



Offline Accessible System for Agricultural E-Commerce Using Unstructured Supplementary Services Data Application

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Abstract– E-commerce has a major impact in the agricultural sector. The way people go about purchasing agricultural products and the way the farmers sell them are important. Sometimes, buyers have to travel far distances to get agricultural products and getting the right quality is not guaranteed. Various market prices cannot be compared because buyers do not have all the time and resources to visit every agricultural farm. Hence, the need for an offline accessible means of trading electronically which would help farmers and other buyers, make their appropriate business transactions online. This study is concerned with the application of Unstructured Supplementary Services Data Application (USSD) and Short Messaging Service to connect farmers to an e-commerce platform. Entity relationship model use case diagram and Unified Modeling Language class diagram were used in the system design. The farmer accesses the offline service via a USSD short code (offline module) and they can then manage their crop inventory and other basic details. Their crop inventory is then synced to the online e-commerce platform for buyers to compare prices, view crop availability and order crops. The farmer can either accept or reject to do business with a buyer via SMS and the buyer will be notified in the All Orders section of the platform. The system helps to connect farmers that do not have smartphones and Internet access to an online marketplace thereby increasing their access to market.

Index Terms– Information and Communication Technology, Unstructured Supplementary Services Data Application, Short Messaging Service, Farmers and E-Commerce

I. INTRODUCTION

A major activity in the agricultural value chain is the selling of the products harvested by farmers. Farmers use different channels to market and sell their harvest. Some of these channels include going through extension agents, middlemen and via an e-commerce platform. E-commerce platforms for Agriculture are now developed to help buyers to find agricultural produce, compare prices and buy online.

Farmers get exploited by middlemen and their access to market is limited to the reach of the middlemen they work with [1]. Literate farmers now use e-commerce platforms to

sell their produce to counter the exploitation while getting access to markets they could previously not reach.

According to the Minister of Education in Nigeria, Adamu Adamu, the rate of illiteracy in Nigeria is alarming, saying between 65 and 75 million people are illiterate in the country [2]. Also, Internet penetration is only as high as 53% [3]. This means that the majority of the target users of agricultural e-commerce platforms do not have the Internet to use them nor can they even use them.

According to the National Communications Commission reports for August 2017 [4], there are 240,769,059 connected telephone lines in Nigeria and only 96 million Internet users. This means that the farmers that are the target users of the electronic commerce platforms are mostly not connected to the Internet. Also, these farmers find it challenging to navigate the World Wide Web making it hard for them to use electronic commerce platforms.

The implementation of an offline accessible system for agricultural E-commerce using USSD is very important because farmers get wider reach for their farm produce, reduces post-harvest loss for farmers as well as easy tracking of crop inventory.

The study aims at developing an e-commerce platform that gives offline access to farmers to manage their crop inventory.

II. LITERATURE REVIEW

Zwass (1996) defines electronic commerce as the sharing of business information, maintaining of business relationships and conducting business transactions by means of telecommunication media. E-commerce draws on technologies such as mobile commerce, electronic funds transfer, supply chain management, Internet marketing, online transaction processing, electronic data interchange (EDI), inventory management systems, and automated data collection systems. E-commerce has become an important tool for small and large businesses worldwide, not only to sell to customers, but also to engage them. Mobile devices are playing an increasing role in the mix of e-commerce, this is also commonly called mobile commerce, or m-commerce. In 2014, one estimate saw purchases made on mobile devices making up 25% of the market by 2017 [5]. Unstructured

Supplementary Service Data (USSD), sometimes referred to as "Quick Codes" or "Feature codes", is a protocol used by Global System for Mobile (GSM) cellular telephones to communicate with the service provider's computers. USSD can be used for WAP browsing, prepaid callback service, mobile-money services, location-based content services, menu-based information services, and as part of configuring the phone on the network [6]. USSD is similar to Short Messaging Service (SMS), but unlike SMS, USSD transactions occur during the session only. With SMS, message can be sent to a mobile phone and stored for several days if the phone is not activated or within range.

