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The Development of a Mobile Application Using Google Maps and GPS for Farm Enumeration

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Abstract:- Providing adequate and robust data about persistence farmers for planning and policy execution has always been a problem in Nigeria. Applying paper-based system with trained enumerators to collect this data have proved ineffective over the years. There are efforts on automation of the enumeration, however, a mobile application that is based on Global Positioning System (GPS) and Google Maps for mapping the farm coordinates in addition to the automated enumeration process that is to capture information about farmers and their cultivated crops is the focus of this research The research project therefore is centered on developing mobile application for the enumeration of persistence farmers in designated farm centers. Our proposed system works on both Android and IOS platforms to capture the necessary information about farmers. The app captures farmer details which include; the biodata and other identity documents. The most defining part is the farm mapping; this system links real farmers with their farmlands using Global positioning system (GPS) for an accurate measurement of farm size in m^2 and acres; it also gives the exact location of your farm on Google maps. The system offers web services to manage the enumerated famers and to perform other related operations. The accurate enumeration of farmers is the first step in solving the incessant security challenges bedeviling persistence agriculture in Nigeria and bringing down the price of the entire value chain of staple food.

Keywords:- *DSS, GPS, Google Map, Mobile App, Farm Enumeration.*

I. INTRODUCTION

The world population is anticipated to rise to over 9 billion in the year 2050 which is about 34% higher than it is today. In the same regard the world food production will have to increase by 70% on today's scale so as to meet up with the population (UN, 2022). The above expectations, combined with considerable pressure on margins, calls for maximizing efficiencies as a priority for large scale production which can only be achieved through proper data acquisition and management by the relevant stake holders in the agricultural value chains especially the government. Given currently-projected growth, however, sub-Saharan Africa will need to more than triple its crop production by 2050 to provide adequate food per capita (FAO, 2009).

According to the World Bank report, three out of four people in developing countries live in rural areas and earn as less as $2 a day (Peer, 2023). These people live largely on subsistence farming whose contribution adds up to the growth of the agriculture sector. Agriculture practiced either in a small or big scale have been identified as the mainstay of most nations of the world especially the developing countries (Ogubdari & Awokuse, 2016). The entire value chain is an industry that provides employment, revenue generation for individual and states and well as contributing to the food and health security of the populace.

Smallholder farming structures are very diverse and make a contribution appreciably to global agricultural output. Their aggregate food production results into the majority contribution of the developing nation's overall food supply (FAO, 2009). They produce 70 percentage of Africa's exact deliver and an envisioned 80 percent of the food in Asia and Sub-Sahara-Africa collectively (Dan-Azumi, 2011).

In the postmodern world, data are an inevitable tool in planning. Accurate information is a fundamental component of today's decision-making processes and this can only be achieved through proper data gathering (Tiwari, 2023). From economics to humanities, data play an inestimable role in planning development and helps in policy formulation by any government. If data gathering has made serious advancement in fields like information technology, healthcare, education and even sports, there is an obvious need for it in the agricultural industries.

Nigeria has been battling with insecurity issues that has also affected the persistence farming especially that of insurgency, farmer-herder crises, kidnapping and armed banditry activities. Food insecurity is worsened by national insecurity as a result of protracted armed conflicts involving sundry groups, especially the Boko Haram group and Fulani herders (Nwozor et al., 2019). The activities of these groups in terms of invasion and sacking of farming communities have resulted in many civilian fatalities, thus creating acute insecurity. The state of insecurity in many of these farming communities has made it practically difficult for farmers to continue to engage in agricultural production optimally, thus affecting productivity and causing market disruptions with attendant food price shocks (Fadare et al., 2019). Many other crises involving land identifications that has not only affected the production value chain, it also affected the

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Government and donor agencies in planning and execution of policies (Madumere et al., 2020). For instance, the Central Bank of Nigeria (CBN) as part of the implementation of the Government's Agriculture policy and in line with its development function established the Anchor Borrowers Programme (ABP) in the year 2015. The programme thrust of the ABP is provision of farm inputs in kind and cash (for farm labour) to small holder farmers to boost production of these commodities, stabilize inputs supply to agro processors and address the country's negative balance of payments on food (CBN, 2020).

