Farm Sense Report

youthmappers Research

Leveraging Open Data and Geo-spatial Technology for Food Security

A report of the farm sense data-driven Agricultural web portal that maps existing farms and farm produces.

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Table of Content

1.0 Background

Food security has become an issue of global concern in recent times. Nowadays, food security is being transformed by data, especially open data. Open data - data that anyone can be use, re-use and redistribute - is shaping solutions to enable more efficient and effective decision making at multiple levels across the agricultural value chain, fostering innovation via new services and applications, and driving organizational change through transparency. A wide range of data is needed by a variety of agricultural actors to meet different needs; to empower farmers, optimise agricultural practice, stimulate rural finance, facilitate the agricultural value chain, enforce policy and promote government transparency and efficiency. Through the adoption of open data in agriculture, farmers can benefit through improved communication and data driven decision in the application of fertilizers, planting and harvesting. Furthermore, researchers can use it to access crucial agricultural related information, and policy makers can use it to for evidence-based investment.

Nigeria, with her huge natural and human resources is not spared. Nigeria has the ambition of diversifying her economy from crude petroleum dependency. The country also faces a looming food security crisis with a growing population that is increasingly dependent on imported foods. The once dominant subsistence-oriented farm economy is at risk of gradual marginalisation.

Ondo State is one of the foremost states in agriculture in Nigeria. The state is positioned and blessed with an opportunity to grow exportable products due to balanced seasons, arable lands and an interested government. However, there is a lack of access to open data that will help to improve the policy decisions that shape food systems and everything that depends on them. This data, when used well, serves to ensure and improve efficiency along the entire food value chain.

This project seeks to develop a platform that will be a repository for farmer's data which will be analysed and visualized regularly. The platform can then be used as a recommendation tool to aid decision making, project the activities of farmers, and tell their stories.

1.1 Goals and Objectives

Goal:

The goal of this project was to establish a web platform that provides access to open data and information on farms and farmers' activities in Akure (North / South) and Ifedore LGAs of Ondo State.

Objectives:

1. Increase access of the government and other agricultural stakeholders to open data on farms and farmers information in Akure (North / South) and Okitipupa LGAs of Ondo State.
2. Reduce frustration in accessing data on farms and farmers in Akure by the government and agricultural stakeholders for planning and decision making purposes.
3. Improve access to standardized educational resources for student, innovators, and youths who have little or no knowledge of agriculture and farming.
4. Improve the quality of road data and point of interest (POI) to help facilitate decision making.

1.2 Team Structure and Project Team Composition

The Leadership Team was comprised of Deputy Directors, Managers and Senior Analyst of the GIS & Analytics Department at eHealth System Africa, an NGO whose mission is to build stronger health systems through the design and implementation of data driven solutions that respond to local needs and provide underserved communities with tools to lead healthier lives.

Core Project Team provided the day to day project management, GeoSpatial Data Management expertise and deployment of the farmsense project. Figure 1 shows the overall project structure where a project lead sits right at the top and manages the technical lead, software developers and Data Analyst team to deliver the project outputs and objectives.

