ASHESI UNIVERSITY COLLEGE

A PLATFORM TO CONNECT INVESTORS WITH SMALLHOLDER FARMERS

APPLIED PROJECT

B.Sc. Computer Science

Simon Baaman Suuk

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A Platform to Connect Investors with Smallholder Farmers

APPLIED PROJECT

Applied Project submitted to the Department of Computer Science, Ashesi

University College in partial fulfilment of the requirements for the award of

Bachelor of Science degree in Computer Science

Simon Baaman Suuk

April 2017

DECLARATION

I hereby declare that this applied project is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature:

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Candidate's Name:

……………………………………………………………………………………

Date:

……………………………………………………………………………………

I hereby declare that preparation and presentation of this applied project were supervised in accordance with the guidelines on supervision of applied project laid down by Ashesi University College.

Supervisor's Signature:

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Supervisor's Name:

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Date:

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ACKNOWLEDGEMENT

ABSTRACT

This capstone project idea is to develop a system called FarmConnect—a mobile application platform that connects investors with smallholder farmers who are seeking funding for their farm operations. Such funding will help the farmer operate at full capacity hence increasing the level of food security in Ghana.

FarmConnect will be able to provide interested investors with concrete data that will inform their decision to invest in a chosen smallholder farmer. Also, an example farmer who farms with a hoe, who does not have a business plan, who does not farm using agricultural data like rainfall pattern, and has no way of accessing market information to inform his or her farming activities should be able to farm with knowledge when he or she uses FarmConnect. The farmer can employ current market trends about crops, location of farming, be more organized in terms of their farming operations to enable investors who want to invest in their farm operations have the interest to do so. They should be able to farm with knowledge.

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1.1   Problem Statement

A look at the USAID Financing Ghanaian Agriculture Project (USAID-FinGAP) gives a picture of the investment atmosphere in Agriculture in Ghana. The USAID-FinGAP is a five-year agricultural investment initiative in Ghana. It was designed to unlock finance and investment in the rice, maize, and soy value chains in northern Ghana. Since its inception in July 2013, USAID-FinGAP has been offering technical assistance through its network of Business Advisory service (BAS) providers. These providers identify, prepare, and package financing proposals for viable agribusiness opportunities. These are intermediary services which are mostly accessible to medium-scale and large-scale farmers.

The term smallholder farmer has varied associated meanings in different demographical locations. For this project, a smallholder farmer is viewed as one involved in agricultural holding run by his or her family using mostly (or only) their own labour and deriving from that work a large but variable share of the family's income, in kind or in cash. The family relies on its agricultural activities for at least part of the food consumed. Another important dimension is the resource base which is considered to be "small": it is, often, barely able to sustain an acceptable livelihood. Smallholders typically strive to further develop their resource base to improve and enlarge agricultural production (Bosc et al., 2013). Smallholder farmers need services provided by services like the BAS providers but they lack the capacity in terms of the know-how; the procedure to follow to obtain such services (Asingwire & Okello, 2011). More also, smallholder farmers rarely have a business plan that can be presented to an investor who is willing to invest in them. There is therefore the need for a system that will enable such smallholder farmers to connect to the investors because they are very valuable in the agricultural value chain as stated above.

1.2   Background

Ghana has three main geographic regions. The coastal belt is traditionally a region of fishing and small-scale farming. The forest zone occupies around a third of the country and is the main agricultural area. Cocoa beans are grown as the major export crop. Farmers also grow rubber, sugar cane and palm oil, as well as foods for local consumption. The northern savannah is suitable for livestock rearing, as well as for crops such as yams, rice and millet. Shea and kola nuts are also harvested in this zone ("Climate & Agriculture", 2016).

As stated by IFAD, feeding a global population of just over 9 billion in 2050 will require a 70 per cent increase in global food production and this will require that smallholder agriculture plays a much more effective role (Ifad.org, 2016). To increase agricultural performance, it is essential to target the smallholder farmers who constitute the largest segment of producers. Policy objectives should aim to improve the delivery of services to smallholder farmers and to develop new ways to include smallholder farmers in more efficient value chains ("Smallholder agriculture in Ghana | IFPRI", 2016). Effectively, to ensure the future viability of the agricultural sector in developing countries like Ghana, it is crucial to equip the smallholder farmers with the right tools.

1.3   Objectives

This document defines the system to be developed. The designer and developer as well as the end user will gain a better understanding by reading this document.

FarmConnect will be able to provide interested investors with concrete data that will inform their decision to invest in a chosen smallholder farmer. Also, an example farmer who farms with a hoe, who does not have a business plan, who does not farm using agricultural data like rainfall pattern, and has no way of accessing market information to inform his or her farming activities should be able to farm with knowledge when he or she uses FarmConnect.

The farmer can employ current market trends about crops, location of farming, be more organized in terms of their farming operations to enable investors who want to invest in their farm operations have the interest to do so. They should be able to farm with knowledge.

1.4   Related Work

Akudugu et al. (2009) examines women farmers' access to credit from rural banks in the Upper East region of Ghana. The paper proposes the modelling of socio-economic, technical, and institutional factors influencing women farmers' access to credit from financial institutions in general and rural banks. In total, 200 women farmers were randomly selected and information on socio-economic, technical, and institutional issues solicited from them. Ratio analyses were carried out and the logistic regression used to model the socio-economic, technical, and institutional factors that have influence on access to credit from rural banks by women farmers. The paper provides empirical evidence of close gender parity in terms of credit supply by rural banks in Ghana. About 44 per cent of the credit portfolios of rural banks in Ghana go to women and the remaining 56 per cent goes to men. Education, application procedures, access to land, income level, farm size, membership to economic associations, savings, type of crop grown, interest rate and distance to rural banks are the socio-economic, technical, and institutional factors that influence women farmers' access to credit. However, the paper is limited to only women farmers. There is the need for further research that considers men and women to establish whether there is gender insensitivity by financial institutions in Ghana and other developing countries. This paper brings to light the issues of access to productive resources such as production credit by women in developing countries, particularly Ghana.

Denkyirah et al. (2016) also observed that smallholder rice farmers in the Upper East Region of Ghana lack access to credit and this can hinder adoption of technologies introduced in the region, eventually impacting on productivity of rice which is one of the major cereals

cultivated and consumed in Ghana. A total of 140 rice farmers were sampled for the study in Kassena-Nankana district in the Upper East Region using a multi-stage sampling technique. This study employed the probit model to estimate factors that influence rice farmers' access to credit. The result of the study revealed that rice farmers invested the credit they access from formal and informal sources into non-agricultural activities which are mostly not what the credit was taken for. The probit result revealed that age, marital status, membership of farmer based organisation, extension visit, record keeping and farm income were the significant variables that influenced rice farmers' access to credit. Age and farm income negatively influenced farmers' access to credit while marital status, member of farmer based organisation, record keeping and extension visit positively influenced farmers' access to credit. The study recommends that rice farmers should be encouraged and sensitized to use the credit for agricultural activities to increase productivity. Extension agents should train rice farmers on record keeping since record keeping was seen to be a key factor that positively influenced farmers to receive credit especially from formal credit sources. Lastly, rice farmers should be encouraged to form groups, given that it also positively influenced farmers' access to credit.

Ansah et al. (2016). In another study mentioned that many farmers request for production credit to improve farm productivity, but are often denied by financial institutions. This study aims to answer these important but often overlooked questions: What factors characterize farmers who get denied of production credits? Does credit constraint lead to lower yield? A multistage sampling technique was used to select a cross-section of soybean farmers who applied for production credit in the Yendi Municipality and Saboba district of the Northern region of Ghana. A binary probit model was used to examine farmers who get denied of production credit. Correcting for sample selection bias, a propensity score matching was used to examine the effect of credit denial on crop yield. It was discovered that farmers who

are often denied access to production credit significantly lack prior training on their enterprises. In addition to that, farmers who are not members of Farmer Based Organizations, have their own buyers for their produce, have low experience, have no formal education, make no savings from their farm activities and are without access to credit information are more likely to be refused credit when applied. Refusing credit to farmers constrains their farm operations and makes them less productive. Policy implications are enormous; farmers would need to participate in training programmes on crop enterprises to increase chances of receiving credit from lending institutions; governments would need to intensify extension programmes where extension agents can facilitate farmer training.

Again, Bridget (2016) conducted a study using 121 semi structured interviews, two focus group discussions and several key informant interviews to investigate smallholder farmers' challenges over the course of a farming season, focusing on the main farming operations during different phases of the farming cycle. The results show that labour shortages during land preparation and weeding; and limited access to mineral fertilizer and hybrid seed constrain most households (83%) ability to increase total cultivated land. Post-harvest losses due to pests were reported by 42.1% of the respondents; 25% cited high transport costs while 25% lamented the low market prices for farm produce immediately after harvest as important challenges. The paper concluded that understanding of challenges and opportunities over the course of a farming season would aid development actors in designing and implementing appropriate interventions. The paper highlighted some of these challenges over the course of a farming season.

Mpandeli and Maponya (2014) said that macro-and micro-structural constraints, including those linked to and exacerbated by historical, natural, and financial factors are some of the many stressors facing small-scale farmers in Limpopo Province in South Africa are still facing major challenges in the agricultural sector. Some of the challenges found during the

formal surveys and focus group meetings in the Tshakhuma, Rabali and Tshiombo areas were those linked to financial, assets, land ownership and biophysical factors. Specific constraints included: market information and market access; price of inputs, for example fertilizer and herbicides; availability of inputs; irrigation; cost of transport, and natural constraint.

In other related work, which are more solution-oriented, I found out that GiveDirectly provides an end-to-end platform that enables funders to provide direct cash transfers to the extreme poor. Their unorthodox approach - allowing the poor, and not the donor, to choose how to invest - has driven debate both in press and policy circles (GiveDirectly, 2016). More also, One Acre Fund supplies smallholder farmers in East Africa with asset-based financing and agriculture training services to reduce hunger and poverty. Headquartered in Kenya, One Acre works with farmers in rural villages throughout Kenya, Rwanda, Burundi, Tanzania and recently Malawi using a market-based approach. One Acre Fund facilitates activities and transactions at various levels of the farming value chain, including seed sourcing and market support. In 2013, farmers who worked with One Acre Fund realised a 180% return on their investment and significantly increased farm income on every planted acre (One Acre Fund, 2016).