In order to achieve this laudable programme, land allocation have to be properly captured. Farmers' enumeration was expected to be conducted with specific information about each of them, ranging from the size of the farm and how much can be used to expand their Agric businesses. The enumeration exercise if properly carried out can be used to encourage farmers to produce specific crops in commercial quantities which the government can off take and supply to all crop processing mills to process it at affordable prices. The farmers enumeration expected that information of all farmers in Nigeria can be captured for the purpose of knowing the total number of farmers in the country and also to know their scale of production couple with the problem faced by these farmers and finally to empower them for Sustainable food security and Agriculture. With the farmers enumeration application, well informed institutions like the African Development Bank (ADB) Central Bank of Nigeria (CBN), Bank of Agriculture (BOA), Bank of Industry (BOI), National Export and Import (NEXIM) Bank, etc., may positively influence farming situations through controlling and designing of a global or regional agricultural plans, what a farmer grows, how produce are transported and processed, how commodities are traded and the price the farmers might receive. This can be a sign towards achieving sustainable precision farming whose objective is to ensure efficiency and profitability (Thorp, 2014).

Our proposed system captures farmer's information and stores it into the database, and as well uses the integrated Google Map API (Application Programming Interface) and GPS (Global Positioning System) for Mapping the coordinates of farmland through registered agents on the app. Google Maps API allow developers to integrate Google Maps into their websites or mobile applications while the Global positioning systems (GPSs) allow locating specific field locations including the farm location within a few feet or meters of accuracy.

The current system of farmer's enumeration involves the use of paper-based to capture farmer's information, which is stressful as it takes a lot of time to capture farmer information and to transfer information from the point of collection to the center of data assimilation and analysis due to the manual nature of the process. It can be very time consuming to administer paper-based surveys and this is inevitable. This call for more innovating ways and more importantly, the innovation should be tailored to the current realities.

This research aims to develop a mobile application for farmer's enumeration. Specifically, the research will design the architecture for implementing an automated enumeration mobile app that will use Global Positioning System (GPS) and Google Maps to take coordinates of farmland in order to know the size and the position of the farmlands allocated to farmers. The Decision Support System aspect stores the farmers data for future decision making in coloration with the assigned lands. The three internal modules of the architecture, i.e., GPS, Google Maps and DSS are further described.

II. GLOBAL POSITIONING SYSTEM (GPS) IN AGRICULTURE

The installation of satellite navigation systems by US and USSR in the late l980s, provides the military and civilian industries access to acquire worldwide cost-free location data which is continuously available independent of daylight and weather conditions. These systems often are generally termed as the Global Positioning System (GPS) (Tiwari, 2023). GPS is widely available in the agricultural community and its potential is growing. Its uses in farming includes mapping yields (GPS + combine yield monitor), variable rate planting (GPS + variable- rate planter drive), variable rate lime and fertilizer application (GPS + variable-rate spreader drive), variable rate pesticide application (GPS + variable-rate applicator), field mapping for records and insurance purposes (GPS + mapping software) and parallel swathing (GPS + navigation tool) (Tiwari, 2023).

The space segment is based on the constellation of 24 active and 3 spare satellites orbiting the earth. The control segment is a system of five monitoring stations located around the world, with the master control facility located at Falcon Air Force Base in Colorado. The user segment, which is the fastest growing segment, is made up of GPS receivers and the user community. GPS receivers convert the satellites' signals into position, velocity, and time. This information is used for navigation, positioning, time dissemination, and research. Figure 1 depicted the structure of Secure User-Plane Location (SUPL) architecture for assisted GPS (A-GPS).

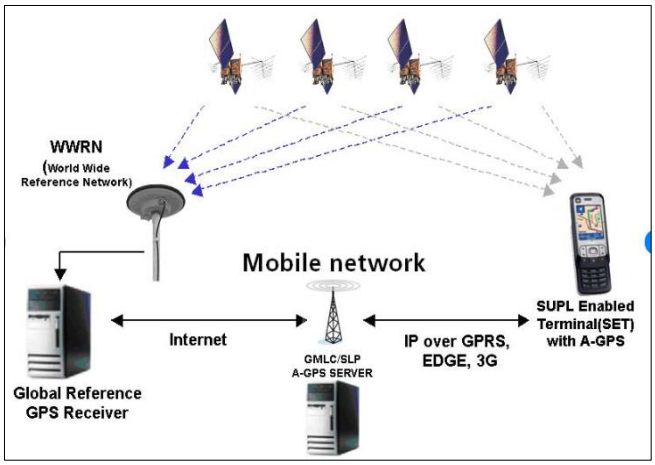

Fig 1 SUPL Architecture for Assisted GPS, (Göze et al., 2008)