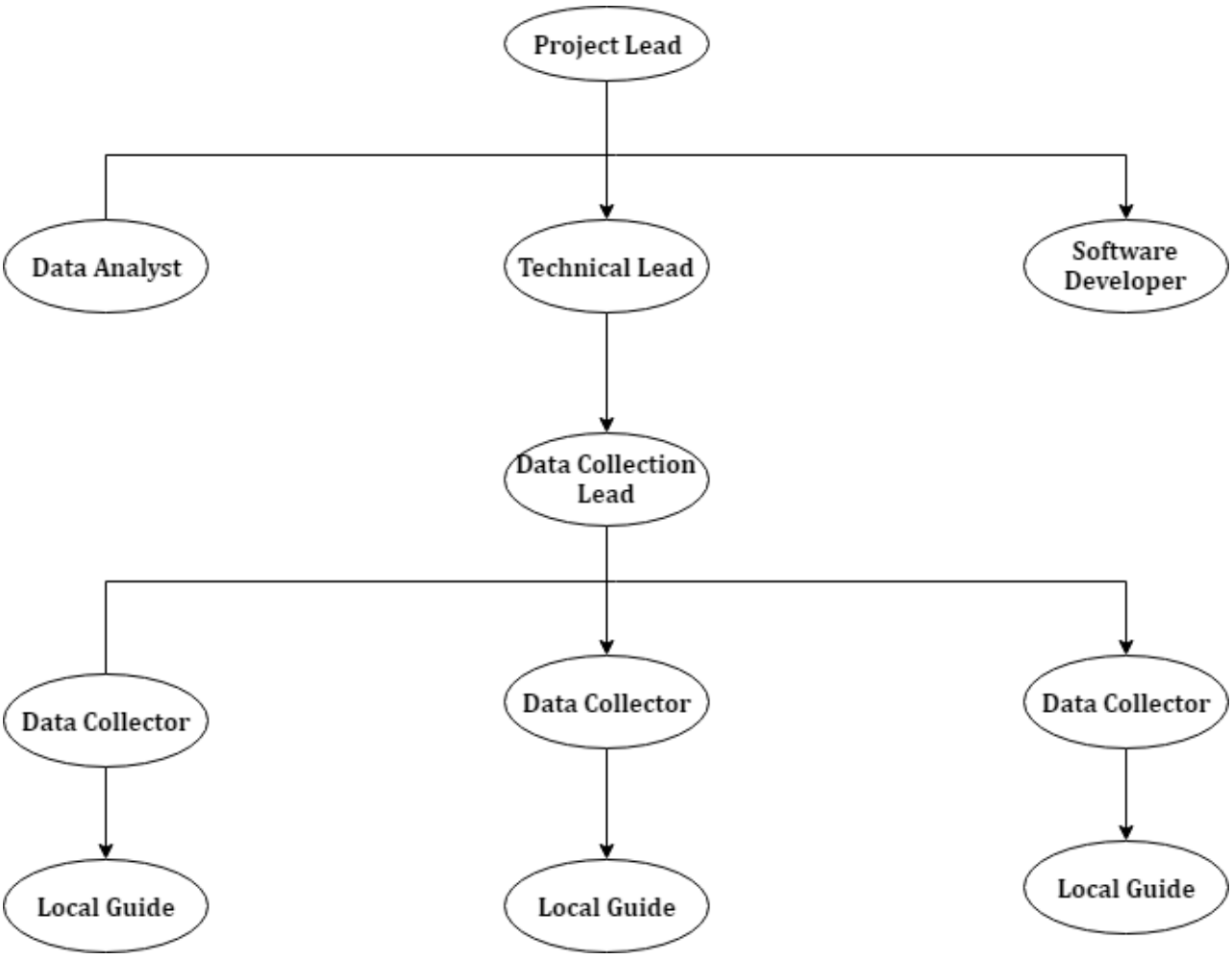

Figure 1: Project Team

Below were the roles and responsibilities of the Project Implementation Team.

- Project Lead: The project leader led and supported in the planning, execution and monitoring of the project. He was responsible for the coordination, follow-through, and resolution of all project related issues. This position handled duties which include project coordination, management, as well as financial analysis to achieve the successful completion of the projects.
- Technical Lead: The technical lead provided technical direction for the project and the team. He was responsible for setting the standard for technical processes and procedures and supervised all technical outputs from all the team members.
- Data Analyst: He was responsible for designing the ODK form for data collection, ensuring the quality and uploading of the collected data, following up and monitoring the field team for the overall data collection.

- Software Developer: They were responsible for developing the http://farmsense.ng platform which is used to display the data collected.
- Data Collection Lead: This person was responsible for community engagement, overall field data collection, quality of field data collection, uploading and confirmation of the data collected, security and logistics of the field team as well as overall coordination of the project field officers.
- Data collector: He was responsible for collecting data from the field, ensuring the quality and validity of data collected, engaging with ward focal persons and village heads on location of farmers, market and water point.
- Local Guide: They provided data collection support and served as navigators to get to farmers, market and water point during the course of the data collection process.

2.0 Process Methodology

FarmSense worked with eHealth Africa (eHA) team, an NGO founded 2009 with a simple idea that communities in developing countries could have better healthcare when providers are able to make data-driven decisions. Working with eHA team, we evaluated existing data, systems and processes and identified gaps. This helped to guide subsequent ideas and restructuring of existing ideas.

The methodology adopted for this activity were implement in five major stages. It started with the identification of the data sets to be used and insights about them. Identified data sets were then harmonised, bringing together datasets of varying file formats, naming conventions, and columns, and transforming them into one cohesive data set.

Next was data reconciliation and harmonization to identify the variance in datasets between what we got from the GRID3, a project by eHA aimed at collecting accurate, complete, and geospatially referenced data relevant to a variety of sectors across Nigeria and Fadama III Ondo, a project incorporated by Ondo State government to address the challenge of poverty in Ondo. This processes involved several stages which is further explained in a latter section.

The Data processing involved standardizing the data to a particular format in preparation for adding it to a predefined database. The fourth stage then involved data analysis which is the process of modelling data with the goal to support decision making. Finally, the last stage involved the web

platform in itself which is arranging these data and map elements visually in such a way it can be easily interpreted.