The issue of access to productive resources such as production credit came to light in this research. Most farmers do not keep records which is key to receiving credit especially from formal credit sources. Also, farmers who are not members of Farmer Based Organizations, who do not have their own buyers for their produce, who have no formal education and are without access to credit information are more likely to be refused credit when applied. Investors, Credit facilities, and various stakeholders can refuse smallholder farmers credit based on the factors above. However, refusing credit to farmers constrains their farm operations and makes them less productive. One Acre Fund and GiveDirectly have designed

solutions to enable smallholder farmers access funding in the midst of these challenges. There is therefore the motivation to do even more. This project does takes inspiration from their works. It seeks to collect essential information from smallholder farmers, analyse and present it on FarmConnect in search a way to convince an investor to invest in the smallholder farmer.

Considering that FarmConnect is being developed for users (the farmer, the investor, and the extension officer) who all have different backgrounds in terms of education, technical know-how, it is important that FarmConnect be such that, each of these users can interact with it naturally without the need for extensive training. As such FarmConnect will make use of sms which has been widely adopted in rural areas (Hargreaves & Robertson, 2009). Farmers who are mostly rural folks will be able to interact with FarmConnect via sms. Investors and extension officers on the other hand are expected to be able to interact easily with FarmConnect since it is assumed that they have at least had some level of exposure using Desktop PC, a laptop or a mobile device.

Chapter 2: Requirements

2.1 Requirements Gathering Plan

The first step is to identify the stakeholders who will be involved in this project. So far, the stakeholders identified are users (smallholder farmers, investors, and administrators—manages accounts).

The plan for requirement gathering is to identify one farmer who fits the definition of a smallholder farmer. After the first time, informal interaction with this farmer, a use case scenario will be written from which other use cases will be extracted. These use cases will help tailor specific interview questions to acquire more information.

2.2 Requirements Gathering Process

Initially FarmConnect was designed to eliminate middlemen since there was the assumption that middlemen prevented the smallholder farmers from reaching the investors directly and so a need for the smallholder farmer to be able to reach the investor without any hindrance. However, from experience, some resource persons identified that the smallholder farmer is not well organized to meet the criteria of a bigger investor and hence the need for a middleman or a facilitator. Also, the experience of some organizations I interacted with shows that there is a trust issue between the investor and the smallholder farmer. An example was cited that the organization used to invest in smallholder farmers especially in grains. They will agree on terms and in the end the farmer does not fulfil their part of the bargain. From such experience, the organization feels that farmers are dishonest, they are indiscipline and their attitude is not right.

In another organization visited, an app is used. With the app, there is an Aggregator who is a business minded person. The Aggregator is interested in buying produce and making profit and selling to bigger institutions. Aggregators can take loan from financial institutions and

may also be supported by the Advance—NGOs who support the Aggregators so they can in turn support the smallholder farmers. Typically, an agent makes 2 visits to the farmer in the Aggregator's network. The first to provide inputs to farmers, and the second to collect the return from the farmers. However, with the app, the agent will make 3 more visits in between the supply of inputs to farmer and collection of returns. The Aggregators using the app can be likened to the Investor in FarmConnect. A closer look at the business flow of the app clearly shows that so much power is given to the agent. The success of both the Aggregator, and smallholder farmer and other third parties depends on the agent. If you don't get a "good" agent, they whole system will not function effectively. It will collapse. Therefore, as a means to combat this challenge in FarmConnect, the agent (extension officer) will be closely monitored by the administrator to overcome the abuse of power should it arise.

2.3 Functional Requirements

From research into related work, information gathered from informal interviews, and visits to organizations and interacting with resource personnel, FarmConnect should be one that:

- Analyses and presents data collected from smallholder farmers in such a way that investors can quickly base their investment decisions on.
- Mines data to equip farmers with information that will enable them make operational decisions with regards to their farm activities.
- Mines data to give investors information that will enable them make informed decisions.

2.3.1 Users of FarmConnect

Four actors or users of FarmConnect have been identified. They include the smallholder farmer, investor, extension officer and administrator.

The Investor

He or she registers using the mobile web application interface. Upon registration and successful login, the investor is able to view the profiles of farmers who have been registered on FarmConnect. The investor can then choose to invest in a farmer who appeals to him or her.

The Extension Officer

He or she equally registers using the mobile web application interface. The extension office will profile and upload farmer data to FarmConnect which will then be processed and beautifully presented.
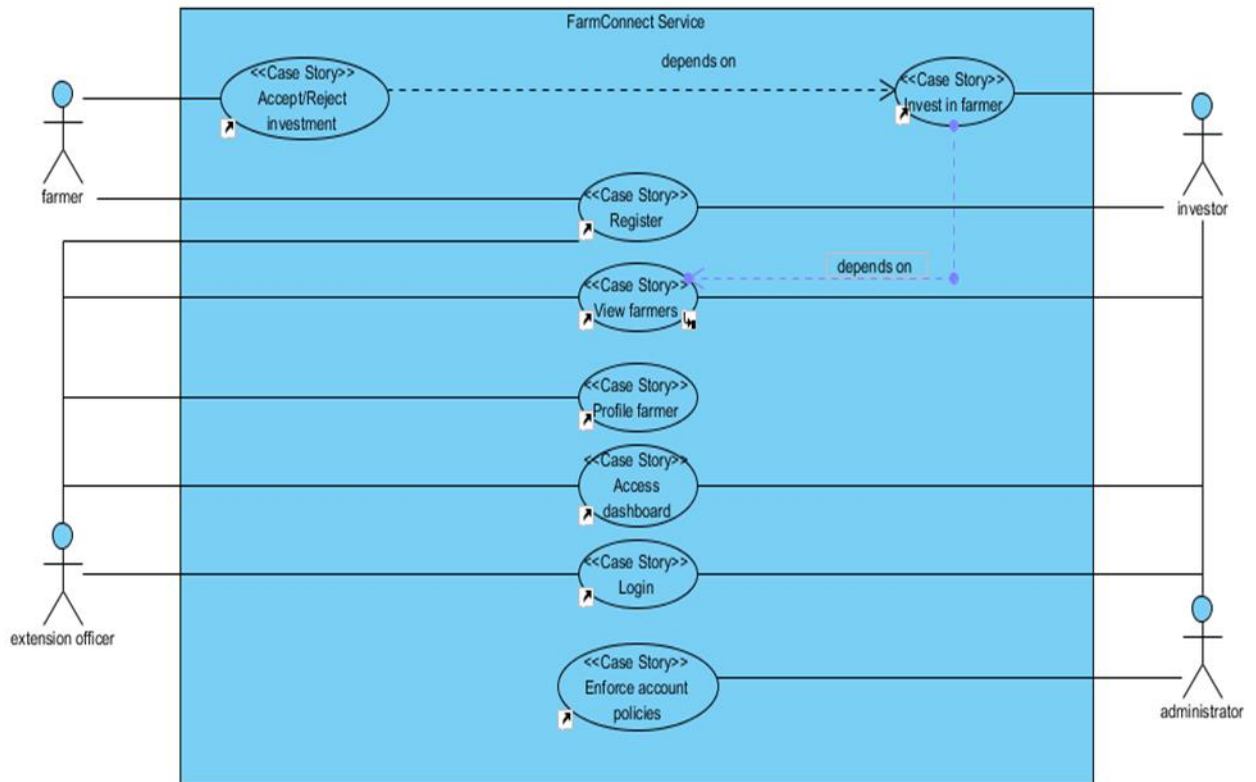
The Administrator

The no user can register as an administrator. Administrator accounts will be created by FarmConnect as and when needed. An administrator will ensure smooth operation of FarmConnect. He or she will not participate in the workflow of the application. He or she will be responsible for enforcing account policies, making sure users comply to policies associated with their accounts.

The Smallholder Farmer

He or she registers to use FarmConnect through sms. For registration to be complete, the smallholder farmer will have to visit an extension officer closer to him or her who have been assigned by FarmConnect. The extension officer will ask various questions which will help gather data about the farmer. These data will be processed by FarmConnect and presented to the investor.

Below is a use case diagram highlighting the identified use cases associated with each user of FarmConnect. Refer to appendices for user stories and functional requirements specific to each of the users above and the use cases below.

2.3.2 Use Cases

Figure 1: use cases diagram

The use case diagram above as well as the user stories and functional requirements outlined under appendices were generated using Visual Paradigm, a software design tool tailored for agile software projects. After identifying the various use cases and functional requirements, I read the documentation and watched youtube videos on how to document software requirement specifications using Visual Paradigm.

2.4 Technical Requirements

2.4.1 Performance

Response time for queries should be less than 400 milliseconds. Using ElasticSearch for data storage will help achieve this since it is incredibly fast when it comes to searching. FarmConnect data servers should be able to process 275 requests in approximately 110,000

milliseconds. The assumption is that, within this period, a request will be made by a user from each of the 275 constituencies in Ghana.

2.4.2 Scalability

The System be designed with the ability to accommodate increasing number of users, transactions per millisecond, number of SQL statements that can run and provide results simultaneously.

2.4.3 Security

There is the need to control access to data. This includes controlling who may view and alter FarmConnect data. Loss or corruption of data will cost investors huge sums of money hence the need to backup periodically. Disclosure of secrets or sensitive information, privileged/privacy information about users should not be tolerated. Physical security such as access to FarmConnect server computers and network should be restricted. There should be access control based on user role or type. Administrators for instance should not be able to participate in the normal workflow of the application. Data should be encrypted where necessary and possible. User's activities should be logged to enable tracing in case there is any fault.