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Monitoring and performing agricultural practices over a large spatial coverage often require advanced and accurate positional information. Agricultural practices requiring adequate land and crop information management calls for accurate positional information, which necessitates the use of Global Positioning System (GPS) for acquiring sample position using Global Navigation Satellite System (GNSSs) (Prem Chandra et al., 2021). GPS instruments have evolved and nowadays, the advanced GPS instruments are readily available in the market that are easily operated via mobile with any operating systems, such as, iOS, Android, or Windows. Availability of GPS signals in several instruments or equipment has been looked as the opportunity to enhance the agricultural farm mapping that will help in innovative agriculture.

➢ *Google Maps Application*

Google Maps is one of the most sought-after innovations by the tech-giant Google Incorporation in the history of technology. This highly rated application enables people to navigate and find the shortest and most convenient route to their desired destination. It offers satellite imagery, aerial photography, street maps, 360° interactive panoramic views of streets (Street View), real-time traffic conditions, and route planning for traveling by foot, car, bike, air and public transportation. As of 2020, Google Maps was being used by over one billion people every month around the world. Google Maps is a powerful mapping and navigation tool with many features to help you get where you need to go.

- *My Maps*:

Create custom maps with markers using images and descriptions. My Maps is a feature on Google Maps that allows you to create custom maps. You can add locations, draw lines and shapes, and add text labels. My Maps is a great tool for creating travel itineraries, plotting points of interest, and more.

➢ *Decision-Support Systems in Agriculture*

A specific class of computerized information system that supports business and organizational decision making activities is the Decision Support Systems (DSS) (Tiwari, 2023). A DSS in agriculture is an interactive visualization system that collects and processes a variety of inputs (raw data from farm-deployed sensors, compound data, agronomic data, microbe data) in order to present to the farm manager a solution to a deriving problem, such as disease pressure, ice and snow, or the need to irrigate. A DSS rather being an automated decision-making tool, assists managers in making better judgments. With DSS large farming data, can be collected, analyzed, and processed as advanced information systems to assist farmers in making appropriate decisions and obtaining higher profits. As a result, agricultural decision support systems for Agriculture have become a popular topic among academics (Kaur et al., 2022).

The control maps for map-based field operations must be generated according to some sort of decision-making system. Even if the decisions are made manually, the volumes of data and the complexities of crop production favor a decision-support system. The decision-making computer program can be deterministic, based upon rules or formulas. The computer determines the correct control action for each small part of the field or orchard based upon the guidelines written into the decision-making program.

This proposed system works on both Android and IOS platforms to capture the necessary information about farmers. The app captures farmer details which includes; the live capture of farmer & Identity documents, and as well uses the integrated Google Map API (Application Programming Interface) and GPS (Global Positioning System) for Mapping the coordinates of farmland through registered agents on the app.

III. METHODOLOGY

The project would be approached by firstly designing the farmer's enumeration mobile app using Flutter / Dart programming language. Secondly MySQL Database will be used to store farmer's information while MySQLite Database will be used for storing farmer's information locally on the mobile device in the absence of network before synchronizing it to the server. The third step is to integrate Google Map API (Application Programming Interface) and GPS (Global Positioning System) for Mapping the coordinates of farmland.

➢ *System Design*

Figure 1 shows a context diagram of Famer Enumeration System which is developed for both mobile and web application. The Farmer Enumeration System which is a DSS is the central point for capturing farmers information, farm details and size using GPS, viewing farmers and farms reports, view analytics reports and disbursement of farm inputs or subsidies to farmers. The accessibility to the system is set accordingly, depending on the responsibility of each party. The Super Admin has the greatest access and permissions such as create/manage Agent. Elaborations of Figure 1 for each user are given in following sections.