The Wireless Application Protocol (WAP) supports USSD. USSD is defined in the GSM standard documents GSM 02.90 and GSM 03.90. USSD messages are up to 182 alphanumeric characters long. Unlike Short Message Service (SMS) messages, USSD messages create a real-time connection during a USSD session. The connection remains open, allowing a two-way exchange of a sequence of data. This makes USSD more responsive than services that use SMS [6]. A basic overview of how USSD works is shown in Fig. 1.

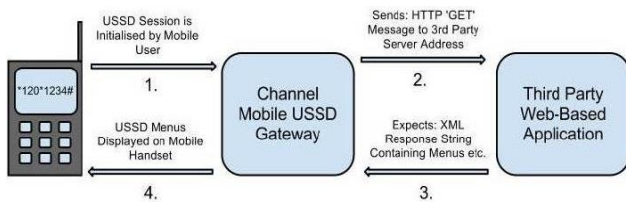


Fig. 1: Basic overview of how USSD works

USSD provides offline accessibility to services. An offline first service generally wraps an online implementation of their service with USSD for users to access them without Internet connection since USSD only requires cellular network. Nigerian banks like First Bank of Nigeria (*894#), Stanbic IBTC (*909#), Guarantee Trust Bank (*737#) and others provide a USSD interface to their service for customers to manage their bank account. According to the Nigerian Communications Commission, the number of connected telephone lines in the country increased to 216 million from 210 million between January and March of 2017, with GSM communications operators having 147 million active lines that can access USSD services nationwide [4].

Most GSM phones have USSD capability. USSD is generally associated with real-time or instant messaging services. There is no store-and-forward capability, as is typical of other short-message protocols like SMS. In other words, a Short Message Service Centre (SMSC) is not present in the processing path. USSD Phase 1, as specified in GSM 02.90, only supports mobile-initiated ("pull") operations [7]. In the core network, the message is delivered over Mobile Application Part (MAP), USSD Phase 2, as specified in GSM 03.90. After entering a USSD code on a GSM handset, the reply from the GSM operator is displayed within a few seconds. A typical USSD message starts with an asterisk (*) followed by digits that comprise commands or data. Groups

of digits may be separated by additional asterisks. The message is terminated with a number sign (#).

There are two modes for USSD initiation: Mobile-initiated (USSD/ PULL or USSD/ P2A; when the user dials a code, e.g., *909# from a GSM mobile handset) and Network-initiated (USSD/ PUSH or USSD/A2P; when the user receives a push message from the network; primarily used for promotional services).

A gateway is the collection of hardware and software required to interconnect two or more disparate networks, including performing protocol conversion [8]. A USSD Gateway routes USSD messages from the signalling network to a service application and back. A "USSD gateway" service is also called a "USSD centre".

USSD Gateway is based upon the ability of the delivery agent or the source to send and receive USSD messages. A USSD is a session-based protocol. USSD messages travel over GSM signalling channels and are used to query information and trigger services. Unlike similar services (SMS and MMS), which are store and forward based, USSD establishes a real time session between mobile handset and application handling the service [9].

There are other related works on E-commerce. These include E-commerce in Agribusiness [10], [11], Information Technology and e-commerce in Agricultural improvement include [12], [13]; Mobile Applications for Agriculture and Rural Development [14], [15].

III. MATERIALS AND METHODS

This system involves the implementation of an E-commerce platform for agribusiness that is accessible offline to farmers via USSD. It is divided into two modules: the online module and the offline module. The online module lets buyers view crop prices per kilogram, quantity available, address of the farmer and farmer's phone number. Buyers can then easily make direct contact to the farmer through phone calls. The offline module allows farmers to manage their inventory via a dedicated USSD short code in their native language of choice without the need for Internet access or a smartphone. The farmers can also set their availability status and request a phone call if they have any difficulties using the service.

