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FOOD FOR THOUGHT: HOW GPS IMPROVES FARMING

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ABSTRACT

The research work examine Global Positioning System (GPS) concept in agricultural production which is becoming more attractive in managing tool that positively impacts the efficiency, productivity, and effectiveness of agricultural operations. Realizing sustainable modern development of agriculture based on Information Technology (IT) which brings agriculture into digital age. With the latest take-off of the NigeriaSat-1, an earth observing satellite for the metrological, natural resources, harzard observation and management purposes, Nigeria now join the league of nations that have access to opportunity afforded by Satellite Remote Sensing in revolutionizing their agriculture. The market for global positioning system receivers and software therefore is of significant importance and offers great opportunity for farmers in both ‘’pre’’ and ‘’post’’ farming seasoning. The study was therefore carried out to review meaning of global positioning system, highlights its component and describes how farmers can harness them for large scale agricultural production.

KEYWORDS: GPS, agriculture, technology.

INTRODUCTION

The agricultural sector uses the precision location information provided by GPS to improve agricultural mechanization and efficiency. In agriculture, efficiency refers to the ability to produce more food, feed, and fiber per unit of labour and other inputs (e.g., seeds, chemicals).

Precision agriculture, abbreviated as PA in this case study, is a concept that refers to the ability for farmers to conduct site-specific management to observe, measure, and respond more precisely to inter-and intrafield variability in crops. Before GPS was available for commercial use, farmers had few technologies that allowed them to proactively manage their fields according to the fields' spatial characteristics. GPS played an essential role in the advent and continued adoption of PA technologies and methods.

If GPS were not available for civilian use, farmers would have continued managing their operations as before, planting and harvesting as they have done historically without the benefit of automated steering or the ability to make decisions based on site-specific information. This counterfactual is not entirely speculative; many farmers today do not use GPS and still farm this way. An alternative system with less accuracy, such as eLoran, could have helped farmers take advantage of some PA technologies such as aerial spraying, coarse yield and soil mapping, or certain kinds of variable-rate technologies (e.g., applying fertilizer to more precisely meet site-specific crop needs), but without GPS these would have been less effective and provided fewer benefits. These technologies would also likely have taken longer to develop.

The proportion of farmers using PA technologies has increased steadily over the last three decades, and these technologies are now used on the majority of Nigeria, farmland. In the event of a 30-day failure of GPS today, there would be a significant planting delay and adverse impact on yields for many farmers, especially the large, mechanized farmers that have fully embraced PA. Many tractors, combines, and other equipment have GPS technologies integrated into their systems. These farmers would face a steep learning curve and significant efficiency losses trying to either retrofit or operate this equipment without GPS, or they would return to earlier ways of applying inputs.

The impacts would be highly dependent on the time of year, with the largest impacts expected during planting seasons. We estimate that in a worst case scenario the economic loss would run into several billion of Naira if it occurred during the planting season.

Man operating farm equipment Precision agriculture is now changing the way farmers and agribusinesses view the land from which they reap their profits. Precision agriculture is about collecting timely geospatial information on soil-plant-animal requirements and prescribing and applying site-specific treatments to increase agricultural production and protect the environment. Where farmers may have once treated their fields uniformly, they are now seeing benefits from micromanaging their fields. Precision agriculture is gaining in popularity largely due to the introduction of high technology tools into the agricultural community that are more accurate, cost effective, and user friendly. Many of the new innovations rely on the integration of on-board computers, data collection sensors, and GPS time and position reference systems.

Many believe that the benefits of precision agriculture can only be realized on large farms with huge capital investments and experience with information technologies. Such is not the case. There are inexpensive and easy-to-use methods and techniques that can be developed for use by all farmers. Through the use of GPS, GIS, and remote sensing, information needed for improving land and water use can be collected. Farmers can achieve additional benefits by combining better utilization of fertilizers and other soil amendments, determining the economic threshold for treating pest and weed infestations, and protecting the natural resources for future use. Farmers and agriculture service providers can expect even further improvements as GPS continues to modernize.

How Does the GPS System Work

Precisely locating positions on Earth is not a new phenomenon. Navigators, sailors, explorers, and surveyors have done this for centuries as they traveled about the world. Most maps and globes display longitude and latitude or some other coordinate projection information. Points on Earth are given unique addresses on maps using specific coordinate systems. Agriculturists commonly use either a geographic system of latitude and longitude measured in degrees or a Universal Transverse Mercator coordinate system that locates positions in meters measured from a specific point. The GPS system uses measured distances to the precisely located GPS satellites to locate positions on Earth. Radio receivers in GPS units monitor radio signals broadcast from the GPS satellites. A GPS position is determined by simultaneously measuring the distance to at least three satellites. The distance to a satellite is measured by the time it takes a radio signal to travel from the satellite to the GPS receiver. Computers in GPS units use information from the radio signals, including broadcast time and unique satellite information, to calculate positions. Information from at least four satellites is needed to calculate elevation. Signal reception from more satellites increases position accuracy. The global positioning system includes a constellation of 24 systematically arranged satellites orbiting Earth in six orbital planes with four satellites in each plane. The satellite orbits are approximately 12,500 miles above Earth. The constellation is arranged to guarantee radio reception from at least four satellites from any location anytime, anywhere on

Earth (Figure 1). GPS receivers normally receive signals from eight to nine satellites in location without obstructions such as buildings or trees.

