



**PROSPECTS OF PRECISION AGRICULTURE FOR EFFECTIVE COCOA
PRODUCTION IN DEVELOPING COUNTRIES (A GLOBAL REVIEW)**

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ABSTRACT

Precision Agriculture (PA) is a new idea in agricultural production which is enhancing a stimulating concept controlling natural resources and noticing modern ecological farming-based data processing. It is bringing agriculture into the technological and computer age. It comprises innovations such as Geographic Information System (GIS), Satellite Remote Sensing and Global Positioning System (GPS). For instance, with the current establishment of the NigeriaSat- 1, an earth remote sensing satellite for the meteorological, mineral deposit, danger observation and administration motives, Nigeria now connects the association of countries that have approach to the chances provided by Satellite Remote Sensing in transforming their agriculture. This paper aims to describe precision agriculture, emphasizes its characteristics and explains how cocoa farmers can utilize them for commercial production. Past reviews revealed that the extent of operation of precision agriculture for effective cocoa production in developing countries is low which has led to the necessity to train cocoa farmers on the benefits to be derived in using precision agriculture. This paper concludes that the introduction of precision farming into the agricultural sector of developing countries will be of immense benefits in making efficient use of equipment for cocoa production and reducing the risks involved in farm management which will result to more cocoa yield and cocoa farmers will have more profit returns. This paper recommends the need to educate and encourage cocoa farmers on the use of labour relieving technologies such as mechanization to reduce excessive spending on labour and to improve the quality and quantity of cocoa products.

Keywords: Agriculture, Cocoa, Developing, Farmers and Precision

INTRODUCTION

Production sector or industry has modified radically in the past couple of centuries, agriculture has also transformed. Expenses, technology and production efficiencies have propelled large scale cocoa farmers around the world to diversify and precision farming has started to acquire reputation (Kolady *et al.*, 2021). Precision agriculture is a mechanized farming that count fully on electronics, ITs and communications, and also requires technical competence and labour-force for plant and animal production that are location-specific and animal-specific respectively (Gawande *et al.*, 2023). Commercial production and foreign trade (or income production) of cocoa production have tolerated great problems recently (Afolayan, 2020). But due to the recent exploration of some developing countries to the growth of commercial cocoa production and extensive agriculture so as to support food security and export earnings, there is need to embrace the uses of technologies of Precision Agriculture, which provide comprehensive applications so as to productively utilize human, natural and man-made resources for sustainable cocoa production and boost cocoa output in developing countries (Adepoju *et al.*, 2022).

Together with the use of GIS, Remote Sensing and GPS, which are the major technologies of Precision Agriculture, there are a variety of sensors, monitors and controllers for farming



equipment such as shaft monitors, pressure transducers and servomotors (Hafezalkotob *et al.*, 2018). All these will allow cocoa (commercial) farmers in the developing countries to use technology devices to control implement motions such as combine harvester more precisely, provide accurate location of all implement actions and chemical applications and analyse all the data together with other sources of data (agronomic, climatic etc.), this match up to a modern and important equipment of supervisory devices for the modern cocoa farmers (Pinardi *et al.*, 2023).

Some cocoa (commercial) farmers in developing countries do not have the potential to operate mechanized farming and lack the major technologies of precision agriculture for effective cocoa production which has resulted to low yield and low profit returns. To ensure effective and efficient of large scale cocoa production, there is need to operate precision agriculture. Therefore, this research work aims to explain the meaning of precision agriculture, identify its benefits and describes how cocoa farmers can utilize them for commercial production.

What is Precision Agriculture?

Precision agriculture is a new aspect of farming practice (Raj *et al.*, 2022). It is a welcome technology in managing and controlling all our resources to achieve establishment of agriculture based on computer technology (Shaikh *et al.*, 2022). Precision agriculture or farming can as well be “site- specific agriculture or spatially- variable crop production. It involves creating farming into the knowledge of computer age. This includes technologies like geographic information system (GIS), satellite remote sensing and global positioning system (GPS) in farming practices (Shafi *et al.*, 2019).

Precision agriculture aims at the implementation of technologies and assumptions to recognize, examine and direct spatial and temporal variability connected with all areas of farming production across all areas of land for maximum profitability, sustainability, improving crop performance, preserving land resources and safe guarding the environment (Junior *et al.*, 2024). Precision agriculture is greener and it is comprehensive approach that conceals a wide variety of themes like, identifying changes in soil resources, soil tillage, irrigation, crop rotation, machinery execution, plant hereditary, chemical, physical and biological farm inputs (Shaheb *et al.*, 2022). The concept of precision agriculture is to improve the farming production system by disclosure and merging of many technologies to increase profit and decrease ecological hazards (Shaikh *et al.*, 2022).

Precision agriculture involves combination of three components: (1) positioning abilities (currently, global positioning system or GPS) to know where machinery is located; (2) synchronized devices for administering nutrient, pesticide, seed, water or other crop production inputs; and (3) databases or sensors that provide information needed to expand input acknowledgement to location-specific conditions (Sishodia *et al.*, 2020). Thorough soil inspection is done using the global positioning system (GPS) consisting of 24 satellites that transfer signals taken by the user recipients. The use of GPS allows soil sample locations to be precisely situated in an area and fertility levels surveyed. Using this technology, producers can spot sites of notable soil variation for example, in terms of fertility level. Fertilizer applicators can then be used to apply fertilizers at variable rates using the technology features of the soil at different sites, these data are arranged into surveys equivalent to each site for the utilization of farm inputs such as fertilizer, pesticide and water of remote sensing according to changes in fertility levels. The objective would be to reduce that variations, thus boosting outputs.