A) Entity Relationship Model

An entity can be a real-world object, either animate or inanimate, that can easily be identifiable and it is represented by means of its properties, called attributes. The associations amongst the various entities are referred to as relationships which have the number of entities in one entity set that they can be associated with. Keys are attributes or collection of attributes that uniquely identify, and entity set, and the two main keys used are Primary Keys (PK) and Foreign Keys (FK). Primary keys are one of the candidates (minimal super keys) keys chosen by the database designer to uniquely identify the entity set. While foreign keys are keys referenced from another table in the database. This is shown in Fig. 2.

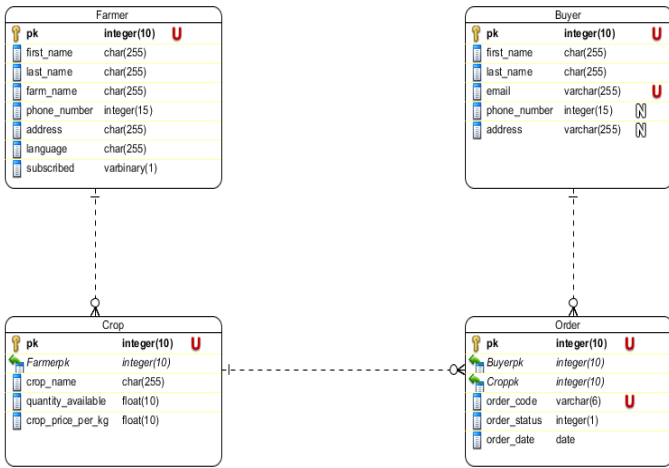


Fig. 2: Entity Relationship Diagram

B) Use Case Diagram

It is a representation of a user’s interaction with the system that shows the relationship between the user and the different use cases in which the user is involved. The user is considered as the actor which is represented by a stick figure and the system of interaction is represented by rectangles with representations represented by solid lines. This is shown in Fig. 3 and Fig. 4.

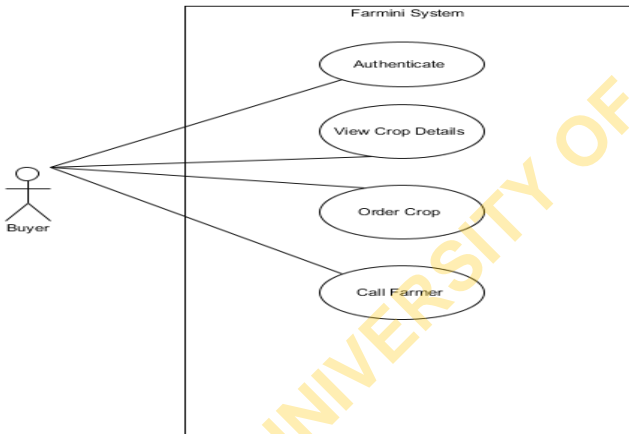


Fig. 3: Buyer Use Case Diagram

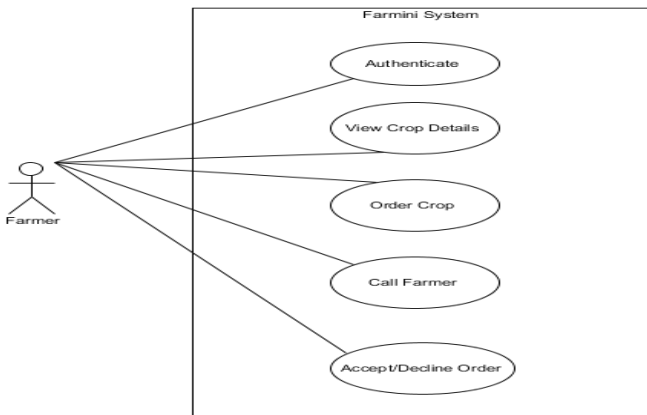


Fig. 4: Farmer Use Case Diagram

C) Data Flow Diagram

Fig. 5 describes the flow of data in the system. It shows the processes that are involved in handling requests and actions from the farmer.