The sample selection used was two - staged random sampling technique. First, Ondo State was purposively selected from South West Region Nigeria. This was followed by selection of three Local Government Areas (LGAs) namely Akure North, Akure South and Okitipupa. And finally, 1)Two hundred and twenty one farms and farmers were randomly selected. 2) One hundred and Forty Five Markets from secondary data sources was validated, 3) twenty water point was collected and 4) Road leading to this point of interest was correctly named. Structured Questionnaire using mobile data collection App was used to obtain primary data about farmers' socio-economic & demographic characteristics, farmers knowledge, attitude and farming practices; as well as their cost and income. The data collected were analyzed using descriptive statistics.

End to End Process - FarmSense project

To develop the farmsense data platform, the following datasets, processes and analysis were collected and used.

2.1 Datasets Used (inputs):

1. **State, Local Government Area (LGA) and Ward List** - This is a sheet containing list of geographic names of wards, LGAs and State This list is non-spatial as it is for capturing corresponding geographical coordinates of farm lands so as they can be mapped.
2. **Farms and Farmer locations** - These are the coordinate of the farm where the survey is being conducted by the collectors. Data reconciliation was carried out with secondary data sources.
3. **Markets** - A reconciliation of this list with the secondary data enabled us extract coordinates for those that already had a geolocation. Those without locations were sent to the field for data collection. This was also preloaded to the data collection form and tracted to ensure that all the market in the list were collected and verified for geo-coordinates.
4. **Road Network** - Updating the road network of the study area is very critical for the farmsense project. As this will facilitate isodistance analysis needed to define cluster of farms providing product to a particular market.

5. **Administrative Boundaries** - Wards, LGA and State boundaries were used as base layers for map production and also operational boundaries to determine where farms are located.

2.3 Data Collections Process and Procedures

Figure 2 shows the data collection process and procedures of the farmsense project. This figure explains how the project begins with stakeholder's collaboration to the deployment of the farmsense platform.