2.4.4 Usability

A documentation and help manual should be provided. The user documentation and help should be complete. The help should be context sensitive and explain how to achieve common tasks. The user interface should be designed in such a way that it is familiar to the typical user. Icons and visuals may be used so that users easily identify and learn what the components do.

2.4.5 Availability

The system should be available 99.99% of the time for any 24-hour period. The peak times

of usage is estimated to be between 11:00 am GMT and 3:00pm GMT since Ghanaians are

active during these times. These are times when system unavailability is least acceptable.

Chapter 3: Architecture and Design

3.1 High Level Architecture

This initial architecture (Figure 2) of FarmConnect service shows that the system can mine farming-related data and persist such data on a central server. The data may also be spread across multiple servers if it becomes too bulky and inefficient to be stored in a single location. FarmConnect will fetch the farming-related data together with profile data on farmers uploaded by Extension Officers (Trained Agents), process and present the data in a visually appealing manner to investors and various stakeholders. Investors can invest in any farmer they are interested in. They also get market information to help them in making informed investment decisions. Farmers can also get information such as market prices on various farm produce to aid decisions in their farming operations.
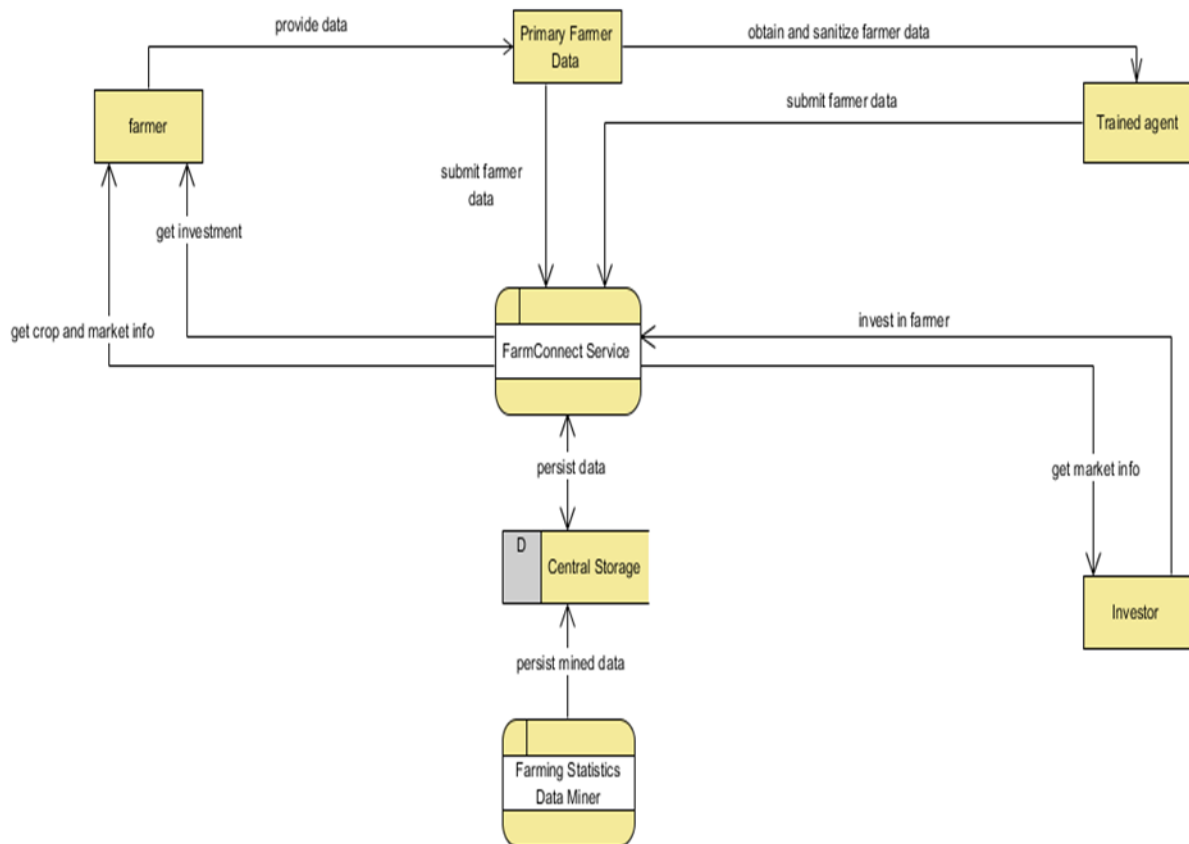
Figure 2: high level architecture 1

3.2 Data Storage

Data storage is done using both relational and schema-less databases. MySQL will be used to store data on users of FarmConnect as well as the transactions performed by users. Referential integrity is very important for the transactions performed by users of FarmConnect hence the need for relational database. However, data sets on farmers as they become huge will have to be spread across multiple servers. It is still expected that fetching farmer data across such distributed system will be fast hence the need for ElasticSearch. Besides, the attributes of farming-related data that will be mined from other sites is not known beforehand. As a result, it will be difficult modelling such data using the relational model. ElasticSearch is a search server which provides a distributable full-text search engine that's accessible through a restful interface. ElasticSearch is schema-less, and uses JSON. It is open-source and built in Java. ElasticSearch is a document-based store. It is an alternative to traditional document stores, so it can be used to replace other document stores like MongoDB or RavenDB. ElasticSearch is incredibly fast when it comes to searching (Codementor, 2017).

For all those coming from traditional MySQL databases, here is a table comparing ElasticSearch terminology with traditional relational database terminology:

MySQL (RDBMS) Terminology	ElasticSearch Terminology
Database	Index
Table	Type
Row	Document

MySQL => Databases => Tables => Columns/Rows

ElasticSearch => Indices => Types => Documents with Properties.

An ElasticSearch cluster can contain multiple Indices (databases), which in turn contain multiple Types (tables). These types hold multiple Documents (rows), and each document has Properties(columns).

3.2.1 Schema for Relational Database Aspect of FarmConnect Data Storage
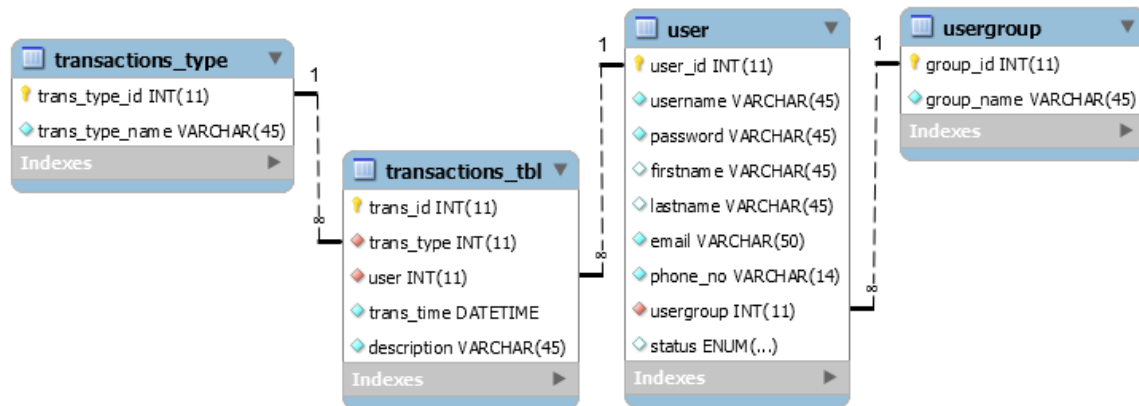

Figure 3: users and transactions database schema

From the schema, a user belongs to a usergroup. A user can perform transactions. Each transaction must belong to a transaction_type.

3.2.2 Structure for Schemaless Aspect of FarmConnect Data Storage

As stated earlier, the attributes of farming-related data that will be mined from other sites and data received from APIs may not be known in advance hence making it difficult to model such data in a relational database structure. Nevertheless, a document which stores farm-related data about a farmer in ElasticSearch is expected to have at least the following properties. Some of these data may be obtained directly when an extension officer is profiling the farmer. Others may be obtained using Esoko API, WorldBank data on agriculture.

- farmer's name
- farm location
- farmer's image

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- farmer's rating

- farm size

- latest prices of farm produce at major markets in Ghana (Agbogbloshie, Bolgatanga, Kumasi_Central, Takoradi, Techiman, Wa)

- farmer's mobile_no

- investment_required

- market opportunity of farm produce at closest market to farmer (demand and supply)

- average farm yield (farmer, peers and national)

- data on critical conditions that affect farm yield

- investment history

- farm revenue

3.3 System Components

FarmConnect consists of the following components:

3.3.1 User module

The user module is made up of an sms application through which the farmer interacts with FarmConnect. See Figure 4, Appendix Item 5: Use Case Accept/Reject investment, Appendix Item 1: Use Case Register, Appendix Item 6: Use Case Profile farmer, and Appendix Item 4: Use Case Invest in farmer for details on farmer's interaction with the system via sms. The user module also has a mobile application interface through which the investor and the extension officer access services provided by FarmConnect. See Appendix Item 1: Use Case Register, Appendix Item 6: Use Case Profile farmer, and Appendix Item 4: Use Case Invest in farmer for details on the services available to them.

3.3.2 Admin module

The admin module has features accessible to only admins. Administrators of FarmConnect cannot participate in the workflow of the application. They exist to enforce account policies and monitor system performance. See Appendix Item 8: Use Case Enforce account policies for details on admin module of FarmConnect.