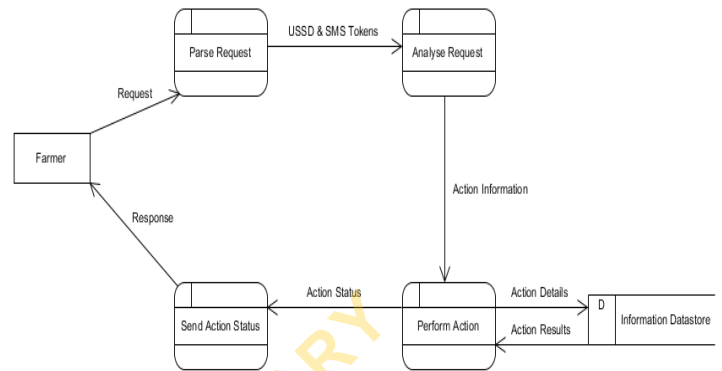


Fig. 5: Data Flow Diagram

IV. RESULTS AND DISCUSSIONS

This section discusses the results obtained from the proposed system. The system is divided into two modules: the USSD module and the E-commerce module.

USSD MODULE: The user (farmer) can access the USSD module by dialling *384*643# on any GSM enabled device. The user is then presented with the setup screen – for a first time user or a welcome screen – for a returning user (Fig. 6 and Fig. 7).

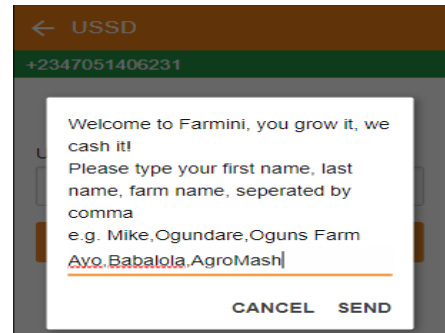


Fig. 6: New User – Welcome Screen

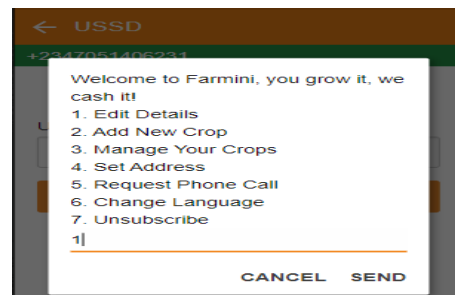


Fig. 7: Returning User – Welcome Screen

A first-time user can then enter their details, and have it saved. This is shown in Fig. 8. After successfully saving the user details, the user can then proceed to add crops to their inventory by selecting the Add New Crop option (Fig. 9 to Fig. 12).



Fig. 8: New User Details Saved

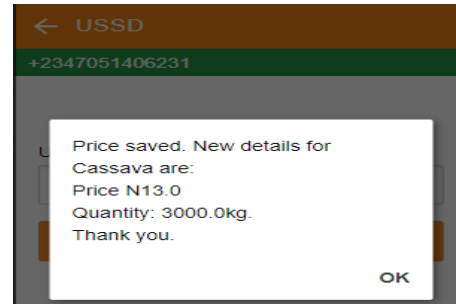


Fig. 12: Crop Saved Screen

Once the user has saved the crop(s) he/she is willing to sell, the user can then edit the crop details by choosing the Manage Crops option from the main menu (Fig. 13 to Fig. 19).