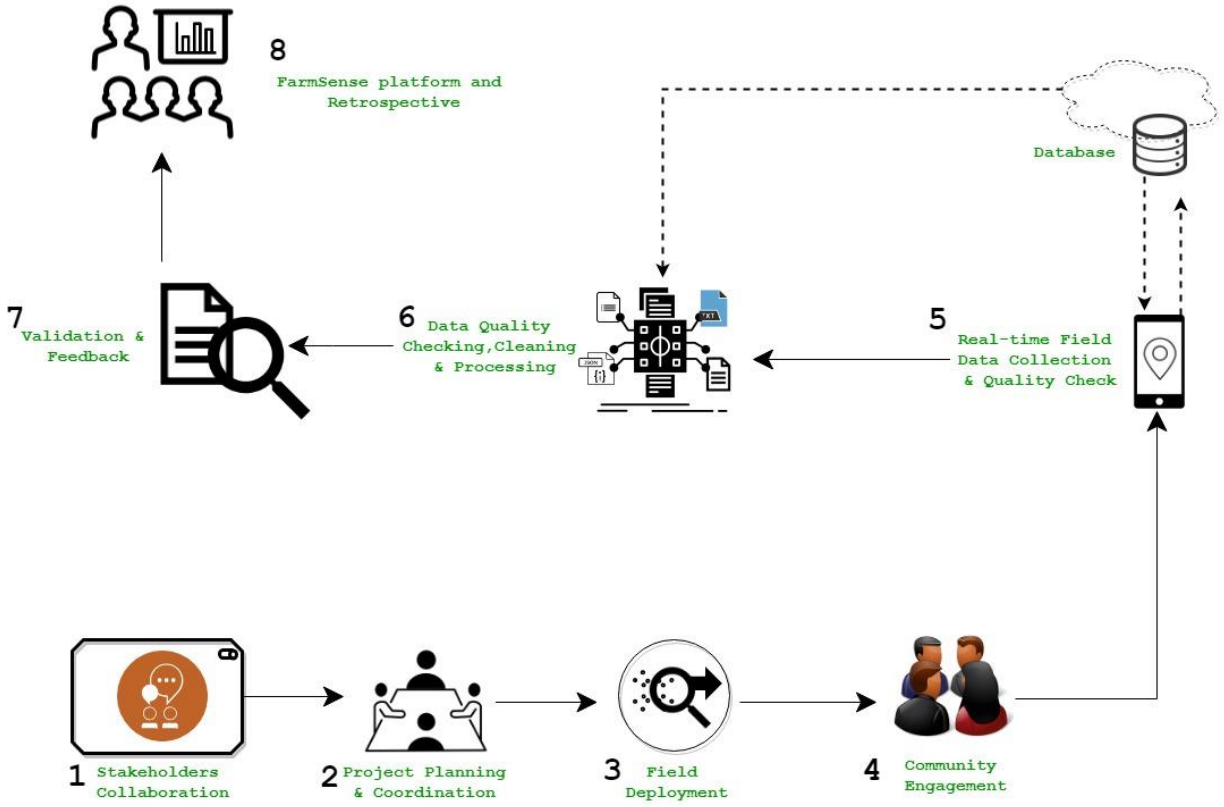

Figure 2: Process Methodology Flowchart

- **Stakeholders Collaboration**: Governments, institution, NGO and Start-ups at State and LGA levels were engaged early in the project as critical stakeholders to agree on project goals, objectives, media for data exchange, Standard Operating Procedures, and policies.
- **Project Planning and Coordination**
    - **Team Selection and Training**: The data collection team were hired through the following assessment process:
        - Shortlisting of qualified candidates.

        - Interview process.
        - Final orientation on the organization and job role.
        - Training sessions on the use of Kobo collect.
        - Data collection procedure and data management (uploading) training session.
    - **Team Deployment and Community Engagement**: The team was deployed to assigned communities where they engaged the community leaders and indigenes. We also hired local guides to help us navigate the farms, correct names of communities, translate conversation and any other relevant local knowledge required.
    - **Form Designing and Equipment Configuration**: A mobile survey application called KoboCollect was used for data collection. It was designed, configured and installed on the Tablet purchased and used for data collection. OSMAnd was used as a navigational aid on the field.
    - **Data Collection Work Planning**: The process for data collection involved the following:
        - The design of a work plan showing breakdown of teams assigned to different settlement locations for different days. For example - On day one, the three teams is assigned to cover 24 farms and ground truthing of 24 markets within Ifedore Local Government Area (LGA) with local guides to help navigating and interpretation.
        - For each member of a team a local guide (Local indigene of that settlement) is assigned to take them around and also help them get correct names of point of interest as required.
        - Once the team gets to the farms, they make use of the KoboCollect app to record the responses of the farmers to a questionnaire and pick the coordinates of the respondent farm. This was done for four (4) weeks.

Data Collection Deployment Photos:

Image 1: Ahmed collecting data

Image 2: Dennis collecting data

Image 2: Mutiu collecting data

Image 1: Ololade collecting data

2.4 Data Processing Steps

There were two stages of data processing. The first stage involved cleaning and validating the raw field data (e.g against satellite imagery base maps) while the second stage involved performing final quality checks on data processed from stage one.

1. Data Processing

Data Cleaning - Involved identifying incomplete, incorrect, inaccurate or irrelevant parts of the data and then replacing, modifying, or deleting the dirty or coarse data.

- Proper Casing - This ensured that the first letter of every word in the database is capitalized.
- Trim - This was used to remove unnecessary spaces between words in a string.
- Removing Special Characters - This step was used to remove all special characters in red which are **(“,” “.” “_” ” / ” ” \ ” “(” “) “ “ : ” “ ; ”).**

Data Validation - Data validation primarily helped in ensuring that the data subsequently stored was accurate (including georeference), consistent and complete. This was achieved by performing additional non-spatial and spatial validation checks.

- Run Duplicate Checks - This stage helped to check for repeating features which could either be spatial (geometry based) or non-spatial (attribute based).
- Data Visualization (or Visual Validation) - Data visualization refers to the techniques used to communicate data or information by encoding it as visual objects (e.g points, lines, polygons) as seen on the satellite imagery.

2. Data Processing

Data Reconciliation - is a process of verifying data during data migration, where the target data undergoes a comparison with the original source data to make sure that the migration architecture has transferred the data accurately.

3.0 Financial Report

FarmSense is fully based on open geospatial technology tools and it was deployed within 7 months in which there was a preassessment of what currently exist on ground, harmonize that data to get the difference and then proceed to the field to collect geospatial data required for the farmsense data platform. There was a capacity building session for the stakeholders and data collections to improve knowledge on understanding the open GIS technology and what the farmsense project is about.

S/N	Cost Category	Amount
1	Data Collection Personnel	xxx
2.	Research Equipment	xxx
3.	Training / Capacity Building	xxx
4.	Mapathon	xxx
5.	Web Portal Development and Maintenance	xxx
6.	Travels & Accommodation	xxx
7.	Miscellaneous	xxx
	Total	**xxx**

3.1 Data collection

FarmSense employed 3 data collectors and 3 local guide. These resources were focused on implementing all the phase of the data collection processes both remotely and physically as need arises.