MATERIALS AND METHODS

Technological tools required in Precision Agriculture

The tools needed for efficient practice of Precision Agriculture include:

- i. **Yield Monitors:** These are crop yield calculating implements fixed on harvesting equipment. They have the ability of specifying yield (kg/ha), total kg, ha/hour, hectare worked, grain moisture content etc. They supply details on crop yield at systematic gaps by time or distance (for example every seconds or every few metres).
- ii. **Global Positioning System (GPS):** GPS is an interconnection of 24 satellites circling the earth which transfer accurate satellite time and site information to land recipients. It is used to spot the site (geo-reference) of yield data collected, and provide preciseness of one to three meters.
- iii. **Geographical Information System (GIS):** This consist of a computer application record system used to input, keep, recover, inspect and present, in survey-like form, dimensionally cited geographical information such as data from GPS and Yield Monitors.
- iv. **Variable Rate Technology (VRT):** This consists of farmland tools such as sprayer and planter with the capability to accurately direct the rate of use of crop inputs and tillage operations. For example, a fertilizer applicator with VRT provide a means of satisfying that fertilizer applications are made only in amounts and sites where they are needed. The basic logic of VRT fertilizer application is to maximize the application of fertilizer in areas of high productivity and increase fertilizer application to area of low productivity.
- v. **Remote Sensors:** This tool generates graphic-data from the soil and crops and this data is prepared and then added to the GIS database.
- vi. **Computer Hardware and Software:** Computer support is required to examine the data collected by yield monitors and GPS, this will be provided in readable patterns such as maps, graphs, charts or reports.

How does a Cocoa farmer commence the operation of Precision Agriculture?

For a cocoa farmer that intended to commence precision agriculture, he has to recognize the three crucial components on which precision agriculture depend on i.e. Information, Technology and Management.

- a) Information is feasibly the current cocoa farmer's most precious asset. Prompt and precise information is important in all stages of cocoa production from planning through post-harvest (Xie *et al.*, 2023). Information obtainable to the cocoa farmer includes crop features, soil components, productivity conditions, weed culture, insect communities, plant growth reaction, data capturing, and post-harvest processing data. The precision farmer must find out and apply the information available at each step in the process.
- b) Current technology in farming is the second key to favourable outcome in Precision Agriculture. Technology is speedily developing and the cocoa farmer must persist with the adaptations that may be of advantage in his or her operation. The personal computer is one example of such technology. The computer can help the cocoa farmer to arrange and control data more efficiently. Computer software, including worksheets, databank, geographic information systems (GIS) and other types of application software are easily accessible.
- c) Management, the third key to favourable outcome, combines the information obtained and the available technology into an encompassing structure. Without the right management, precision cocoa production would not be effective. Cocoa farmers must know how to translate the information available, how to use the technology and how to make solid production decisions.



Benefits of Precision Agriculture for Cocoa Production

With the operation of precision agriculture, a plot of land in a field for cocoa production may be controlled with distinct degrees of input depending upon the yield prospective of cocoa in that specific plot of land. Abobatta (2021) states that the benefits of precision farming are in two pairs:

- (i) the expenses on production in a plot of land can be lessened; and
- (ii) the danger of environmental contamination from agrochemicals applied at degrees greater than those required by the crop can be decreased.

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

- a) *Efficient use of equipment*: Information on soil features and atmospheric conditions can be used to organize and upgrade arrangement of operations, which can expand machinery usage rates and reduce per- acre costs. Also, GPS-based instruction structure can permit farm machinery operators to attain greater field efficiency under strenuous conditions.
- b) *Risk reduction*: At the field level, precision farming provides location-specific management that can identify difficulties with thriving conditions, thereby reducing changes in net gains. At the farm level, precision farming information can be used to enhance variety choice, crop rotation, and other agronomic practices that reduce threat. As well, information on crop growth during season period can help to make more knowledgeable market decisions.
- c) *Management of differentiated products*: In the future, precision technology may help cocoa farmers to distinguish their production in a specific area. For example, a cocoa farmer might separate the best cocoa beans size and good colour that is radiant enough for marketing in more rewarding channels. Also, precision farming technology will permit the extra power that is required when controlling the production of separated products as against the production of regular bulk crops.
- d) *Environmental stewardship*: Precision application of chemical and fertilizer will be equivalent to cocoa crop requirements, and will prevent over-application, which can be useless to the environment. The management practices generated by precision farming technologies will encourage good land stewardship.

CONCLUSION AND RECOMMENDATIONS

Precision agriculture will permit the selection of farm inputs to specific plots of land, thereby making farm inputs to be efficiently used for cocoa production. Depletion of the inputs will also be avoided thereby leading to reduction of farm expenses and prevention of environmental contamination. Generally, there will be increase in cocoa outputs and cocoa farmers will have more revenue returns. The initiation of precision farming into the agricultural sector of developing countries will be of huge benefits in making efficient use of equipment for cocoa production and reducing the risks involved in farm management.

Nigeria has been established into the cycle of Space Technology and Remote Sensing, it is now essential for the nation to cycle along with the global developments of the technology and make the utmost use of the benefits it provides to change its agriculture from primitive stage to global technological rich stage of precision farming. Based on review findings, the paper therefore recommends:

- i) The need to educate and encourage cocoa farmers on the use of labour relieving technologies such as mechanization and combine harvester as these could be alternative methods to reduce



excessive spending on labour, drudgery and to enhance the standard and abundance of cocoa commodities.

- ii) The need to spread details on procedures and schemes for attaining rapid agricultural mechanization.
- iii) The need to prepare training facilities by arranging courses and seminars purposely planned to assure competently trained manpower for suitable mechanization.

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