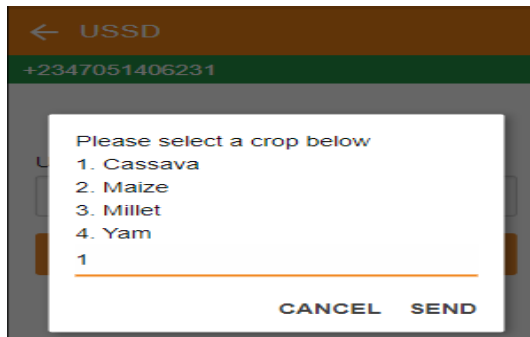


Fig. 9: Add New Crop

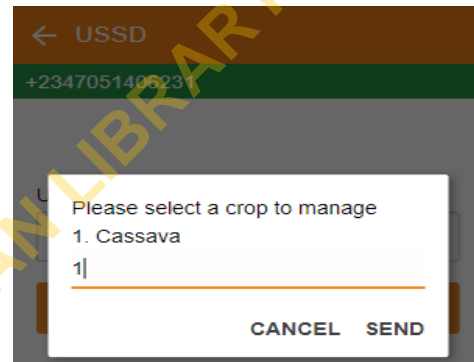


Fig. 13: Select Crop to Manage

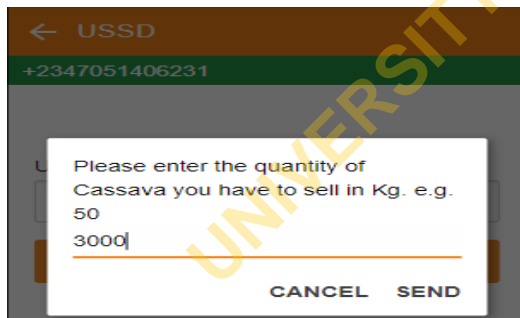


Fig. 10: Set Quantity Screen

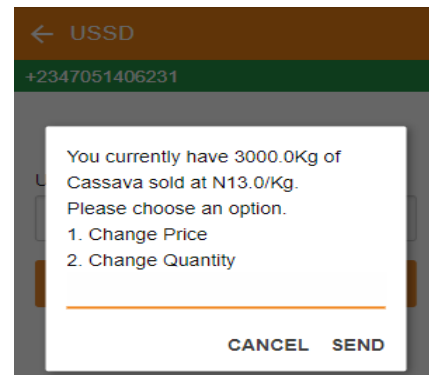


Fig. 14: Choose Crop Detail to Edit

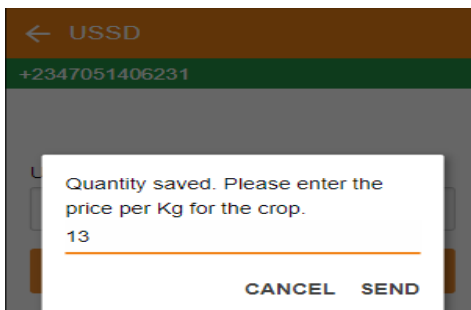


Fig. 11: Set Price Screen

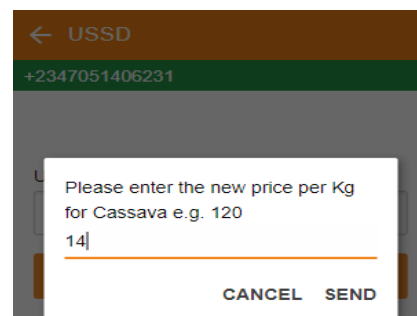


Fig. 15: Change Price of Crop

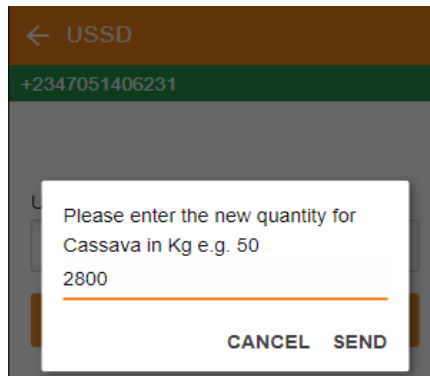


Fig. 16: Change Quantity Available

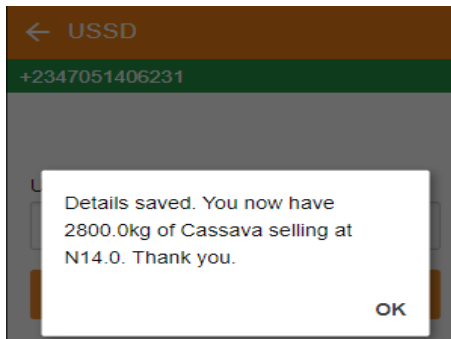


Fig. 17: Crop Details Saved

From the main menu, the user can set their primary address. This is the address where they can be reached for a pickup of the crops they are selling. These are shown in Fig. 18 and Fig. 19.

