on farm size, since all systems increase the efficiency of field operations.

Accessories

Accessories to enhance guidance system performance include tilt sensors and inertial mass units. A tilt sensor allows the system to measure the offset of the GPS antennae caused by the vehicle's rotation (which can be 5 degrees or more in agricultural vehicles) and cause 3- to 12-inch offsets in ground coordinates. Some filtering and smoothing can minimize this effect within a guidance unit, but hilly and contour guidance should have this sensor to attain a higher level of accuracy. Inertial mass units — usually built into the unit — also help maintain accurate guidance when satellite reception is poor. These units typically allow 10 or more minutes of guidance without satellite assistance and are especially useful in RTK units that may have long restart times to reestablish "integer" counting after a signal loss.

Implement Guidance

No matter which system is used, most suffer from reduced accuracy in contoured fields, hills, or when making turns that can create large implement drifts. Active or passive implement guidance is available as

Farming Operation	GPS System WAAS	Omnistar	RTK
Soil sampling	√	√	√
Yield monitoring	√	√	√
General tillage	√	√	√
Spraying	√	√	√
Planting wheat	√	√	√
Planting corn	Marginal	√	√
Strip tillage		Depends on service	√
Second pass cropping		Depends on service	√
Cultivating (2-inch)		Marginal	√
Second-pass banding of fertilizer			√

Figure 2. The chart presents an overview of types of systems appropriate for specific operations. Accuracy and use of a system for a particular purpose varies widely and depends on location, type of application, tractor set-up, cropping system, unit manufacturer, and user expectations.

active or passive-type steering control. Choosing a system depends on the type of guidance system used, crop type (row or broadcast), and terrain (hilly or contoured). Active implement guidance is not widely used in Kansas.

Guidance System Settings

To properly set up a system, the implement and antennae offset distances must be set per vehicle/implement combination, and the overlap setting should be set to match the type of guidance system. Doing so will maximize field efficiencies per unit.

For an RTK unit, the overlap setting should be 3 to 4 inches less than full toolbar width, 4 to 6 inches for OmniStar, and 12 to 15 inches for WAAS-type systems. Setting the parameter at less than the available accuracy reduces field efficiencies and the unit's economic benefit.

Diagnosing GPS Problems

• Power Connector

Some units use a cigarette lighter plug as the main power connector. While simple to use, the plugs can disconnect with time and normal vibration.

Depending on manufacturer and design of the socket and plug unit, some plugs are more susceptible than others to unintended disconnection. Possible problems range from varying materials to inadequate spring tension that can cause brown-out conditions (low amperage flow). Such conditions can result in "lock up" or "restart." A loose plug is not usually detected unless it includes an LED light. Using marine twist-lock lighter plugs and housing or other vehicle-approved electrical connectors with locking tabs can help prevent unintentional disconnections. (Note: Making this change requires training and appropriate equipment.)

• Satellite Strength and Loss Problems

Tractor cabs can be electrical and magnetic "busy areas" with the added electronic, radio, and GPS equipment. GPS antennae usually mounted on the top of the tractor cab contain a metal base plate that acts as a choke for noise coming from the cab.

Although usually not a problem, some antennae need a larger choke ring to block out noise, depending upon the farm equipment on which it is mounted. This problem is sometimes solved by putting a large piece of metal (1 to 2 feet in diameter and grounded to the tractor frame) underneath the GPS antennae. This plate will serve as a choke to help block electronic noise from the tractor cab.

Improvements expected for GPS and guidance systems might include Internet utilities, stronger transmitters, and increased bands for greater accuracy.

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