3.2 Research Equipment

The research equipment purchased during the field data collection included 4 GPS enabled tablets, 4G LTE MIFI/internet connectivity, SD card and stationary (pen, notebook pad, sticky notes, whiteboard pen, etc.)

3.3 Training / Capacity Building

After the stakeholder engagement and the development / testing of surveys for the farmsense project, there was need to train data collectors and local guides on their respective duties. Also, there will be some training after the successful implementation of the web platform. The cost of the training consist of training materials and well as logistics involved such as content development, venue etc.

3.4 Travels & Accommodation:

Travel & accommodation made a chunk of the expenses as the project lead would be available for requirement gathering, stakeholder engagement and data harmonization for the project / data collection and the third phase is running alongside training.

3.5 Web Portal Development and Maintenance

The web portal expenses consist of employment of 1 software developer, 1 UI/UX designer, agricultural extension consultant, domain name, host name and 1 year maintenance of the platform.

3.6 Mapathon:

This is consists of expenses, like power cost, internet, snacks, projectors, freebies and mapathon venues fees.

3.7 Miscellaneous:

Additional cost like, branded T-shirts, gift for local community leaders, stakeholders and unplanned expenses.

3.0 Results and Analysis

The demographic information of the farmers are:

Figure 3: Gender, Cooperative, Smartphone and Storage.

In figure 3, out of the 221 farmers, only 52 of the farmers are female. This shows a progressive increase of gender diversity in Agriculture. Only 29 of the total farmers are part of any society or cooperation. The larger population believes that farmers' cooperative societies are a huge waste of time and very expensive as their needs or complains are not heard or changes made to them. We also found that a large population of the farmers do not have access to storage facilities, which expose their product to farm disease. While for the ones that own storage facilities, such facilities are not up

to standard. We also, wanted to understand how technology can be of help to these farmer. But, we realized that 188 of the 221 farmers do not have access to a smartphone. That means, any solution that would be provided for smallholders farmer will be offline driven.

