Trends in Precision Agriculture

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Introduction
Precision agriculture is no longer a generic term defining our desire to more precisely manage equipment and agronomic inputs. As precision agriculture enters its sixteenth year, it has become an industry within itself and features a suite of hardware and software components aimed to improve efficiency in all areas of production agriculture. As we look back on the past sixteen years we can see clear innovations in precision agriculture that have helped shape the future direction of this industry. During its infant years, precision agriculture was focused on methods to collect production data across the field using newly available GPS technology. This was mainly focused on yield monitoring and grid soil sampling to better understand trends and management zones. During the mid to late 1990’s precision agriculture shifted focus towards machine control products for variable rate fertilizer placement and steering assistance, including lightbars and autosteering. The past five years have brought on another precision agriculture revolution focused on automating sections of our implements and requiring ever increasing accuracy from our GPS receivers.

This past history clearly indicates the future direction of precision agriculture products and user requirements. Automation has provided growers a tremendous benefit in enhancing field efficiency, reducing input cost, and allowing for advanced production practices that were previously unachievable. Adoption of automation systems will continue to increase as will the development and release of new automation products. At the heart of all automation systems is the GPS receiver and it will continue to play a major role in driving the future potential of new systems.

The role of GPS in improving accuracy
GPS receivers are the core component of any precision agriculture machinery system and will continue to be the limiting factor on machinery performance. Less accurate GPS receivers will lead to the poor performance of autosteering systems and disappointing results of autoswath systems for sprayers and planters. No matter how advanced the control hardware is on the tractor or implement, poor quality GPS will always limit the overall machine performance.

By receiving information from satellites, GPS receivers are able to calculate the position of the receiver on earth. Errors though are common in GPS receivers and are caused by a wide range of factors including weather, satellite orbit accuracy, and the local environment. These errors are reduced by using a GPS Correction or Differential GPS (DGPS). DGPS systems are the norm for precision agriculture products, but the source of the GPS Correction signal can still vary significantly. As the signal quality increases so does the system cost.
Current GPS correction solutions

Currently there are five types of GPS Correction solutions used in precision agriculture products:

- **Low Cost**: Low cost GPS receivers use a free correction service called WAAS which is available throughout the US. These receivers are very low cost, have a small antenna area, and are generally not very accurate. They are used exclusively for mapping broad areas for management zone delineation or for soil sampling. They can also be used for yield monitoring, but will provide reduced accuracy along the boundaries of a field where tree shading is significant.

- **Single Frequency GPS**: Single frequency GPS receivers also use the free WAAS correction service, but these receivers have significantly better antennas and more advanced electronics than low cost receivers. These receivers will typically produce ±12 inches accuracy during pass-to-pass field operations which is suitable for non-critical guidance operations including tillage, spraying, and seeding/drilling. Single frequency receivers are also the standard receiver used for variable rate fertilizer application.

- **Dual Frequency GPS**: Dual frequency GPS correction offers significant advances over single frequency correction and provides a much more stable correction signal. The dual frequency component allows the receiver to better correct for atmospheric errors and these receivers also use a high quality reference network rather than the free WAAS network. This comes at a cost as the user must pay a yearly subscription fee to access the dual frequency reference network. This fee ranges from $750 - $1500 per year and is sold through OmniSTAR (HP and XP) and John Deere (SF2). Dual frequency though will provide pass-to-pass accuracies of ±4 inches or better which is ideal for precise autosteering for planting.

- **GLONASS**: GLONASS is the Russian version of GPS and is currently operating with 17 active satellites. Many US based precision agriculture vendors are offering receivers that are both GPS and GLONASS compatible. The addition of GLONASS satellites offers several unique advantages. First, by receiving data from additional satellites, the receiver is able to calculate a more precise position. Also, a higher density of satellites in the receiver’s view makes it possible to maintain adequate accuracy when operating near large tree lines. This is difficult to accomplish with GPS only systems. Many new GPS receivers are GLONASS compatible and typically require only a software activation to get them running.

- **RTK**: RTK correction is the most accurate type of GPS correction because it utilizes a reference station located very close to the GPS receiver. RTK is not new and is often characterized as very accurate but very expensive. When using RTK the user must buy an RTK capable receiver for their tractor as well as an RTK base station. The user is also responsible for moving the base station near enough to the tractor so that they can maintain line of sight communication. While this can be costly and a management hassle, RTK is the only type of GPS correction that can provide year-to-year position stability. This enables a host of new production methods including controlled traffic, strip tillage/fertilization/planting, and extremely precise autosteering and autowidth control.
Iowa’s FREE statewide RTK network (IaRTN)

Although RTK receiver costs have come down in recent years, the investment into RTK equipment is still quite high both from a cost and complexity standpoint. If producers are operating over a multi-county area, multiple base stations are often needed. The management time needed to maintain multiple RTK base stations is often unrealistic for a single producer. To offset this challenge, RTK Networks began to form around 2004 which allowed producers to subscribe to an RTK correction service that was maintained by a secondary company or group of equipment dealers. The costs of these subscriptions are often very similar to the cost of a Dual Frequency subscription and the adoption of this service has been high around areas where it is provided. For producers not located near an RTK network provider or in an area where line-of-site to the RTK base is not possible, the Iowa Department of Transportation’s new RTK Network (IaRTN, www.iowadot.gov/rtn/index.html) is a viable competitive solution.

IaRTN is a network of 78 RTK base stations that are located throughout the state. Each of the base stations is connected to a central data server that is managed and maintained by the Iowa DOT. Access to the RTK correction data has been made available, free of charge, to any public or private entity. These base stations have been organized as a Continuously Operating Reference Station or CORS for short. Since the data server is centrally located, two-way radios can no longer be used to provide the correction signal. In CORS receivers a cell phone is required to receive the RTK correction. With the wide distribution of base stations throughout the state, this investment by the DOT has guaranteed that anywhere a cell phone signal is present RTK service is available at no charge. Since the CORS network uses cell phone service to transmit the correction signal, standard GPS receivers cannot utilize this resource. The GPS receiver must be specifically sold as a CORS enabled receiver in order to access the network. A dedicated cell phone service is typically used for CORS receivers and requires a data only plan which can range from $25 - $50 per month. Both CORS and traditional RTK Networks offer tremendous opportunities for achieving high accuracy GPS while minimizing the user cost and complexity.