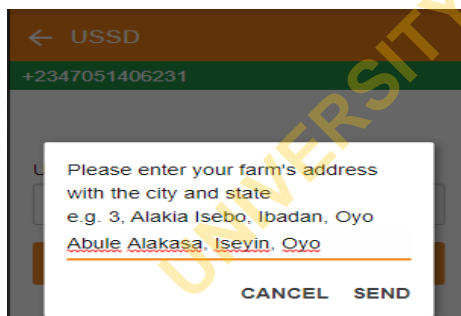


Fig. 18: Set Farm Address

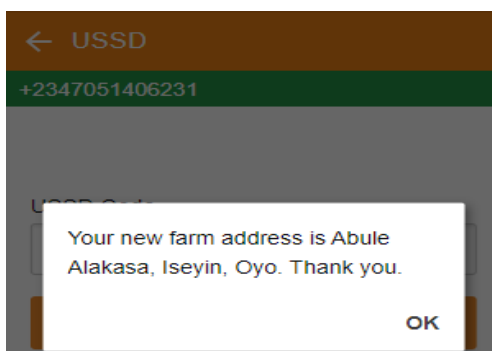


Fig. 19: Farm Address Saved

One of the most appreciated features by the test users of the USSD module is the multilingual support. From the main menu, a user can choose the Change Language option to change to any of the four available languages – English, Yoruba, Hausa, and Igbo languages. This is shown in Figure 20. For users that do not want their crops to be listed as one of the items available for sale on the E-commerce module, they can unsubscribe by choosing the Unsubscribe option and once they are ready to start selling again, they can subscribe again by choosing the Subscribe option from the main menu. This is shown in Fig. 21. Once a farmer receives an order, they receive an SMS showing the details of the order and they can reply with “1” to accept the order or “2” to reject the order. After accepting the order, the buyer can then give the farmer a phone call to facilitate the sales.

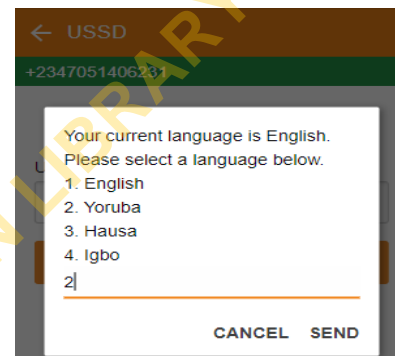


Fig. 20: Change Language

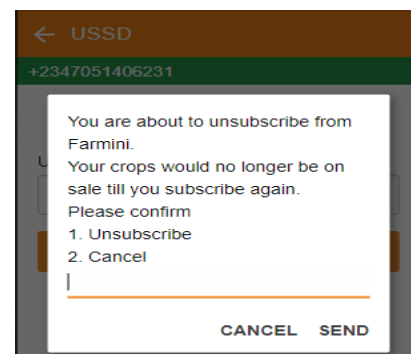


Fig. 21: Subscribe/Unsubscribe

E-COMMERCE MODULE: From the homepage, which can be accessed via <http://farmini.herokuapp.com>, a user can get an overview of what Farmini, the system is all about and can then proceed to sign up or login. After successfully logging in or signing up, a user can then view available crops according to their category and make an order for the crop (Fig. 22). After ordering, the user can then view the status of their orders and if an order has been accepted by a farmer, then the user gets access to the phone number of the farmer for direct communication and commerce to take place (Fig. 23 and Fig. 24).