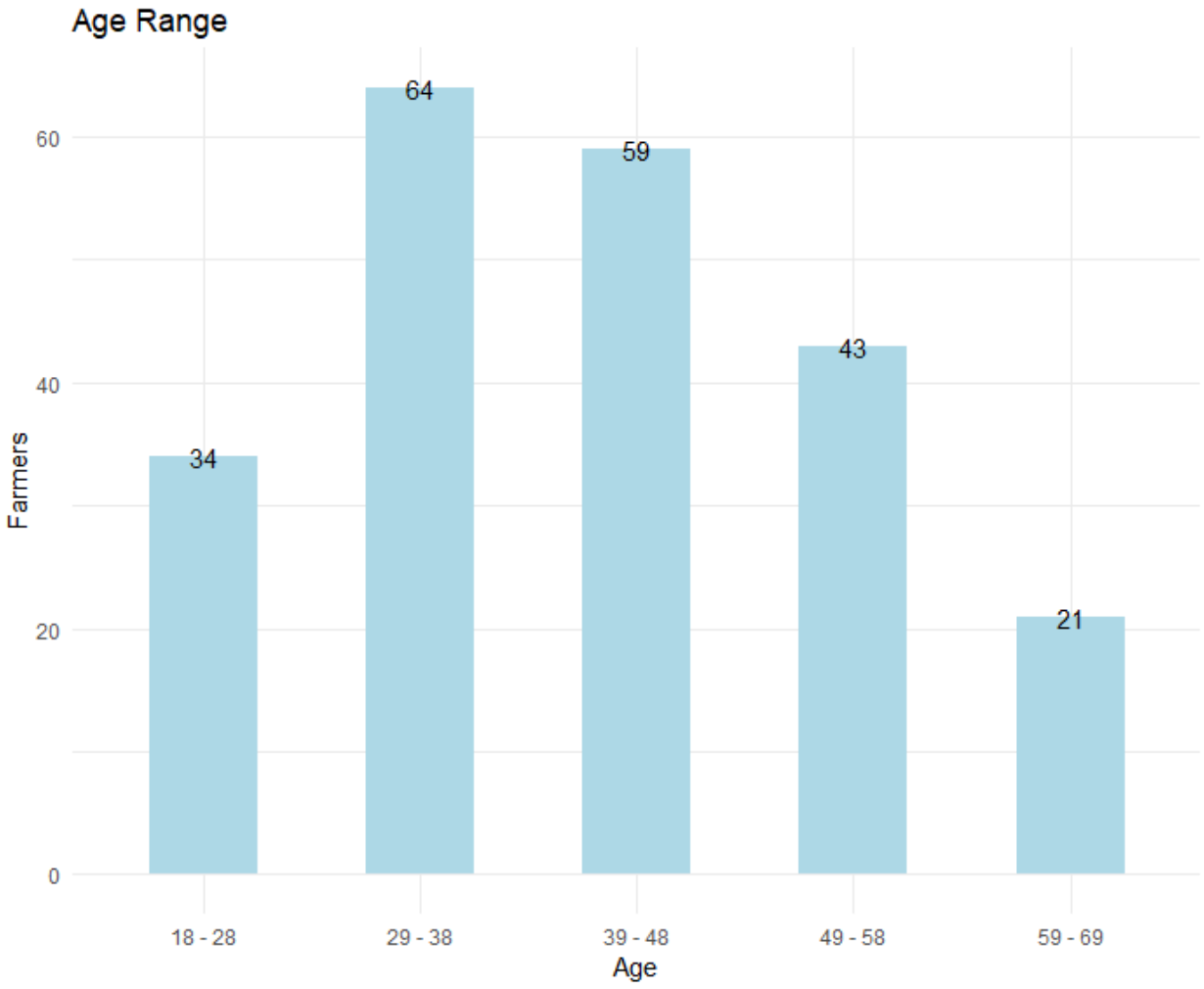

Figure 4: Age range representation

Figure 4 shows the age distribution of farmers. 157 farmers are between the age of 18 and 48. This shows that youth are getting to understand the role they play in agricultural and food for the nation.

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
2	8	15	15.0361990950226	20	45

Figure 5: Descriptive statistics of farmer_experience

In figure 5, the descriptive statistics carried out on the number of farming experience years, shows that there is a mean average of 15 years, mode value of 20 years and median of 15 years. This shows the relevant experience of the farmers in agriculture.