3.3.3 SMS Center

The SMS Center is a module that receive, process and send appropriate responses to all sms that come to FarmConnect. Figure 4 below for example shows how the Farmer sends sms request to be registered. The module responds with an sms instructing farmer the next steps to take. It also sends an sms to the nearest extension officer to the farmer to take appropriate action. Figure 5 below shows how FarmConnect sends an sms to the farmer when an investor proposes an offer. The farmer must reply the sms with 1 indicating acceptance or 0 indicating rejection of the proposed investment offer. See implementation section for how all this work in the system using APIs and code snippet.
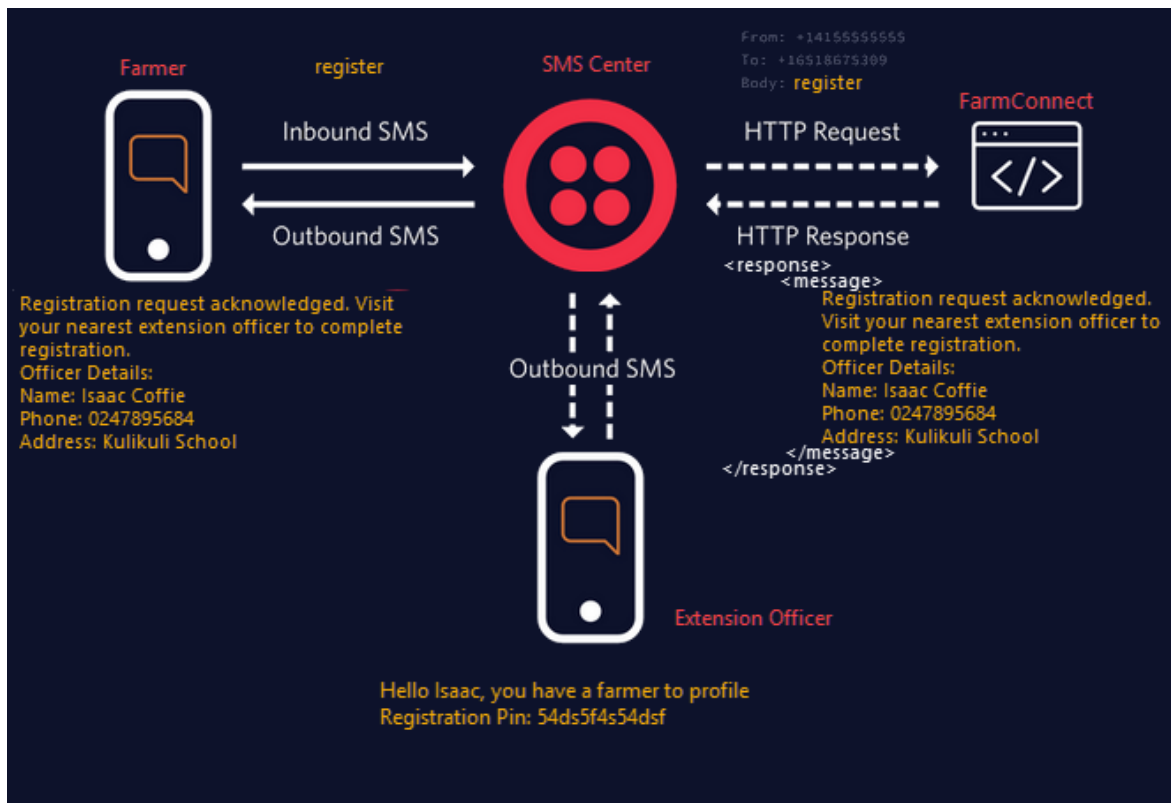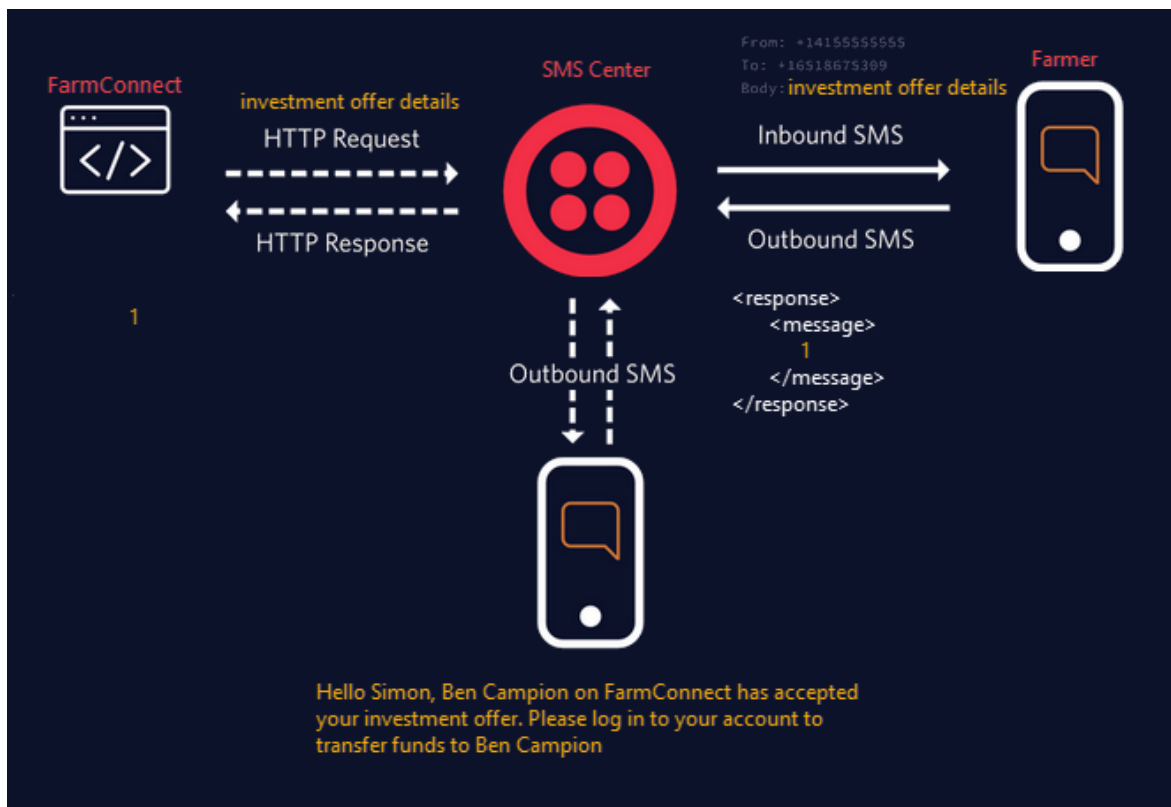
Figure 4: smallholder farmer sms registration

Figure 5: accept or reject investment sms

3.3.4 Payment Processing module

This module is responsible for transferring money from the investor to the farmer. This is achieved using MPower Payment System. The investor can transfer funds either from Mobile Wallets (Mobile Money), Credit & Debit Cards, FCB Speedbank Vouchers & Bank Transfers to FarmConnect MPower account. Upon receipt, FarmConnect transfers such amount to the farmer via Mobile Money. This is one of the reasons why it is required for the farmer to own a Mobile Money account before they can register on FarmConnect. See implementation section for how this is implemented using APIs and code snippet.

Chapter 4: Implementation

4.1 Setup

To decide the platform to use, web, mobile and desktop application were considered systematically. I considered each platform by looking at the advantage and disadvantage of using it in the project.

4.1.1 Web

It should be used because both farmers and investors may want to transmit information over the internet. More also, a web application will allow the farmer and the investor to overcome communication challenges created by geographical boundaries, transacting with each other seamlessly. That is the same system installed on different computers which are in different parts of the world will still be able to communicate or interact or transact with each other. No reason was particularly identified for FarmConnect to not be a web application.

You did not address the issue of access to internet

4.1.2 Mobile

It should be used because the investor or the farmer may need to access the system on the go. The system should be portable enough to meet this requirement. Also, a farmer who does not own a smartphone should still be able to use FarmConnect services. No particular reason was identified for the system not to be mobile.

4.1.3 Desktop

A desktop solution will not allow the system to be portable. Also, interaction between the same systems installed on different computers becomes difficult. Besides, not all smallholder farmers can own and operate a desktop computer.

Hence, the conclusion of the evaluation is FarmConnect should be such that it combines mobile and web technologies. FarmConnect should be able to integrate existing solutions like esoko farmer support services and VOTO mobile technologies. It should integrate easily with APIs.

4.2 Implementation Resources

4.2.1 Server Side

PHP: PHP is very accessible and cheap to setup. It is easy to deploy and there are a lot of people who know how to use the language which makes finding and reusing components quick and easy. It is not quite bulky as compared to java. It can integrate with a lot of other technologies with less difficulty.

Apache web server: Apache Web Server is designed to engender Web servers that have the capability to host one or more HTTP-based websites. Eminent features include the ability to support multiple programming languages, server side scripting, an authentication mechanism and database support.

4.2.2 Client Side

Framework 7: This is a full featured HTML Framework for building iOS & Android Apps. Framework7's learning curve is pretty easy. If you know HTML, CSS, and a bit of JavaScript, then it is easy to create apps with Framework7.

4.2.3 Build System

Adobe PhoneGap Build System: Adobe PhoneGap provides a way to create cross-platform mobile applications using technologies such as HTML, CSS, and JavaScript. Applications created with PhoneGap can be distributed to various vendor app stores (ex: Apple App Store) and installed on an end-user's device like any other native application.

4.2.3 Data Storage

Elasticsearch: Elasticsearch is a NOSQL, distributed full text database. This means that the database is document based instead of using tables or schema. Elasticsearch is a distributed search engine that is incredibly easy to scale and returns results at lightning speed.

How about Analytics tools? Most software generates tons of data that is worth analysing. Elasticsearch comes with Logstash and Kibana which give a full analytics system. Since there will be analytics and forecasting for farmers and investors, Elasticsearch will prove very useful.

4.2.4 Reporting and Charting

Google Charts will be used for drawing charts. It is free, simple to use, and has a rich gallery of interactive charts and data tools.

4.2.5 APIs

MPower Payments API: MPower is a new payment service that works with a preferred digital wallet or bank account to offer a convenient, safer, and overall better payment experience. It is a complete end-to-end online and mobile payment transactions solution to enable consumers and businesses send, spend and receive payments. MPower Payments supports payment methods including Mobile Wallets (Mobile Money), Credit & Debit Cards, FCB Speedbank Vouchers & Bank Transfers. This will be used to transfer funds from investors to farmers.

Twilio API: Twilio is a communications platform that enables phones, video, voice-over-IP, and messaging to be embedded into desktop, web, and mobile software. Twilio allows software developers to programmatically make and receive phone calls and send and receive text messages using its web service APIs. This will be used to send and receive messages on the platform.