V. SUMMARY AND CONCLUSION

In this study, we focused on exploring GSM technologies that enable access offline for users and how it can be beneficial to farmers with respect to agricultural E-commerce and agribusiness. This paper discusses USSD, E-commerce, agribusiness and gives an overview of how these technologies can improve existing systems. We showed that E-commerce for agriculture, which has been primarily online for farmers and limits farmers' entry to the online market, can be made accessible offline using a combination of USSD and SMS therefore expanding farmers' access to the online market. We implemented this by applying a combination of USSD and SMS technologies to give offline access to online E-commerce for farmers and demonstrating this technique can be helpful to farmers' day-to-day commerce while increasing their income. The result of this work is of immense use to farmers and buyers of agricultural produce and it has a large capability for expansion. Further expansions could be made such as making it possible for any agricultural produce to be managed by a farmer offline as well as increasing the number of native languages supported.

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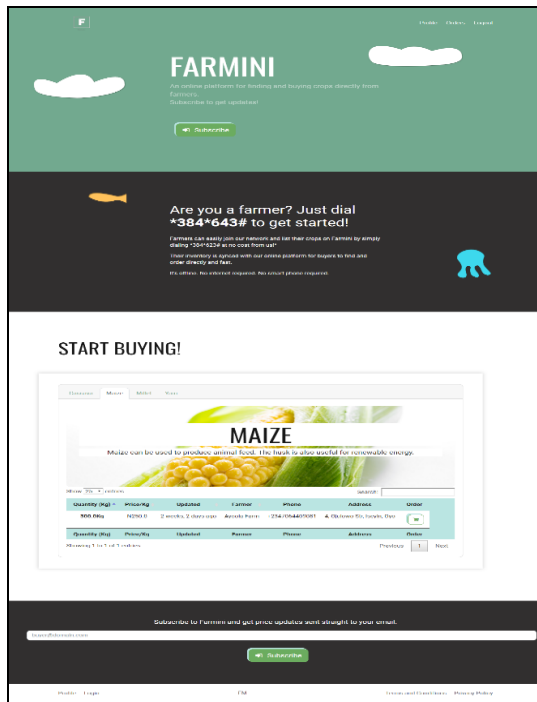


Fig. 22: Home Page

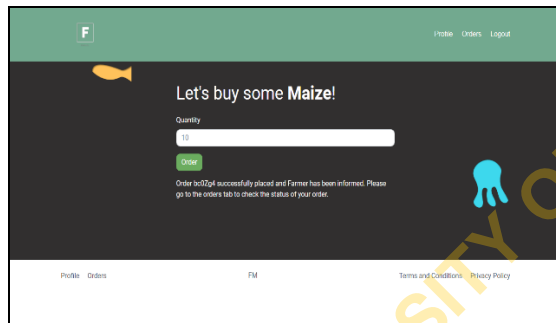


Fig. 23: Buy Page

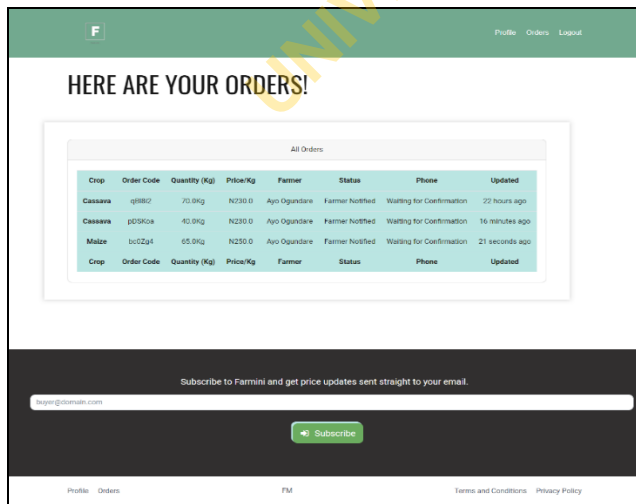


Fig. 24: Orders Page

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