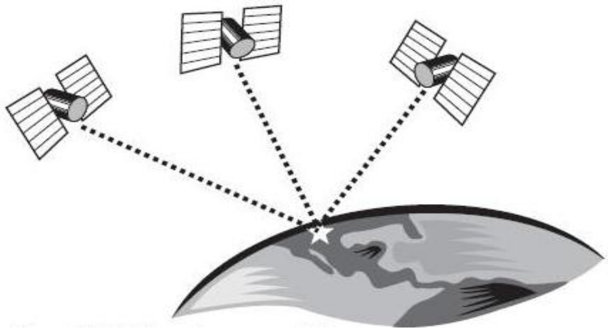

Figure 1: Satellite system representation

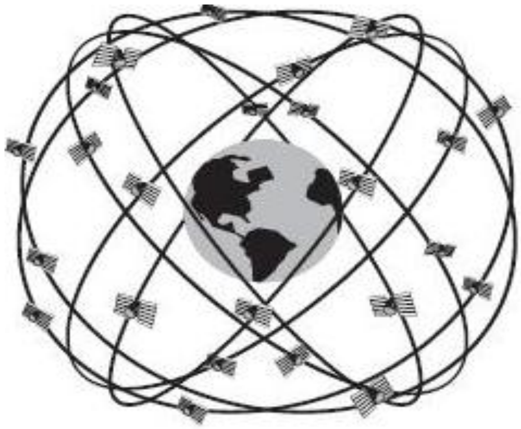

Figure 2. Satellite constellation and Orbital plane

Potential application of GPS in Farming

GPA-assisted PA technologies allow farmers to manage inputs such as seeds, agrochemicals, and fuel more efficiently, increase yields, and reduce farmworker fatigue and errors. The three most common categories of these technologies are yield and soil mapping, machinery guidance and control systems, and variable-rate technologies.

GPS-assisted machinery guidance and control systems; automatically steer farm equipment in a predetermined path to help farmers reduce overlaps or skips or have built-in input control valves to avoid applying inputs where they are not needed (e.g., headlands). Aerial spraying, or crop dusting, is another GPS-assisted technology that has transformed the way that agrochemicals are applied to agricultural fields.

GPS-assisted yield and soil mapping; quantifies and maps information pertaining to yield and/or soil variability throughout a field. Farmers can use this information along with other farm-specific information (e.g., soil, climate, pests) to diagnose issues within the field and respond proactively.

Yield Monitoring Systems; Yield monitoring systems typically utilize a mass flow sensor for continuous measuring of the harvested weight of the crop. The sensor is normally located at the top of the clean grain elevator. As the grain is conveyed into the grain tank, it strikes the sensor and the amount of force applied to the sensor represents the recorded yield. While this is happening, the grain is being tested for moisture to adjust the yield value accordingly. At the same time, a sensor is detecting header position to determine whether yield data should be recorded. Header width is normally entered manually into the monitor and a GPS, radar, or a wheel rotation sensor is used to determine travel speed. The data is displayed on a monitor located in the combine cab and stored on a computer card for transfer to an office computer for analysis. Yield monitors require regular calibration to account for varying conditions, crops, and test weights.

GPS Assisted Variable Technologies; in The Global Positioning System (GPS) provides opportunities for agricultural producers to manage their land and crop production more precisely. Common names for general GPS applications in farming and ranching include precision agriculture, site-specific farming, and prescription farming. GPS applications in farming include guidance of equipment such as sprayers, fertilizer applicators, and tillage implements to reduce excess overlap and skips. They can also be used to precisely locate soil-sampling sites, to map weed, disease, and insect infestations in fields, and to apply variable rate crop inputs and, in conjunction with yield monitors, record crop yields in fields.

Equipment Guidance Systems; Lightbar-guided and automated steering systems help maintain precise swath-to-swath widths. Guidance systems identify an imaginary A-B starting line, curve or circle for parallel swathing using GPS positions and a control module. The module takes into account the swath width of the implement and then uses GPS to guide machines along parallel, curved, or circular evenly spaced swaths. Guidance systems include a display module that uses audible tones or lights as directional indicators for the operator. The guidance system allows the operator to monitor the lightbar to maintain the desired distance from the previous swath. Guidance systems require two principle components: a lightbar or screen, which is essentially an electronic display showing a machine's deviation from the intended position, and a GPS receiver for locating the position (Figure 3). This receiver must be designed for this purpose and it must operate at a higher frequency (position calculations are usually 5 to 10 times per second) than a GPS receiver designed to record positions for a yield monitor. GPS receivers designed for guidance can be used in conjunction with a yield monitor or for other positioning equipment. Automated steering systems integrate GPS guidance capabilities into the vehicle steering system. Automated steering frees the operator from steering the equipment except at corners and at the ends of fields.