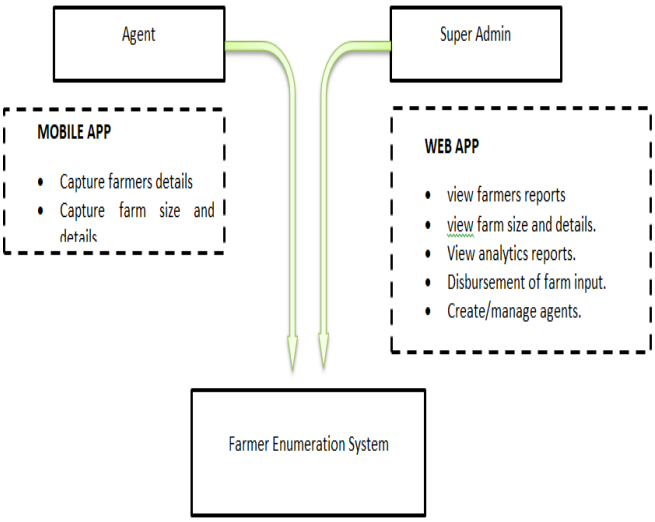

Fig 2 Farmer Enumeration System Details

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A. Super Admin

The Super Admin utilizes the web application to access various functionalities such as viewing detailed farmers reports including crop yield, growth, viewing farm size and details such as location and soil type, accessing analytics reports to aid in decision-making, disbursing farm inputs like seeds, fertilizers, and pesticides to registered farmers, and create/managing agents who act as intermediaries between farmers and the organization.

B. Agent

The Agent utilizes the mobile application to capture farmers' details such as name, location, and contact information, as well as capturing farm size and details such as crop type, acreage, and soil type.

IV. SYSTEM REQUIREMENT

- Hardware requirements should include a dedicated server with high processing power, RAM, and storage capacity for the web application, and mobile devices with sufficient RAM and storage.
- The operating system for the server is up-to-date and compatible with the development environment and technology stack.
- A database optimized for handling large datasets and capable of handling concurrent connections with sufficient storage and memory is employed.
- The mobile application should be built using native development frameworks and should be compatible with various screen sizes and resolutions, with an intuitive user interface.
- The web application is built using popular web development frameworks with responsive design principles, intuitive user interfaces.
- The system is designed with appropriate security measures, including encryption, secure user authentication, and protection against security threats.
- The development tools used for building the application is up-to-date and compatible with the latest technologies.
- Overall, the system should be scalable, secure, and reliable, with a well-defined architecture that can handle large datasets and high traffic. It should also be regularly updated with the latest security patches and have a disaster recovery plan in place in case of unexpected events.

V. RESULTS AND DISCUSSION

The live application obtained from the design have the working modules as follows

A. Add Farmer

Figure 3 shows the add farmer page of the mobile app which allows the agent to capture new farmer details such as name, gender, date of birth, marital status, phone, email, crop yield, image etc. farmers details can be captured using internet connectivity as well as locally (without internet connectivity).