SMS Gateway API: Using their free service you can turn your Android phone into a free SMS Gateway. Allowing you to both send and receive SMS messages programmatically using their restful API.

4.3 Implementation Process and Approach

A series of prototypes for the mobile application interfaces were designed and shown to colleagues and Faculty Interns. Feedback and comments received were used to improve the designs to finally come up with colours and interfaces shown for example by Figure 9. See Appendix Item 9: Implementation Iterations for some design iterations that led to the final design.

The smallholder farmer will not need to interact with FarmConnect through the mobile application interface. They will interact with FarmConnect via sms. This will be during registration when they send sms (message "Register") to a dedicated FarmConnect mobile number to initiate the process. FarmConnect will reply the smallholder farmer with the details of the extension officer to visit to complete their registration. Also, FarmConnect will notify the extension officer in advance of the farmer who need to be profiled. How does the system know which extension officer details to send? Will it query the database? Another instance when they will be interacting with FarmConnect via sms is when they need to accept or reject an investment offer received.

4.3.1 SMS Center

The sms center was first implemented using Twilio API. To use the API, you register for an account and download their SDK and follow the instruction manual to install it. Below is a code snippet showing how the API is used to send sms.

```php
1. <? php
2. $recipient = (string) sprintf("%'.+13d", $_REQUEST['recipient']);
3. $farmer_num = (string) sprintf("%'.+13d", $_REQUEST['farmer_num']);
4. $farmer_pin = $_REQUEST['farmer_pin'];
5.
1. // Get the PHP helper library from twilio.com/docs/php/install
2. // Require the bundled autoload file - the path may need to change
3. // based on where you downloaded and unzipped the SDK
6. require __DIR__.'/twilio-phpmaster/Twilio/autoload.php'; // Loads the library
7.
8. // Use the REST API Client to make requests to the Twilio REST API
9. use Twilio\ Rest\ Client;
10.
11. // Your Account SID and Auth Token from twilio.com/console
12. $account_sid = 'your account id';
13. $auth_token = 'your token';
14. $client = new Client($account_sid, $auth_token);
15. // Use the client to do fun stuff like send text messages!
16. $client - > messages - > create(
        1. // the number you'd like to send the message to
```

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```php
17.          $recipient,
        1. array(
        2.   // A Twilio phone number you purchased at twilio.com/console
18.          'from' => '+12818164490',
        1.   // the body of the text message you'd like to send
19.          'body' => 'Hello Isaac, You have a Farmer to profile! Mobile Number:'.$f
    armer_num.
20.          ' Registration Pin:'.$farmer_pin
        1. )
        );
```

Figure 6: send sms twilio

Twilio API offers a trial account and that means a limited number of sms can be sent. Moreover, the idea of building webhooks to respond to inbound sms using the API through what they call TWIML (Twilio XML) was quite complicated to learn. Consequntly, I then decided to look for a free and an alternative easier to comprehend. I found SMS Gateway. To use their API, you will need to download the SMS Gateway API app free on the Android play store. The app allows you to communicate to your device using their API service. The next step is to open yourself a free account. You can then read their documentation to find

out how to perform a wide variety of tasks including sending and receiving SMS messages programmatically through your Android phone using their API service. Below are code snippets showing how to send and receive sms.

Send sms

The Send sms

```php
1. <? php
2. $extension_officer = (string) sprintf("%'.+13d", $_REQUEST['ext_num']);
3. include "smsGateway.php";
4. $smsGateway = new SmsGateway('email, 'password');
5. $deviceID = your device id;
6. $number = $extension_officer;
7. $message = 'u have a farmer to profile!';
8. $result = $smsGateway - > sendMessageToNumber($number, $message, $deviceID); ?>
```

Figure 7: send sms

Reply sms

Reply sms

```php
1. <? php
2. // reply to sender
3. echo "visit ur nearest ext officer.";
4.
5. // send message to extension officer
6. // Get cURL resource
7. $curl = curl_init("http://localhost/sms_center/sms-gateway-
   me/send.php?ext_num=+233247995869");
8.
9. // send the request
10. curl_exec($curl);
11. // Close request to clear up some resources
12. curl_close($curl);
13. ?>
```

Figure 8: reply sms

4.3.2 Login/Register.

Unlike the smallholder farmers on FarmConnect, the Investors, Extension Officers, and Administrators will interact with FarmConnect through the mobile application interface. As such they need to be logged to access features of FarmConnect that they are entitled to. Apart from the administrator who is assigned a unsername and password by the system, the others must register to be able to log in and use the services. See Figure 9.

Figure 9: login/register

When the investor logs in, he or she can view an ordered list of registered farmers. See Figure 10 below. In deciding the data to display for each listed farmer below, it was taken into consideration that investors do not have time to waste and as such the data should be precise and relevant as much as possible. The list should communicate the image of the farmer, the name of the farmer, the investment required, the average yield, the investment history if any, and trust level represented by colour codes.

Figure 10: list of farmers

4.3.3 The Colour Codes

A combination or a group of three (3) same or different colour codes represent the trust level—the level of confidence with which FarmConnect can declare that the smallholder farmer in contention is not fraud. The first colour code with the initial 'M' indicates whether the farmer is mobile money registered or not. Mobile money was chosen because mobile network operators collect details such as the voter, health insurance or passport ID number, the passport picture as well as biographic and demographic details before registering a user. As such, it will be easy to trace a farmer using their mobile money registration details should any fraud arise. The second colour code with the initial 'F indicates whether the location of the farmer is verified or not. The third colour code with the initial 'S' indicates whether the

farmer has obtained a verified stamp from an assemblyman of the farmer's location or not. A red colour code indicates not verified and orange colour code indicates verified. For instance, Figure 11 shows that the farmer has no mobile money registration, farm location is not verified and farmer has not obtained a stamp from his or her assemblyman. On the other hand, Figure 12 shows that the farmer has mobile money registration, farm location is verified and farmer has obtained a stamp from his or her assemblyman.

Figure 11: red colour codes (not verified)

Figure 12: orange colour codes (verified)

4.3.4 Detail Farmer Profile

The investor can click to view the detail profile of any of the listed farmers shown by Figure 10 and possibly invest in the farmer. Detail profile shows data such as farmer's name, farm description, farm location, security rating (trust level colour coded), performance rating, investment required, market opportunity at closest market to farmer (demand and supply), farm yield, latest prices of farm produce, data on critical conditions that affect farm yield, investment history, farm revenue, etc. In implementing this feature, consideration was made as to the most relevant five (5) or more criteria based on which an investor will be fully convinced to invest in a farmer. The criteria decided on were:

- market opportunity at closest market to farmer (demand and supply)

- farm yield

- latest prices of farm produce

- data on critical conditions that affect farm yield

- investment history

- farm revenue.

These criteria were all factored into building a very attractive profile, sample shown by Figure 14 below which will attract the investor to invest in the farmer. The location of the farm is displayed using google maps. Also, the data is displayed using google charts so the investor can easily visualize the data.

The Google Charts were implemented using simple JavaScript. You load some Google Chart libraries, list the data to be charted, select options to customize your chart, and finally create a chart object with an id that you choose. Then, later in the web page, you create a <div> with that id to display the Google Chart. See the code snippet below for example implementation.

```
1.  //load all the packages you need
2.  google.charts.load('current',   {
3.        'packages':   ['bar',  'table',  'corechart']
4.  });
5.
6.  // draw Market Opportunity (demand and Supply) pie chart
7.  google.charts.setOnLoadCallback(drawOptChart);
8.
9.  // for market opportunity pie chart
10. function drawOptChart()  {
11.     var data =  google.visualization.arrayToDataTable([
12.         ['Type', 'Quantity'],
13.         ['Demand (Bids)', json.farmer_data[selected_farmer_id].demand],
14.         ['Supply (Offers)', json.farmer_data[selected_farmer_id].supply]
15.     ]);
16.
17.     var monthNames =  ['January', 'February', 'March', 'April', 'May', 'June', 'July', 'August', 'September', 'October', 'November', 'December'];
18.
19.     // set chart options
20.     var options = {
21.         'title':   'Average ' + monthNames[new  Date().getMonth()]  +  ' Demand/Supply',

