Benefits of Precision Agriculture in Nigeria

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This study was carried out in National Centre for Agricultural Mechanization (NCAM) situated at Ifelodun Local Government Area (LGA) of Kwara State, Nigeria. The research work examines Precision Agriculture concept in agricultural production which is becoming an attractive idea in managing natural resources and realizing modern sustainable development of agriculture based on information technology (IT). It includes technologies such as Geographic Information System (GIS), Satellite Remote Sensing and Global Positioning System (GPS). And it also brings agriculture into digital age. With the latest take-off of the NigeriaSat-1, an earth observing satellite for the meteorological, natural resources, hazard observation and management purposes, Nigeria now joins the league of nations that have access to the opportunities afforded by Satellite Remote Sensing in revolutionizing their agriculture. The market for precision farming therefore is of significant economic importance and offers great opportunities for local farmers in both "pre" and "post" farming seasons. The study was therefore carried out to review the meaning of precision agriculture, highlights its components and describes how Nigerian farmers can harness them for large scale agricultural production.

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I. INTRODUCTION

The National Centre for Agricultural Mechanization was established, formally by the Decree No. 35 of 1990 with the mandate to accelerate the positive transformation of the agricultural sector of the Nigerian economy in order to increase the quality and quantity of agricultural products. This mandate is being achieved through adoptive and innovative research and development activities which include:

i. To encourage and engage in adaptive and innovative research towards the development of indigenous machine for farming and processing techniques;
ii. To design and develop simple and low-cost equipment which can be manufactured with local materials, skill and facilities;
iii. To standardize and certify in collaboration with the Standards Organization of Nigeria (SON), agricultural machines, equipment and engineering practices in use in Nigeria;
iv. To bring into focus mechanical technologies and equipment developed by various institutions, agencies or bodies and evaluate their suitability for adoption;
v. To disseminate information on methods and programmes for achieving speedy agricultural mechanization;
vi. To provide training facilities by organizing courses and seminars specially designed to ensure sufficiently trained manpower for appropriate mechanization;
vii. To promote co-operation in agricultural mechanization with similar institutions in Nigeria, and with international bodies connected with agricultural mechanization.

A very critical mandate of NCAM is to ensure the availability of sufficiently trained manpower for

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appropriate mechanization of Nigeria's agriculture. This has made the Centre to establish an Agro-metrological unit of National Centre for Agricultural Mechanization (NCAM) related to major technologies of Precision Agriculture in which an agricultural mechanization method which depends strongly on electronics, ITs and communications, and also requires technical skill and manpower for plant and animal production respectively.

The way manufacturing has changed completely in the last two centuries, farming has also changed. The classic picture of the farmer one of bucolic simplicity is wildly out of date. Technology, cost and economies of scale have driven commercial farmers around the world to change, and precision farming is beginning to gain popularity (Doug et al, 2003).

Precision agriculture is an agricultural mechanization method which depends strongly on electronics, ITs and communications, and also requires technical skill and manpower for plant and animal production that are site-specific and animal-specific respectively (Asoegwu, 2007). 1990 assessments indicated that 82 million hectares out of Nigeria's total land area of about 91 million hectares were arable, however only about 34 million hectares were being cultivated on a small scale. Big scale and export (or revenue generation) oriented agriculture have suffered countless setback in recent times. With the renew quest of the Federal and some State governments into the development of large scale agriculture and mechanized farming in order to shore up food security and foreign exchange earnings, there is need for adoption of uses of technologies of Precision Agriculture, which offer a wide range of applications in order to effectively harness human, natural and man-made resources for sustainable agricultural production and improved crop yields in Nigeria (T'Miebaka, 2004).

Along with GIS, Remote Sensing and GPS, which are major technologies of precision Agriculture, there have appeared a wide range of sensors, monitors and controllers for agricultural equipment such as shaft monitors, pressure transducers and servomotors. Together they will enable commercial farmers in Nigeria to use electronic guidance aids to direct equipment movements such as combine harvester more accurately, provide precise positioning of all equipment actions and chemical applications and analyse all of that data in association with other sources of data (agronomic, climatic, etc), this add up to a new and powerful toolbox of management tools for the progressive farm manager.

Therefore, this study was carried out to review the meaning of precision agriculture, highlights its components and describes how Nigeria farmers can harness them for large scale agricultural production.