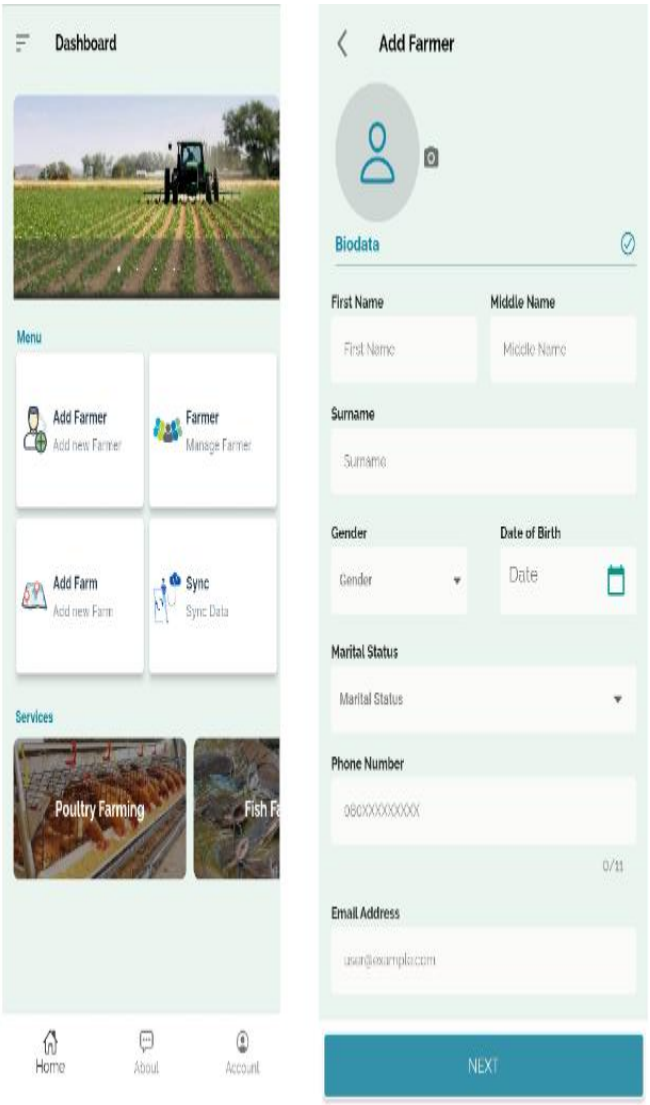

Fig 3 Add Farmer

B. Add Farm

Farm details can be captured through the mobile app by the agent which contains the farm location, farm size (in square meters and hectares) and also the farm land coordinates, which would be captured through the integrated technologies in the app (GPS and Google Map) as given in Figure 4.

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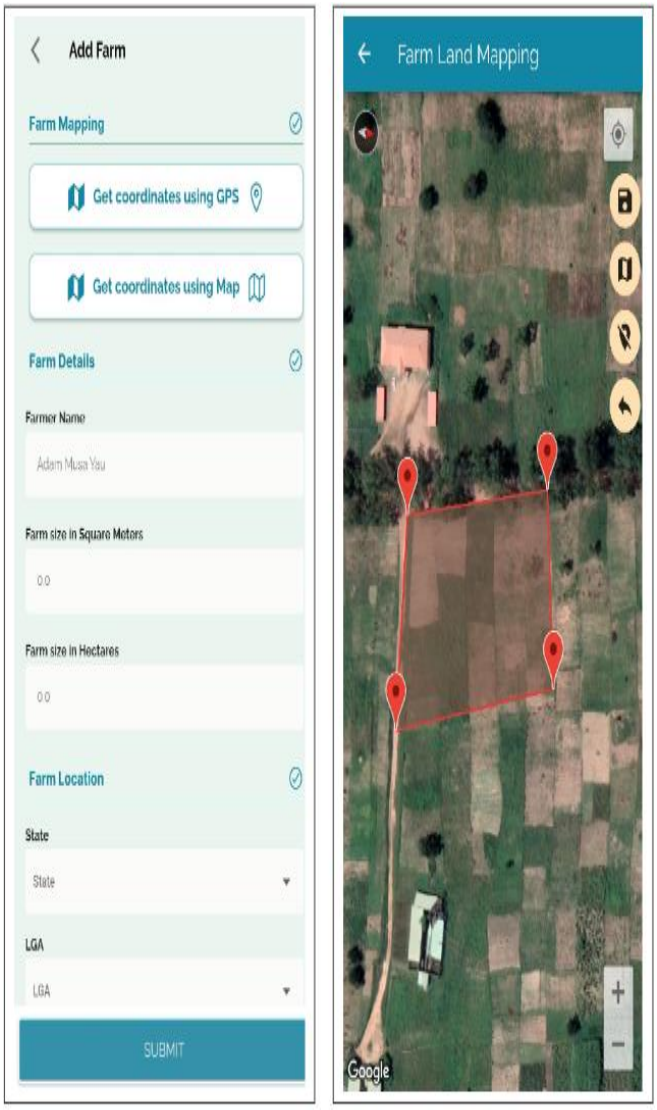
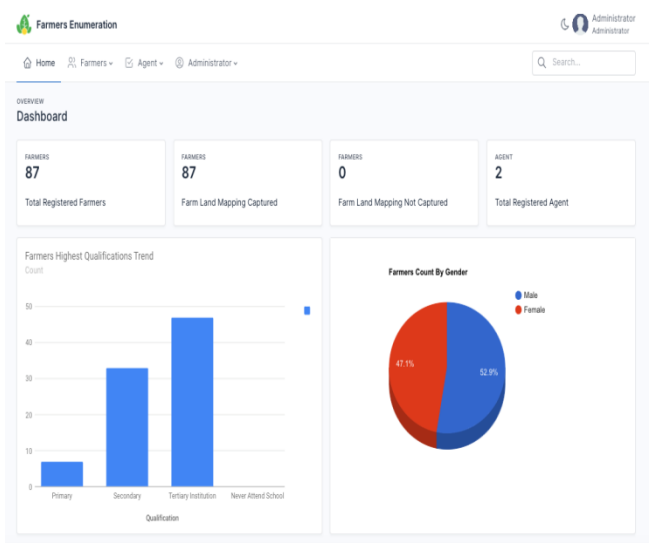