22.                  'titleTextStyle': {
23.             fontSize:  16,
24.                     bold:  false,
25.                     italic:  false
26.         },
27.                  'pieSliceText':  'value'        |
28.     };
29.
30.     // attach chart to div element
31.     var chart  =  new  google.visualization.PieChart(document.getElementById('piechart'));
32.     chart.draw(data,  options);
33. }
```

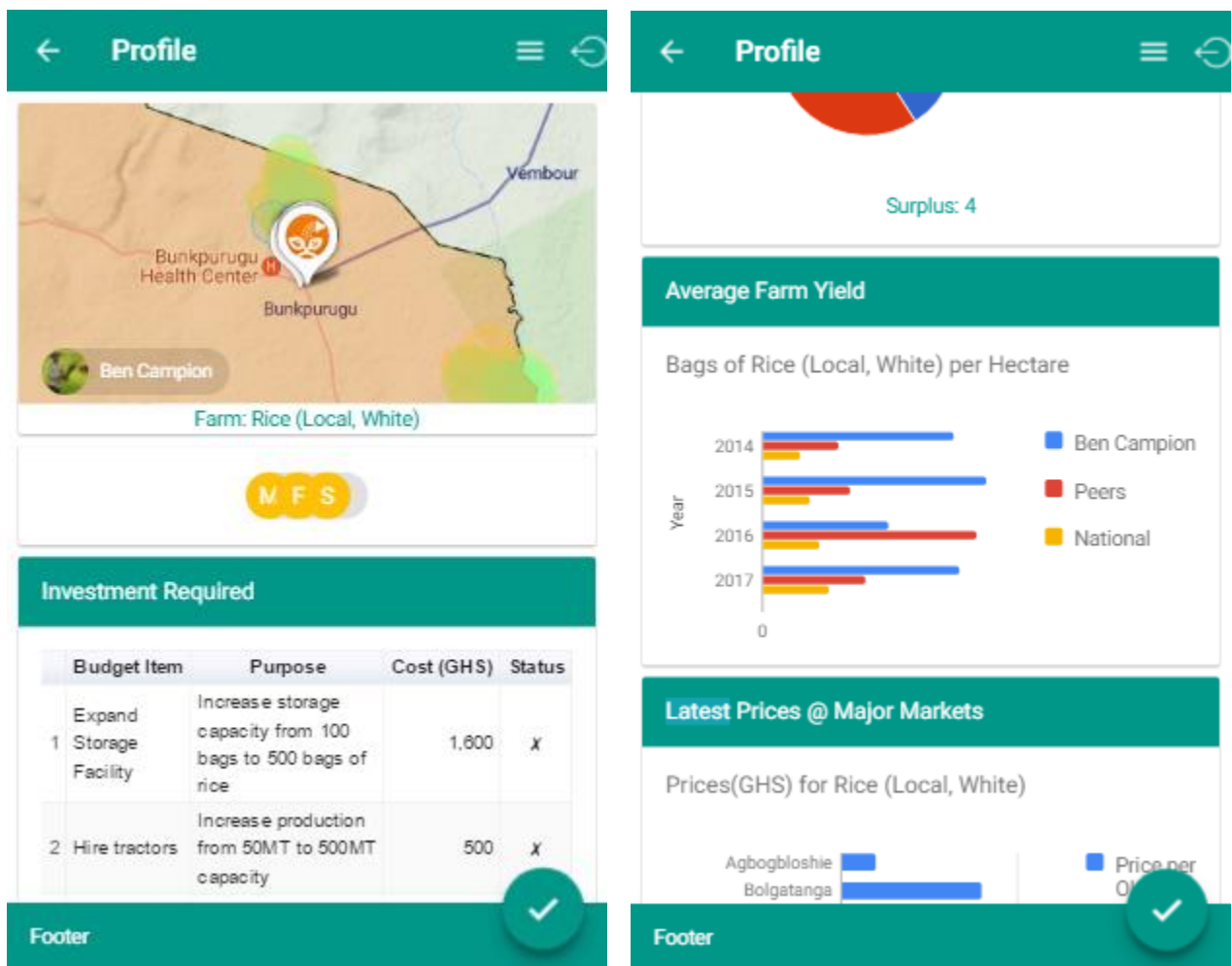*Figure 13: example google chart implementation*

Figure 14: farmer profile/invest in farmer

The investor can click on the floating button on the footer shown on *Figure* 14 to invest in the farmer. A confirm dialog as shown on Figure 15 will be displayed asking the investor to select the percentage (%) return on their investment, confirm the recipient's mobile phone number, and the amount to be transferred. An sms will be sent to the farmer to accept or decline the investment offer. A notification (see as part of Figure 16) is shown to investors accordingly telling them they will be notified when the farmer accepts or rejects their investment offer. Also, a successful transfer of funds to the farmer will be confirmed by a dialog shown as part of Figure 16. See payment processing for how the transfer of funds is implemented.

Figure 15: transfer funds

Figure 16: funds transfer successful

4.3.5 Payment Processing

The payment processing was implemented using MPower Payment System. To use the API, you first register for an MPower account to acquire API keys. You then download and unzip their client SDK to install. Finally, you require Mpower PHP library in your code and then set up your API keys. Below is a code snippet showing how payment is processed using the API.

```php
1.  <? php
2.  $farmer_name;
3.  $mobile_no;
4.  $amount_to_transfer;
5.  if (isset($_REQUEST["mobile_no"])) {
6.      $farmer_name = $_REQUEST["farmer_name"];
7.      $tmp_no = $_REQUEST["mobile_no"];
8.      $mobile_no = (string) sprintf("%'.010d", $tmp_no);
9.      $amount_to_transfer = (double) $_REQUEST["amount"];
10. } else {
11.     exit();
12. }
13.
14. //Require Mpower PHP library
15. require 'mpower.php';
16.
17. //Setup your API Keys
18. MPower_Setup::setMasterKey(YOUR_API_MASTER_KEY);
19. MPower_Setup::setPublicKey(YOUR_API_PUBLIC_KEY);
20. MPower_Setup::setPrivateKey(YOUR_API_PRIVATE_KEY);
21. MPower_Setup::setMode(["test" | "live"]);
22. MPower_Setup::setToken(YOUR_API_TOKEN);
23.
24. //DirectPay Request //You can pay any MPower account directly via your third party apps.
25. $direct_pay = new MPower_DirectPay();
26. if ($direct_pay - > creditAccount($mobile_no, $amount_to_transfer)) {
27.     echo $direct_pay - > description.
28.     "\n";
29.     echo $direct_pay - > response_text.
30.     "\n";
31.     echo $direct_pay - > transaction_id.
32.     "\n"; //echo "<br><br>"; //echo "We will notify you when $farmer_name Accepts or Rej
    ects your offer.";
33. } else {
34.     echo "Error : ".$direct_pay - > response_text.
35.     "\n";
36. } ?>
```

Figure 17: mpower payment processing

Chapter 5: Testing and Results

5.1 Unit Testing

The key conception is that each piece of code needs its own tests and the best person to test that code is the developer working on it. Allowing developers to test their code as they write it ascertains that quality is built in from the commencement. Hence, unit tests were performed for adding, getting, updating, and deleting data from both MySQL and ElasticSearch databases. See Table 1: sample unit testing for an example unit test.

Unit Test point	Testing	Expected Result	Actual Result
SQL statement to delete booking	Run SQL statement with test inputs using MySQL WorkBench. Test input: no test input SQL query: `"SELECT * FROM farmers";`	*6 row(s) returned*	*6 row(s) returned*

getFarmers() method in DatabaseHelper class	Code to create object of the class and call the method with test inputs and compare output in database.
	
	Test input: no test input
	
	Code:
	
	``php
	1. <? php
	2. include_once("databasehelper.php");
	
	3. $obj = new DatabaseHelper();
	4. $obj -> getFarmers();
	5. while($row = $obj -> fetch()) {
	6. echo "$row";
	7. }
	8. ?>
	``
		Count of number of farmers returned should be 6	*Count of number of farmers returned is 6*

getFarmers() method in DatabaseHelper class	PHP unit test to test the code.
	
	Test input: no test input
	
	Code:
	
	``php
	<? php
	include_once("databasehelper.php");
	class TestDatabaseHelper extends
	PHPUnit_Framework_TestCase {
	   public function testGetFarmers() {
	      $obj = new DatabaseHelper();
	      // get all farmers available
	``
		OK (1 test, 2 assertions)	OK (1 test, 2 assertions)