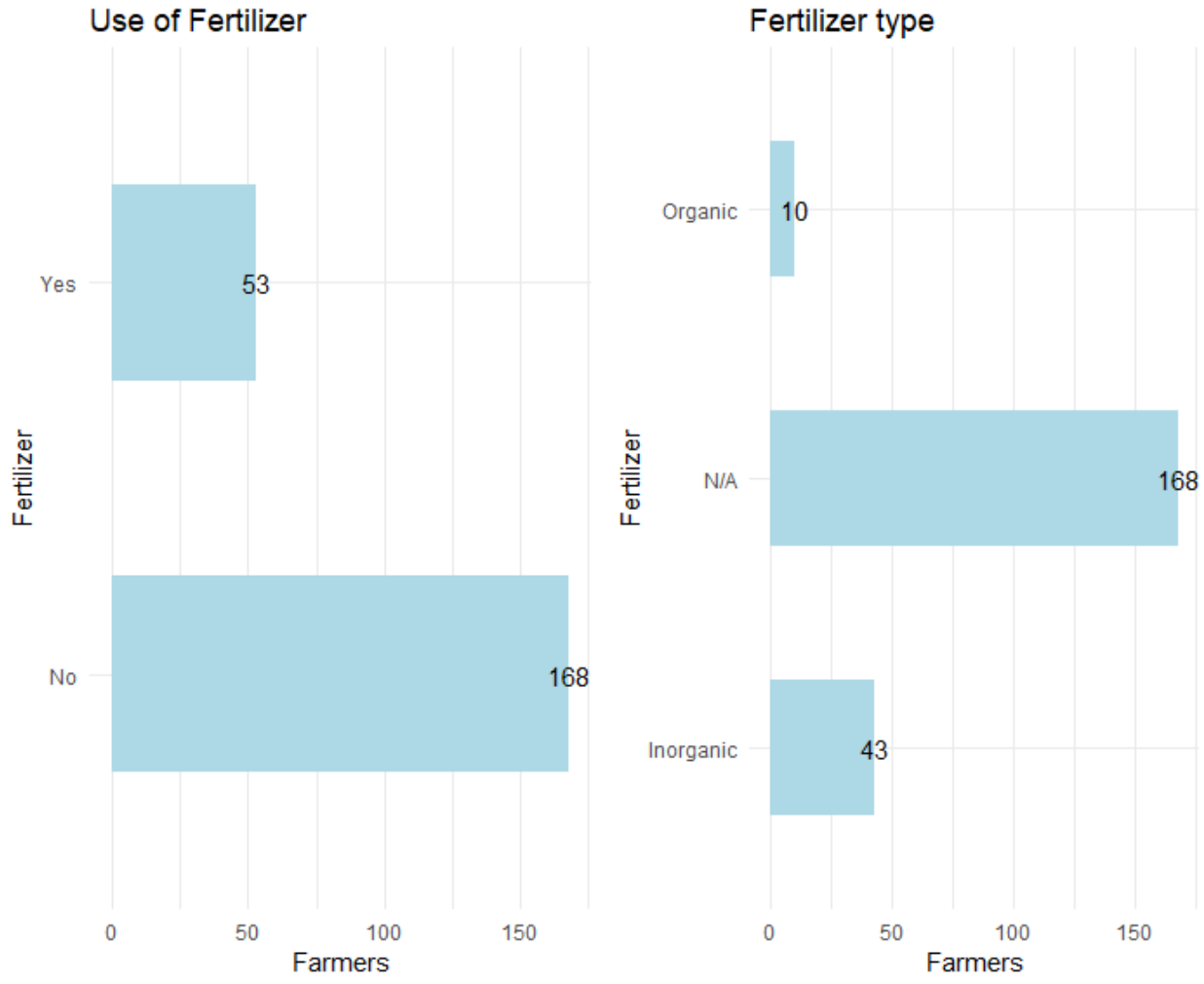

Figure 6: Chart of displaying fertilizer and fertilizer type

Figure 6, shows that a large percentage of farmers do not use fertilizer for farming because of the cost and mindset that they don't need it. However the small percentage that do, make use of inorganic fertilizer more.

Figure 7: Chart showing standard of living, price satisfaction, buying and selling method and sells method

From the analysis in figure 7. We found out that 92% of farming income and livelihood depends on agriculture and farming. Even at that, they struggle with the discouraging price at which the farm product is been priced and bought. However, most of the farmers find it convenient to sell product to the off takers. Even though the off taker does not respect their effort from the price at which is been priced and bought.