II. WHAT IS PRECISION AGRICULTURE?

Gary (2004) defined Precision Agriculture as a comprehensive system designed to optimize agricultural production through the application of crop information, advanced technology and management practices. Precision agriculture requires integration of three elements: (1) positioning capabilities (currently, global positioning system or GPS) to know where equipment is located; (2) real-time mechanisms for controlling nutrient, pesticide, seed, water or other crop production inputs; and (3) databases or sensors that provide information needed to develop input response to site-specific conditions (Karlen et al, 1998). Intensive soil investigation is carried out using the global positioning system (GPS) consisting of 24 satellites that transmits signals picked up by the user receivers. The use of GPS allows soil sample sites to be accurately located within a field and fertility levels mapped. This technology also allows yield samples to be taken from accurately located positions and then compared to soil test results. Using this technology, producers can pinpoint locations of significant soil variability for example, in terms of fertility level. Fertilizer applicators can then be used to apply fertilizers at variable rates using the technology characteristics of the soil at different locations, these data are plotted unto maps corresponding to each location for application of farm inputs such as fertilizer, pesticide and water of remote sensing according to variations in fertility levels. The combination of variable fertilizer applications and yield monitoring can lead to better understanding of variability within a field. The objective would be to reduce that variability, thus increasing yields.

Precision agriculture also involves the determination of physical, chemical and biological components within fields in ways that optimizes farm returns and minimizes chemical and environmental hazards (T'Miebaka, 2004).

III. GOAL AND OBJECTIVES OF PRECISION AGRICULTURE

The goal of precision farming is to gather and analyse information about the variability of soil and crop conditions in order to maximize the efficiency of crop inputs within small areas of the farm field. To meet this efficiency goal, the variability within the field must be controllable. Efficiency in the use of crop inputs means that fewer crop inputs such as fertilizer and chemicals will be used and placed where needed. The benefits from this efficiency will be both economic and environmental. Environmental costs are difficult to quantify in monetary terms. The reduction of soil and groundwater pollution from farming activities has a desirable benefit to the farmer and to society (Gary, 2004).

IV. HOW DOES A FARMER GET STARTED IN PRECISION AGRICULTURE?

In order for a farmer to get started, he has to understand the three key elements on which precision agriculture rely i.e. Information, Technology and Management.

Information is perhaps the modern farmer's most valuable resource. Timely and accurate information is essential in all phases of production from planning through post-harvest (Gary, 2004). Information available to the farmer includes crop characteristics, soil properties, fertility requirements, weed populations, insect populations, plant growth response, harvest data, and post-harvest processing data. The precision farmer must seek out and use the information available at each step in the system.

Modern technology in agriculture is the second key to success in Precision Agriculture. Technology is rapidly evolving and the farmer must keep up with the changes that may be of benefit in his or her operation. The personal computer is one example of such technology. The computer can help the farmer organise and manage data more effectively. Computer software, including spreadsheets, databases, geographic information systems (GIS) and other types of application software are readily available. The global positioning system (GPS) has given the farmer the means to locate position in the field to within a few feet. Sensors are available that can monitor soil properties, crop condition, harvesting, or post-harvest processing and give instant results or feedback which can be used to adjust or control the operation.

Management, the third key to success, combines the information obtained and the available technology into a comprehensive system. Without the proper management, precision crop production would not be effective. Farmers must know how to interpret the information available, how to utilize the technology, and how to make sound production decisions.

V. PRECISION AGRICULTURE: KEY TECHNOLOGIES & CONCEPTS REQUIRED

The tools required for effective Practicing Agriculture include:

i. Yield Monitors: These are crop yield measuring devices installed on harvesting equipment. They have the capability of indicating yield (kg/ha), total kg, ha/hour, hectare worked, grain moisture content, etc. They provide information on crop yield at regular intervals by time or distance (e. g.

every second or every few metre). The yield data from the monitor is recorded and stored at regular intervals along with positional data received from the GPS unit. GIS software takes the yield data and produces the yield maps.

ii. Global Positioning System (GPS): GPS is a network of 24 satellites orbiting the earth which transmit precise satellite time and location information to ground receivers. It is used to pinpoint the location (geo-reference) of yield data collected, and provide accuracy of one to three meters.

iii. The ground receiving units are able to receive this location information from several satellites at a time for use in calculating a triangulation fix thus determining the exact location of the receiver. This is used to produce yield maps for each field.