```
        $this->assertEquals(true, $obj-
> getFarmers());
        // count the number of rows
        $this->assertEquals(6, $obj->result-
>num_rows);
    }
}
```

Table 1: sample unit testing

5.2 Component Testing

Component testing is a method where testing of each module in an application is done separately. It finds the defects in the modules. Component testing may be done in isolation from rest of the system. See Table 2: sample component testing for an example component test.

Component Test point	Testing	Expected Result	Actual Result
SMS module	Send outbound sms using HTTP request. Test Input: http://localhost/sms_center/sms-gateway-me/send.php?ext_num=+233247895684	*SMS received on phone:* *"Hello <extension officer>, you have a farmer to profile"*	*SMS is received on phone:* *"Hello Isaac, you have a farmer to profile"*
	Reply inbound sms sent by farmer requesting to register. Test Input: http://localhost/sms_center/sms-gateway-me/reply.php	*Receive sms reply on phone:* *"visit your nearest extension officer to complete registration"*	*SMS reply received:* *"visit your nearest extension officer to complete registration"*
Payment processing module	Send HTTP request. Test Input: "http://localhost/payments/mpower_php/process_payment.php?farmer_name=Ben Campion&mobile_no=+23324789 5684& amount=3100"	*HTTP response: "We will notify you when <farmer> Accepts or Rejects your offer"*	*Got HTTP response: "We will notify you when Ben Campion Accepts or*

			Rejects your offer"

Table 2: sample component testing

5.3 System Testing

It focuses on testing the system as a whole. Once the components are integrated, the system as a whole is rigorously tested to ensure that it meets the Quality Standards. See Table 3: sample system testing for an example system test.

System Test point	Testing	Expected Result	Actual Result
Application Landing Page	Launch by clicking app icon to access the landing page of the application	*See page with login and register buttons*	*Landing page displayed with login and register buttons*
Application Home Page	Enter username and password, click login button on landing page	*See page with list of farmers displayed*	*Home page with list of farmers is displayed*
View Detail Profile of Farmer	Click on a listed farmer displayed on the Home page	*See page detailing the profile of farmer.* *Elements of profile: farmer's name, farm description, farm location, rating, investment required, market opportunity, farm yield, latest prices of farm produce*	*Profile of farmer is shown with farmer's name, farm description, farm location, rating, investment required, market opportunity, farm yield, latest prices of farm produce*

Table 3: sample system testing

Chapter 6: Conclusions and Recommendations

Features related to Extension Officers and Administrators are still pending. They have not been implemented. However, features related to Investors and Smallholder farmers have been implemented. This is because the current phase of implementation assumes that an extension officer has collected data on the smallholder farmer and uploaded to FarmConnect servers. Therefore, the focus is to fetch such data, process, analyse and present the most relevant of it to the investor so he or she can quickly decide whether to invest in the farmer or not.

A field test has not been conducted where real smallholder farmer data is collected, processed, and presented on FarmConnect to enable a real investor test the system. Dummy data has been used. Therefore, it is necessary that real data be collected and an investor allowed to test the system in order to confidently ascertain that all things being equal, the smallholder farmer can find investment using FarmConnect platform.

A real investor has not tested FarmConnect. Nevertheless, data such as image of the farmer, the name of the farmer, the investment required, the average yield, the investment history, and trust level represented by colour codes should give the investor some level of confidence to trust the farmer.

Features that will enable the farmer to farm with knowledge of weather, market trend will be implemented in the next phase of implementation.

What has been most challenging during this current phase of implementation is getting test data that mirrors that of a smallholder farmer in the real world. As such, much of the data used so far were modelled with assumptions. That means FarmConnect has to be tested with real field data to see how it functions under actual constraints in the environments.

APPENDICES

Appendix Item 1: Use Case Register

Primary Actors	⚇ extension officer, ⚇ farmer, ⚇ investor
Level	Summary
Complexity	High
Use Case Status	Base
Implementation Status	Scheduled
Preconditions	A farmer should have a mobile money account
Post-conditions	A confirmation notification should alert the user of a successful or failed registration
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 **The administrator should receive such notification for enforcement of policies**	UC02.REQ005	Functional
📄 **The extension officer should receive notification about the farmer whose profile has to be completed**	UC02.REQ003	Functional
📄 **The farmer can send sms to the system to initialize registration process**	UC02.REQ001	Functional
📄 **The farmer should be assigned to the closest extension officer to complete the registration**	UC02.REQ002	Functional
📄 **The notification should include the duration given the extension officer within which to complete the registration**	UC02.REQ004	Functional

User Story

As farmer, ext. officer or investor, I can register for an account so that I can use the system

Properties

Sprint	N/A
Status	Pending

Conversation

- I want to be able to register offline as a farmer

- I want the extension officer to be monitored so he or she does not delay my registration

Confirmation

sms sent from number without mobile money account should not be processed for registration
extension officer's application to register should have met requirements before processed

Scenarios

extension officer

1. launch app
2. click register as extension officer
3. fill in details
4. click submit button

farmer

1. send sms (register to 123)
2. visit extension officer assigned to complete registration

investor

1. launch app
2. click register button
3. fill in details
4. click submit button

Appendix Item 2: Use Case Login

Primary Actors	👤 administrator, 👤 extension officer, 👤 investor
Level	Summary
Complexity	Low
Use Case Status	Initial
Implementation Status	Scheduled
Preconditions	On application access, a screen must show a login form to allow for the entry of a user's security credentials.
Post-conditions	A correct username/password combination should authenticate the user and allow access to the application. An incorrect combination of username/password should display an appropriate notification to the user. Such notification should simply address an incorrect combination but not reveal the validity of the username or the password
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 **A correct username/password combination should authenticate the user and allow access to the application.**	UC03.REQ006	Functional
📄 **A user's security credentials shall consist of a minimum of a user name and a password.**	UC03.REQ002	Functional
📄 **After login, a user's role is shown in a clearly visible section of the application, suggested is a page header location**	UC03.REQ008	Functional
📄 **An incorrect combination of username/password should display an appropriate notification to the user. Such notification should simply address an incorrect combination but not reveal the validity of the username or the password**	UC03.REQ007	Functional
📄 **On application access, a screen must show a login form to allow for the entry of a user's security credentials.**	UC03.REQ001	Functional

📄 **The user must change the password after a configurable period.**	UC03.REQ004	Functional
📄 **The user must choose a different password than the current one when changing password after a password expiry event.**	UC03.REQ005	Functional
📄 **The username shall be treated as case insensitive.**	UC03.REQ003	Functional

User Story

As an admin, ext. officer or investor, I can log in to use the system

Properties

Sprint	N/A
Status	Pending

Conversation

■ I want my account to be safe

Confirmation

	login should be successful for correct username/password combination
	login should not be successful for incorrect username/password combination
	password should expire after the configured period
	notification should be sent to user to create new password

Scenarios

1. launch the app
2. enter username and password
3. click login button

Appendix Item 3: Use Case View farmers

Primary Actors	👤 extension officer, 👤 investor
Level	Summary
Complexity	Medium
Use Case Status	Base
Implementation Status	Partially Complete
Preconditions	A correct username/password combination should authenticate the user and allow access to the application.
Post-conditions	Display a list of registered farmers The list should communicate the investment required, average yield, the investment history if any, and trust level represented by color codes
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 Display a list of registered farmers	UC12.REQ001	Functional
📄 Farmers whose profiles have been visited should be archived in investor's dashboard	UC12.REQ004	Functional