FIGURE 3: GPS and Agriculture

Field Mapping with GPS and GIS; GPS technology is used to locate and map regions of fields, such as high weed, disease, and pest infestations. Rocks, potholes, power lines, tree rows, broken drain tile, poorly drained regions, and other landmarks can also be recorded for future reference. GPS is used to locate and map soil-sampling locations, allowing growers to develop contour maps showing fertility variations throughout fields. The various datasets are added as map layers in geographic information system (GIS) computer programs. GIS programs are used to analyze and correlate information between GIS layers.

Precision Crop Input Application; GPS technology is used to vary crop inputs throughout a field based on GIS maps or real-time sensing of crop conditions. Variable rate technology requires a GPS receiver, a computer controller, and a regulated drive mechanism mounted on the applicator. Crop input equipment, such as planters or chemical applicators, can be equipped to vary one or several products simultaneously.

Variable rate technology is used to vary fertilizer, seed, herbicide, fungicide, and insecticide rates and for adjusting irrigation applications.

GPS Errors

The quality of GPS units and operational errors associated with the GPS system determine the accuracy of GPS-located positions. There are several sources of GPS errors. GPS radio signals can "bounce off" objects such as buildings and trees prior to acquisition by the GPS receiver, resulting in lower accuracy. This is called multipath error. (Figure 4). The satellites use very accurate atomic clocks to generate the timing data received by the GPS receivers. However, even small errors in timing from clocks in the satellites and GPS units cause errors in GPS positions. Signal delay errors can be caused by atmospheric interference such as electrically charged particles in the ionosphere. A layer of water vapor located below the troposphere can also alter the speed of travel of radio signals. Errors from GPS satellites' orbit and location are also significant. Pressures from solar radiation and gravitational forces of the sun and moon can alter satellite locations. GPS receiver quality also affects GPS accuracy. More costly GPS units generally provide more accurate GPS positions than less expensive units.

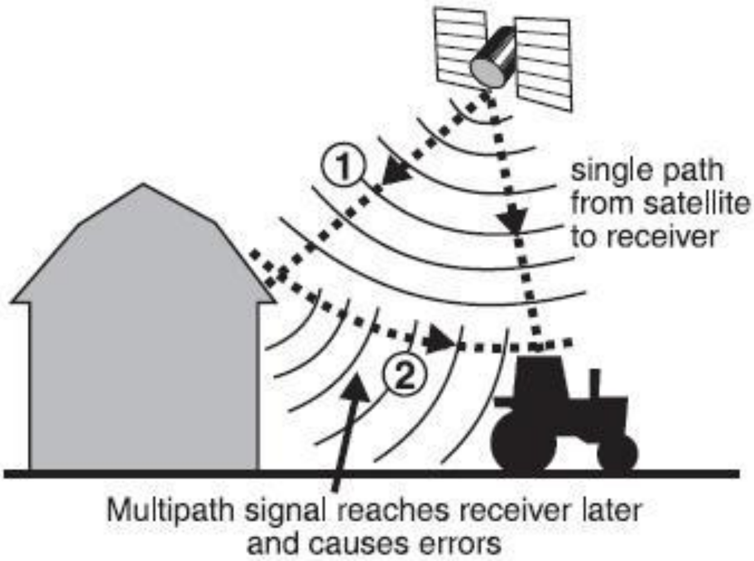

Figure 4. Multipath signal errors.

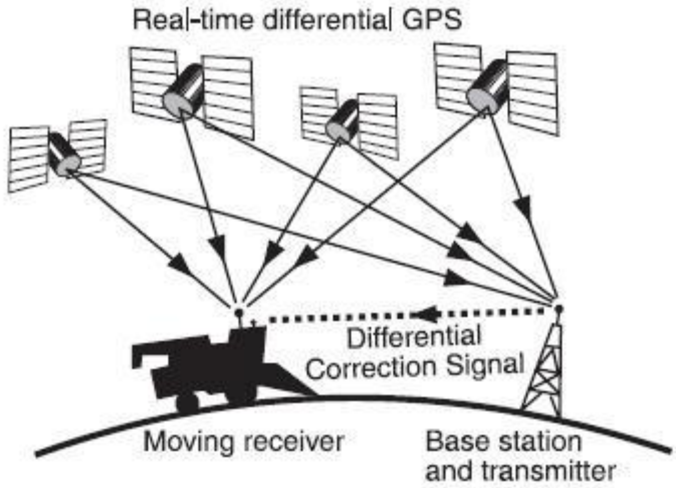

Figure 5. Base station DGPS representation.

CONCLUSION

Global positioning system has revolutionized positioning concepts, though it started primarily as a navigation system for the military. Today the global positioning system (GPS) has become an international utility. In addition to its ease of use, and worldwide all weather operation, GPS owes its popularity to the dependable high accuracy with which positions, time and direction can be determined. As a tool of precision agriculture, GPS satellites broadcast signals that allow GPS receivers to calculate their position. This information is provided in real time, meaning that continuous position information is provided while in motion. Having precise location information at any time allows crops, soils and water measurements to be mapped. GPS receivers, either carried to the field or mounted on implements allow users to return to specific locations to sample or treat those areas.

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