iv. Geographical Information System (GIS): this consist of a computer software database system used to input, store, retrieve, analyse and display, in map-like form, spatially referenced geographical information such as data from GPS and Yield Monitors.

v. Variable Rate Technology (VRT): This consists of farm field equipment such sprayer and planter with the ability to precisely control the rate of application of crop inputs and tillage operations. For example, a fertilizer applicator with VRT provide a means of assuring that fertilizer applications are made only in amounts and locations where they are needed. The basic logic of VRT fertilizer application is to optimise application of fertilizer in areas of high productivity and increase fertilizer application to area of low productivity.

vi. Remote Sensors: This equipment produces image data from the soil and crops and this data is processed and then added to the GIS database.

vii. Computer Hardware and Software: Computer support is required to analyse the data collected by yield monitors and GPS, this will be supplied in readable formats such as maps, graphs, charts or reports.

5.1 Method of approach

To practise precision agriculture, farmers must select and use the necessary equipment and technology. By selecting equipment capable of high accuracy application, the farmer has achieved the first step in implementing precision agriculture. The same is true in planting, tillage, harvesting and post-harvest equipment decisions. With this background in mind, comprehensive precision agriculture system can be viewed in two phases: Site specific management and Postharvest process control.

Site specific management is the field phase of the production system. Once the necessary equipment and technology are in place, the farmer can decide to continue to manage the fields by a site specific approach. In site specific management, the field is broken down into smaller grids and decisions are based on the requirements of each grid. GPS/GIS technology and variable rate equipment are used to apply inputs based on the grid requirements. By treating each grid according to its prescription, over application of chemicals and seed are avoided on areas where it will do no good. Areas that require the higher rates can still receive them.

Post harvesting processing is the second phase of the comprehensive approach. By using sensors to monitor the postharvest process, computers can be used to enhance the quality of the product or reduce energy requirements. The best quality product can then be delivered to the consumers.

IV. BENEFITS OF PRECISION AGRICULTURE

Through precision agriculture an area of land within a field may be managed with different levels of input depending upon the yield potential of the crop in that particular area of land. Earl et al (1996) states that the benefits of precision farming are in two folds: (i) the cost of producing the crop in an area of land can be reduced (ii) the risk of environmental pollution from agrochemicals applied at levels greater than those required by the crop can be reduced.

Precision agriculture is of immense benefits to farmers in the following ways:

1. Efficient use of equipment

Information on soil characteristics and weather can be used to plan and improve scheduling of operations, which can increase machinery utilization rates and lower per- acre costs. Also, GPS- based guidance systems can allow farm machinery operators to achieve greater field efficiency under difficult conditions. They can reduce overlap and missed applications of inputs (e.g. spraying), helping fatigued operators maintain higher field efficiency.

2. Risk reduction

At the field level, precision farming provides site-specific management that can point out problems with growing conditions, thereby reducing variability in net returns. At the farm level, precision farming information can be used to improve variety choice, crop rotation, and other agronomic practices that reduce risk. As well, information on crop growth during the season can help you make more informed market decisions.

3. Management of differentiated products

In the future, precision technology may help farmers differentiate their production within a particular field. For example, you might segregate higher protein wheat for marketing in more rewarding channels. In addition, precision farming technology will allow the additional control that is required when you are managing the production of differentiated products as opposed to the production of regular bulk crops. It will allow documentation of crops conditions and control of inputs to meet the very specific requirements of these crops.

4. Environmental stewardship

Precision application of chemical and fertilizer will better match crop requirements, and will prevent over-application, which can be non-beneficial to the environment. The management practices generated by precision farming technologies will promote good land stewardship.

VII. CONCLUSION

As growers adopt precision agriculture, new technologies will continue to emerge. The next big advancement will be the use of artificial intelligence. While AI will never be able to replicate the kind of complex decisions farmers are required to make on regular basis, it could very well be used to help make those decisions easier.

Today’s farmers have access to a wealth of data. So much data, in fact, they often don’t know what to do with it. AI has the capability of analyzing huge amounts of data in a short period and using it to suggest the best course of action. This information could then be used to predict the best time to plant, to predict the outbreaks of pests and disease before they occur, and to offer in-field inventory management that could offer yield predictions prior to harvest.

I hope this provides some insight into precision agriculture today and the continued important role it will play in the future. Expect industry and technology companies to continue to explore the possibilities posed by the marriage of technology with the needs of the ag producers to produce enough food to feed the world’s projected 9 billion people by 2050.

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