📄 The list should be ordered based on investor's preferences, yield, investment history and trust level	UC12.REQ003	Functional
📄 The list should communicate the investment required, average yield, the investment history if any, and trust level represented by color codes	UC12.REQ002	Functional

User Story

As an investor, ext. officer, I can view list of farmers so that I can perform some action on a selected farmer.

Properties

Sprint	N/A

Status	Pending

Conversation

- I want to see the farmers

- I want to be able to trust the farmer

- I want to see farmers that match my interests

- I want farmers recommended to me

Confirmation

| **should display a list of registered farmers ordered based on investor's preferences, yield, investment history and trust level** |
|---|
| Farmers whose profiles have been visited should be archived in investor's dashboard |

Scenarios

1. login
2. scroll to view list of farmers
3. click a listed farmer to view profile

Appendix Item 4: Use Case Invest in farmer

Primary Actors	☺ investor
Level	User
Complexity	High
Use Case Status	Base
Implementation Status	Partially Complete
Preconditions	Investor should be able to view data about the farm and the farmer to make informed investment decision
Post-conditions	Farmer should receive an sms with investment details The farmer should be able to reject or accept the offer by replying a code to the sms received
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 Farmer should receive an sms with investment details	UC06.REQ007	Functional
📄 Investor should be able to view data about the farm and the farmer to make informed investment decision	UC06.REQ001	Functional
📄 Investor should have the option to offer full funding	UC06.REQ005	Functional
📄 Investor should have the option to offer partial funding	UC06.REQ003	Functional
📄 Successfully made investment should reflect in investor's dashboard	UC06.REQ006	Functional
📄 The data may include farmer, farm description, farm location, security rating, performance rating, investment required, market opportunity at closest market to farmer (demand and supply), farm yield, latest prices of farm produce, data on critical conditions that affect farm yield, investment history, farm revenue	UC06.REQ002	Functional
📄 The investment details should be clear enough to enable the farmer accept or reject the offer	UC06.REQ008	Functional
📄 The investor can cancel the investment transaction if farmer has not accepted within a given period	UC06.REQ009	Functional

User Story

As an investor, I want to invest in a farmer so that I can get some returns

Properties

Sprint	N/A

Status	Pending

Conversation

■ I want concrete data based on which I can decide to invest in a farmer
■ I want data on farmer compared to their peers' performance
■ I don't want raw data; the data should be processed for me to easily use for decisions

Confirmation

investment made should reflect in investor's dashboard
investor should have the option to offer partial funding
investor should have the option to offer full funding
sms should be sent to farmer to confirm investment offer

Scenario

1. login
2. click a farmer to view profile
3. click floating button on the footer to make full investment
4. click on particular budget item out of the total investment needed to offer partial funding

Appendix Item 5: Use Case Accept/Reject investment

Primary Actors	⚩ farmer
Level	Summary
Complexity	High
Use Case Status	Initial
Implementation Status	Scheduled
Preconditions	The farmer can send sms to the system to initialize registration process Farmer should receive an sms with investment details
Post-conditions	The investment details should be clear enough to enable the farmer accept or reject the offer The farmer should be able to reject or accept the offer by replying a code to the sms received
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 The farmer should be able to reject or accept the offer by replying a code to the sms received	UC08.REQ002	Functional
📄 The investment details should be clear enough to enable the farmer accept or reject the offer	UC08.REQ001	Functional

User Story

As a farmer, I have options to accept or reject an investment offer so that I feel satisfied.

Properties

Sprint	N/A
Status	Pending

Conversation

■ I can receive investment offer by sms
■ I can respond to sms offer

Confirmation

| |
|---|
| **investment offer can be accepted by replying to sms with a code** |
| investment offer can be rejected by replying to sms with a code |
| offer should expire after due date. replying to sms should produce invalid response |

Scenario

1. check sms inbox
2. read investment offer details
3. reply sms with code to indicate acceptance or rejection of offer

Appendix Item 6: Use Case Profile farmer

Primary Actors	⚲ extension officer
Level	Summary
Complexity	High
Use Case Status	Base
Implementation Status	Scheduled
Preconditions	The farmer can send sms to the system to initialize registration process
Post-conditions	The extension officer should receive notification about the farmer whose profile has to be completed
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 Data collected may include investment history, farm revenue, farm location, farm yield, investment required	UC04.REQ002	Functional
📄 Extension officer should be able to collect data on the farmer and the farm and upload to system data center	UC04.REQ001	Functional
📄 Profiling should be completed within a stipulated duration	UC04.REQ003	Functional

User Story

As extension officer, I can provide details on farmer so that he/she is attractive to investor.

Properties

Sprint	N/A
Status	Pending

Conversation

■ I want to be able to save my progress
■ I want to submit the farmer profile to the data center when I am done
■ I want to track farmers I have profiled

Confirmation

| **Extension officer should be able to save their progress and continue later** |
|---|
| Notification should be sent to extension officer to confirm successful or failed submission to data center |

Scenario

1. login
2. click a listed farmer to update profile data or continue to complete saved progress

Appendix Item 7: Use Case Access dashboard

Primary Actors	⚥ administrator, ⚥ extension officer, ⚥ investor
Level	Summary
Complexity	Medium
Use Case Status	Initial
Implementation Status	Scheduled
Preconditions	Login
Post-conditions	Customized dashboard based on the user logged in should be displayed
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
Customized dashboard based on the user logged in should be displayed	UC14.REQ010	Functional
It should be possible to generate reports	UC14.REQ001	Functional
The administrator can monitor and analyse log data to keep the system functioning optimally	UC14.REQ005	Functional
The administrator can take some appropriate action on the user to enforce account policies	UC14.REQ009	Functional
The administrator can track the progress of task assigned to extension officers	UC14.REQ008	Functional
The administrator can view all users in the system	UC14.REQ007	Functional
The extension officer can track farmers he/she is/has profiled	UC14.REQ004	Functional
The investor can get recommended push notifications about potential farmers to invest in	UC14.REQ003	Functional
The investor can pay for history data on farmers	UC14.REQ006	Functional
The investor can track investments made	UC14.REQ002	Functional

User Story

As admin, ext. officer or investor, I can access a custom dashboard for quick reference.

Properties

Sprint	N/A
Status	Pending

Conversation

■ I want a page where I can quickly access functionalities particular to my role

Confirmation

| content displayed should be limited to currently logged in user's permission |
| --- |

Scenario

1. login
2. if an administrator
2.1. you are taken straight to dashboard
3. else if extension officer or investor
3.1. click dashboard link
end if

Appendix Item 8: Use Case Enforce account policies

Primary Actors	⚲ administrator
Level	User
Complexity	High
Use Case Status	Base
Implementation Status	Scheduled
Preconditions	User should have SuperAdmin permission
Post-conditions	N/A
Author	N/A
Assumptions	N/A

Requirements

Name	ID	Kind
📄 **A user with the SuperAdmin role must exist. This user may not be deleted/removed from the system, and the role associated to this user may not be modified.**	UC11.REQ001	Functional
📄 **This user should not participate in the workflow in the application.**	UC11.REQ003	Functional
📄 **This user's sole purpose should be to remove/disable users or apply appropriate sanctions to users who breach account policies.**	UC11.REQ002	Functional

User Story

As an administrator, I can disable, remove user accounts to maintain account policies.

Properties

Sprint	N/A
Status	Pending

Conversation

■ A user should exist to monitor the entire system
■ The user can enforce account and system policies

Confirmation

SuperAdmin account cannot be created by normal registration
SuperAdmin account should be created during installation and setup of app

Scenario

1. login with SuperAdmin account details
2. enforce policies as an administrator

Appendix Item 9: Implementation Iterations

Register

Login
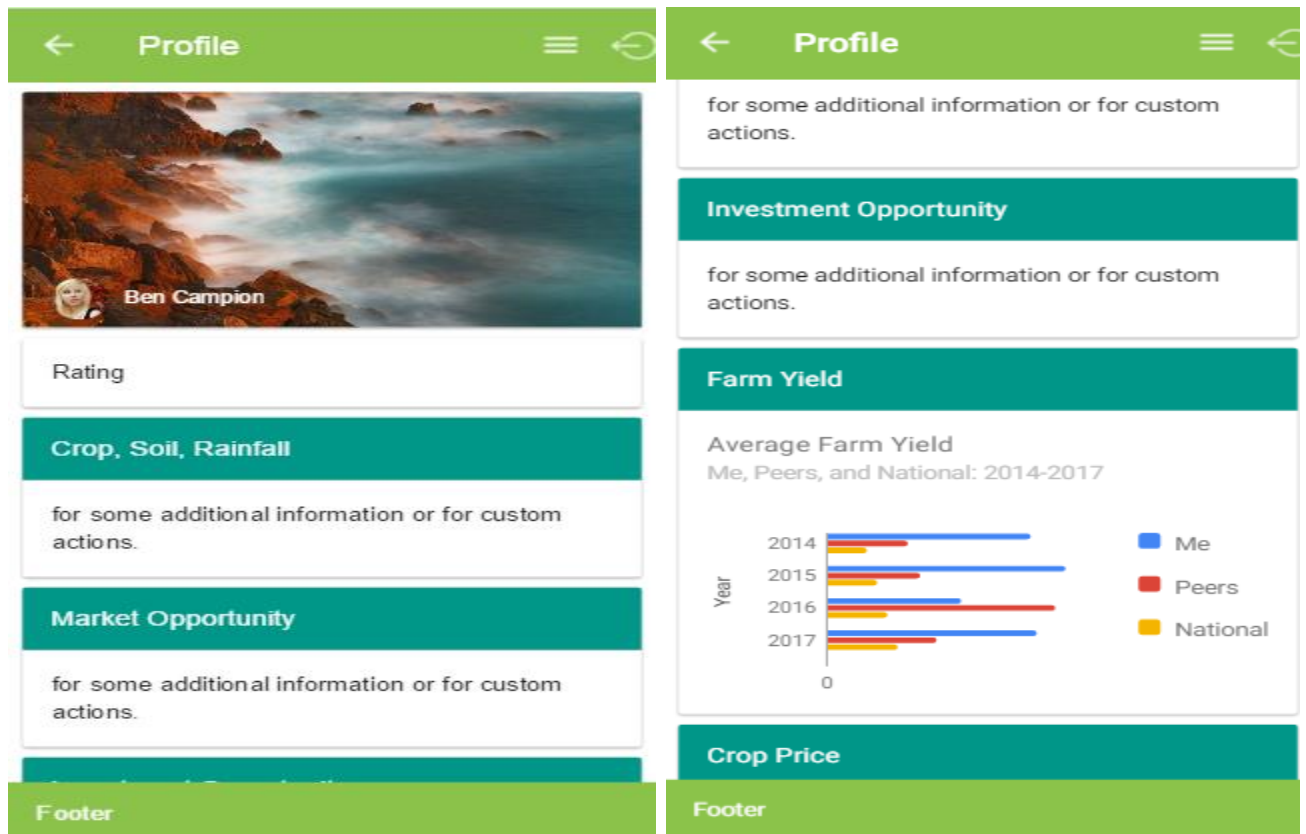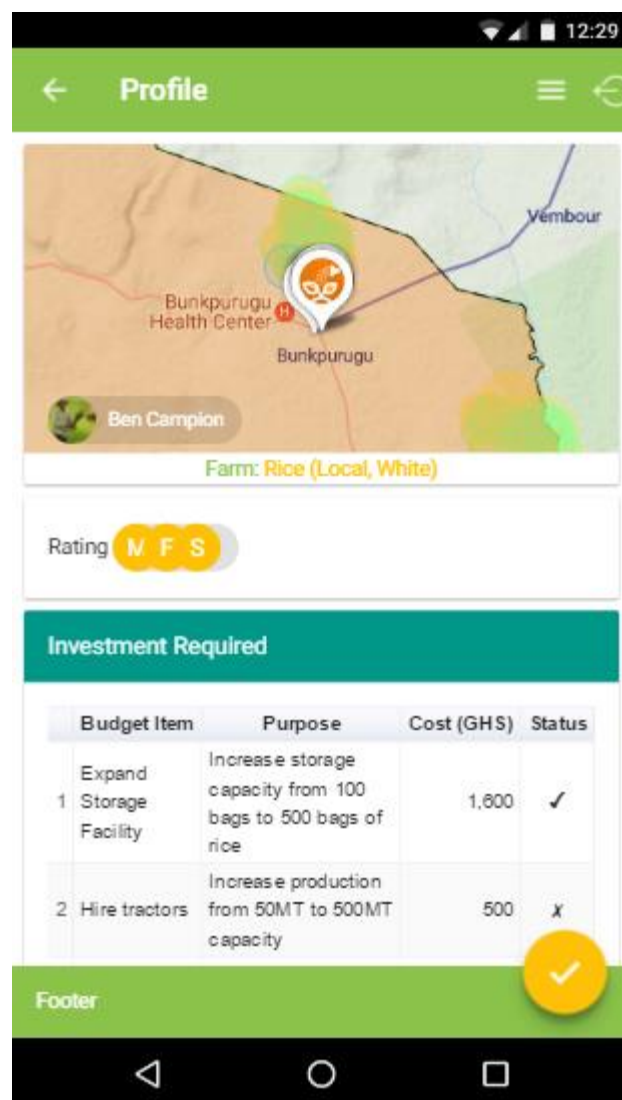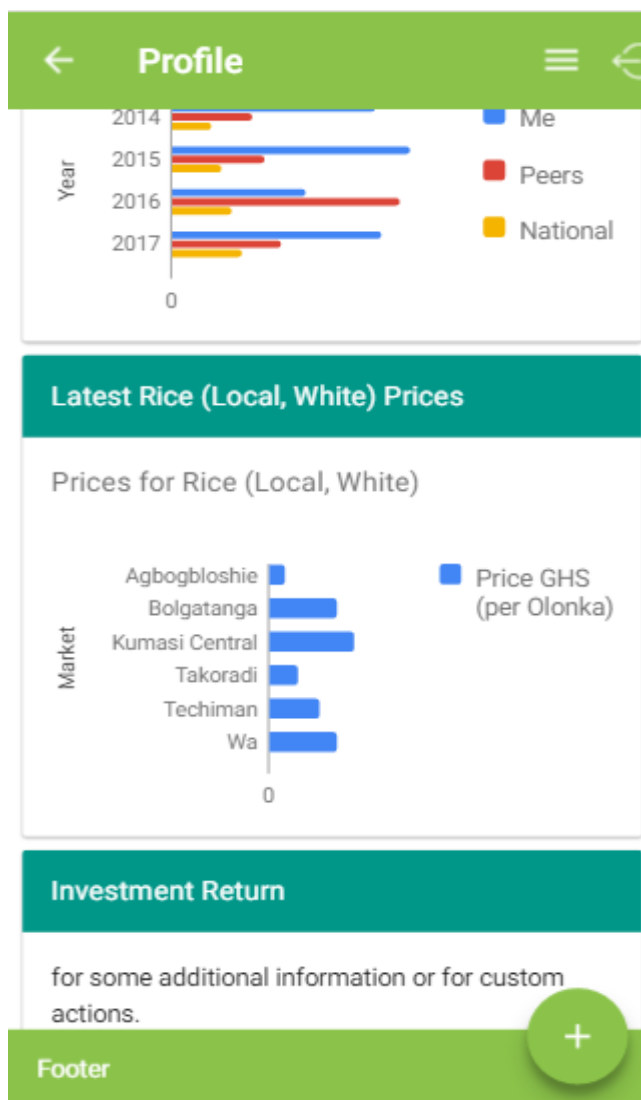
View farmers

Farmer Profile/Invest in farmer

Accept/Reject investment
sms sent to farmer for acceptance/rejection.

Profile farmer
pending

Access dashboard
pending

Enforce account policies
pending

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