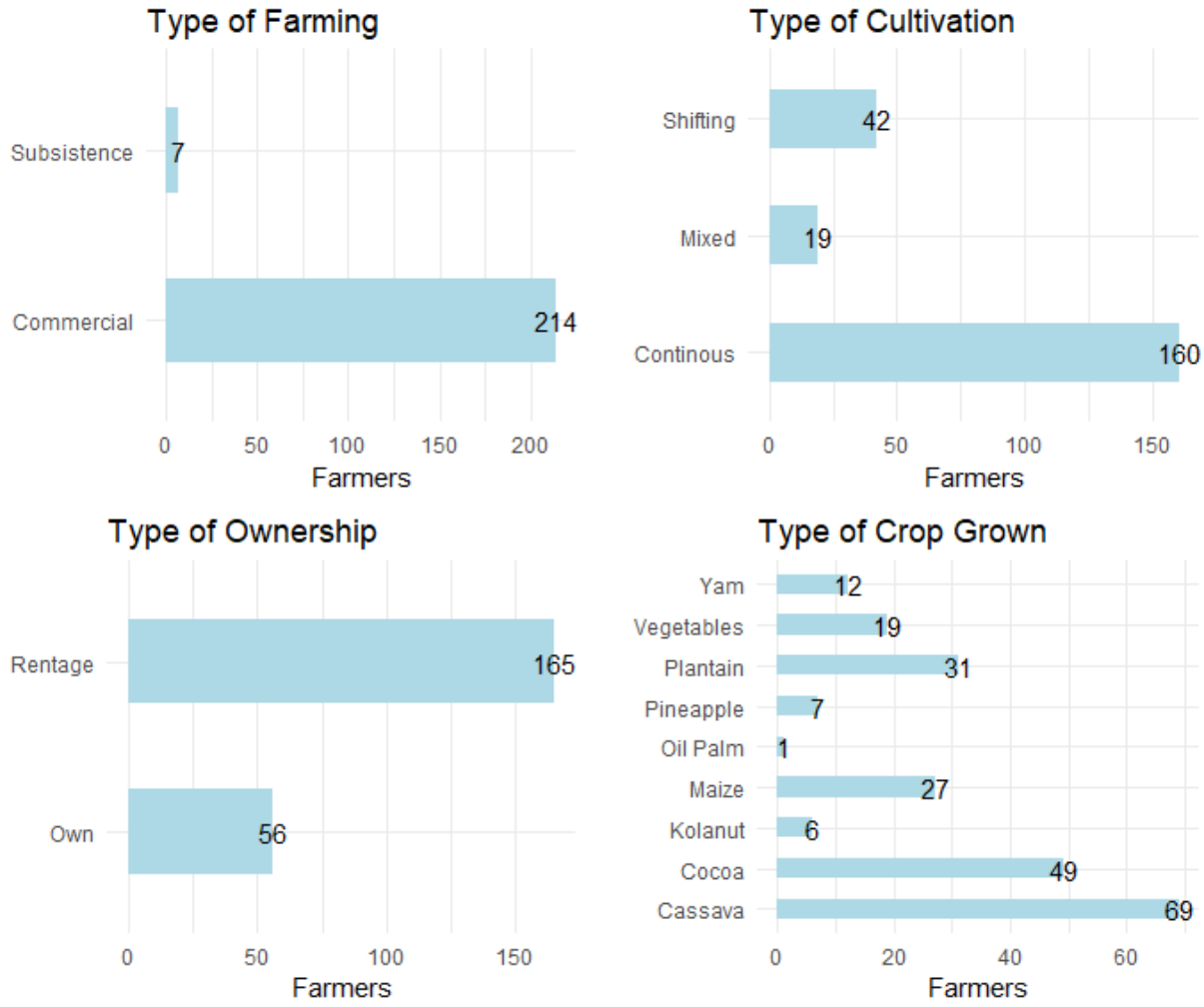

Figure 8: Farms ownership, crop grown, cultivation and type of farming

In figure 8, 214 smallholder farmers of 221 are commercial farmers. That is, they farm with the intention to sell and make a living from the product sold. More so, 80% of these smallholder farmer undergo continuous farming with majority of the farmland on rental and lease. Will also mention the fact that these smallholder farmer engage in labour intensive farming and don't have access to mechanized tool to farm.

5.0 Lesson Learnt

- Initial workshop with stakeholders and the users should have happened very early in the project to help capture all requirements.
- Team should be better enlightened on the best approach to go about data collection in the field.
- The activities need to be a collaboration with the state, as this would make the state take ownership of the project / process and hence, provide us with easy access to unreachable areas.
- It was better to listen to the farmers complains, while setting survey questions. This allows us to provide services that is relevant to their needs.
- There is a general need to create awareness and acceptance of open data and geospatial technology across the stakeholders especially the local guides. This is important in order to engage local youth from community on how to go about mapping their community.
- The local guides should have been involved in the data collection training and process so as to provide more support with mapping the farms.
- There is a general need collaborate with agricultural institution who have existing data and are willing to contribute the data for the cause of open data for agriculture.
- Volunteer whom are willing and self-motivated to collect agriculture data, should be trained and mentored so as to make collect accurate data..

5.1 Observations

- Some farmers did not have any idea of the size of the farm they were working on. We had to work them through how to get an estimate figure.
- The farmers were not interested in big technology to help them produce big yield. As a matter of fact most of the farmers had mastered the art of producing good crops. What they lacked is right and good paying market. This is necessary to improve the farmer's standard of living and serves as a motivation for farmer to farm more products.
- There were few sources of data at Fadama III Ondo project, but the data was not as detailed as expected.
- There is no defined standard and policy for collecting open agricultural data.

5.2 Recommendation

- For a comprehensive geospatial analysis, there is a need to collect extent of farm. So as to perform improved spatial analysis to determine food security of a particular plot of land.
- There is need for a standard open agricultural data policy. This will help streamline the number of attribute to be collected during data collection.
- Working with government should be encouraged as it will help in making the project more successful and faster. Most times, it seems they are not cooperative. But, when they finally become cooperative the project takes flight.
- Standardize price for purchasing agricultural product should be defined. This will help the farmer make better plans towards agricultural production.
- Smallholder farmers should have consistent communication and improved communication in order to decimate information about opportunities and best practices across a community.
- Smallholder should be provided with some form of incentive and low interest loan to purchase agro-chemicals and hybrid seedling from research institutions.
- There is need for better enlightenment on the impact and useful of open data and open geospatial technology for agriculture and food security.

6.0 Conclusion

This document seeks to serve as a guide, describing the process and methodology that was employed in achieving stated objectives of the farmsense project - http://farmsense.ng. And a retrospect to open data in agriculture and food security. From this research, we were able to deduce that the, for a potential efficiency of smallholder farming relative to larger farms, focusing on the capacity of smallholder to achieve high production levels per unit land through the use of fertilizers, best practices and input of government in diversified production systems can help achieve food security.

More so, during the course of this research FarmSense portal was create, an open source, public data repository for agricultural related geospatial reference datasets. Which was established to help meet the need of data for improved decision making. FarmSense understands the relevance of accurate, complete and timely information and it's essentiality to the industry's decisions makers at various levels.

6.1 Future plans

Looking at how successful the data collection process was. We have been able to learn lessons, observations, became more experience with data collection and establish communication with the local authority. We will continue collecting agricultural related data with the aim to harness and achieve an integrated mapping of development needs throughout the local communities identified and eventually across a variety of sectors (e.g health, education, environment, urban planning, etc.). Another part of the project will be stakeholder capacity building and engagement of the farmsense portal.

We also look forward to collaborate with companies, by sharing data collected in order to improve decision making and further enable research. Just recently, Radiant Earth Foundation is currently using the data we collected to train a machine learning model for food security.