Fig 4 Add Farm

C. *Dashboard*

Figure 5 shows the web application dashboard which contains the overview of the entire system as well as analytics reports, which may provide insights into trends or patterns in the data collected.



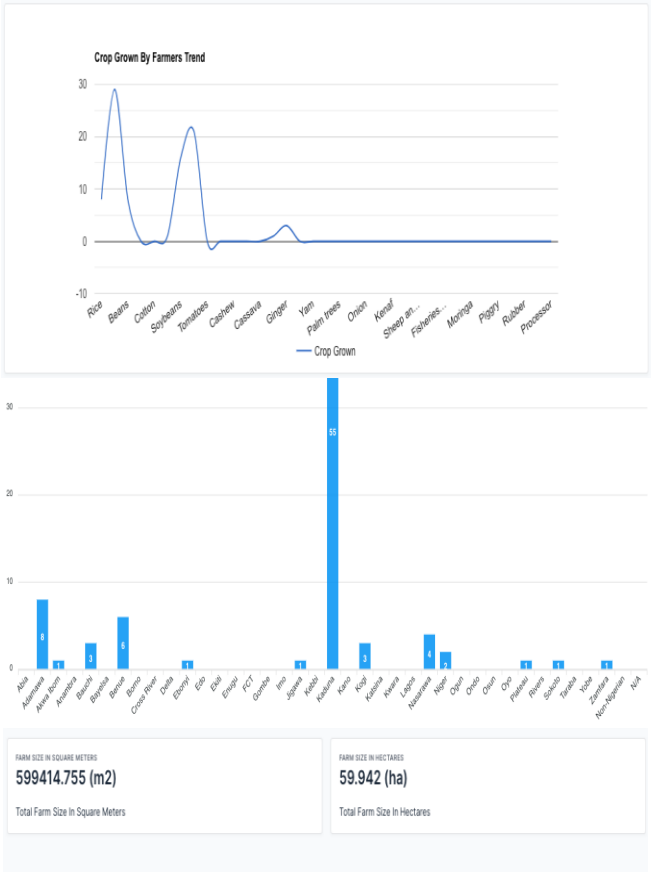


Fig 5 Dashboard

D. *Farmer Report*

Figure 6 shows the farmer's report page which contains all the registered farmers captured through the mobile app by the agents.

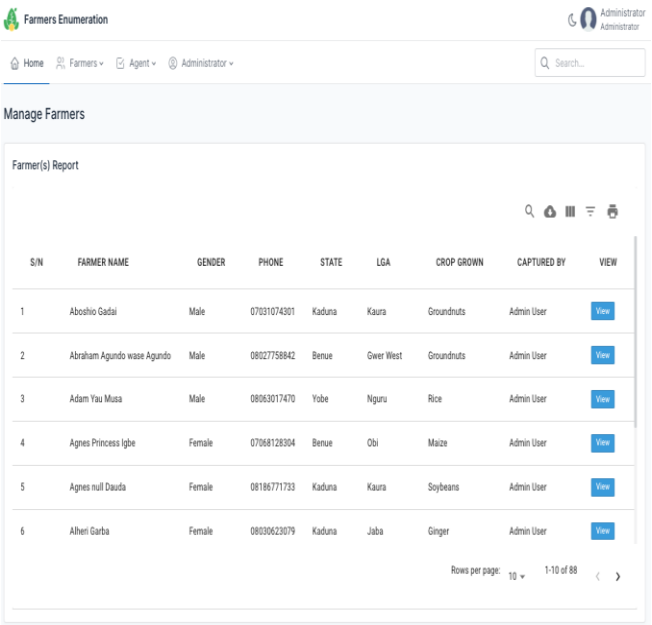


Fig 6 Farmer's Report

E. *Farmer Details*

The farmer's details page displays farmer record which contains both personal and farm details. This is depicted in Figure 7.

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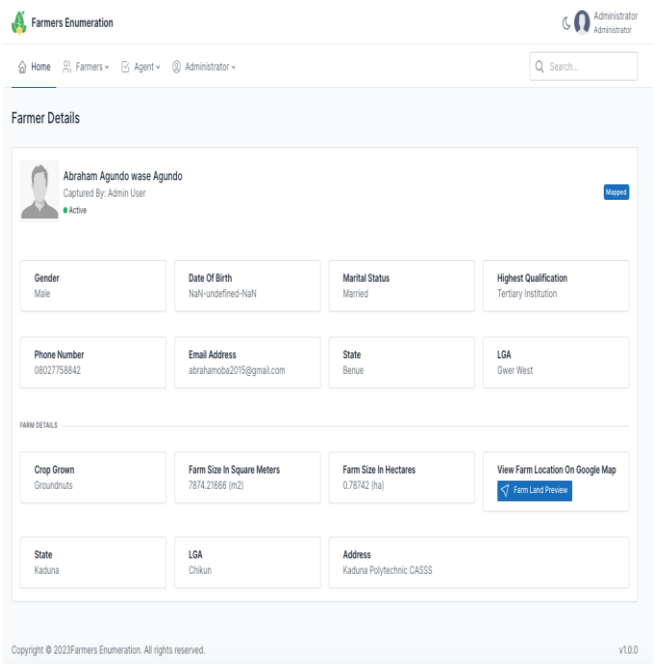

Fig 7 Farmer Details

F. Farm Land Preview

Figure 8 shows farm land preview of each registered farmer on the web application, this contains the size and the coordinates (longitude and latitude) of the land allocated to the farmer.

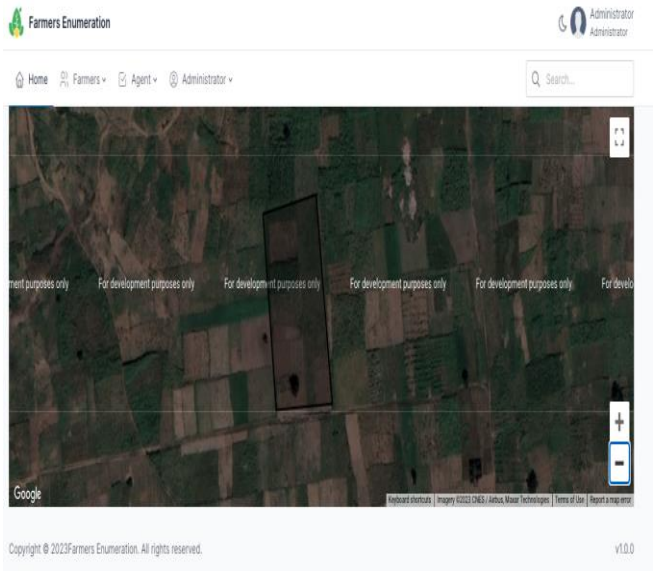

Fig 8 Farm Land Preview

VI. SUMMARY AND CONCLUSION

Mobile Application for farmer's enumeration captures farmer's information and stores it into the database, and as well uses the integrated Google Map API (Application Programming Interface) and GPS (Global Positioning System) for Mapping the coordinates of farmland through registered agents on the app. This proposed system will help government in the distribution of fertilizers and other farm inputs as well as incentives to the enumerated farmers; however It can be used by funding agencies like CBN and BOA to appropriately channel funds to the practicing farmers. The difficulty of the CBN to track the farmers who benefitted from the Anchor Borrowers Programme can be resolved with the application of this system on a larger scale. The inclusion of the GPS feature will enable the system to function in hard-to-reach villages where GSM operations are epileptic. With this, farmers are encouraged to put more efforts recognizing that they can capture their farm data themselves or through their trusted community allies and forward directly to the central database. The government and donor agencies will have direct contacts with the farmers and data for analytics are readily available.

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