Harnessing the Potentials of Mobile Phone for Adoption and Promotion of Organic Farming Practices in Nigeria

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Abstract. The goal of organic agriculture is to show the interrelationship between farm biota, its production, and the overall environment. In cooperation with various Organic Farming unions, a system called the organic farming mobile agricultural extension services (OrgFarMob) was developed to provide farmers with instant information to problems with organic crop cultivation. Hence, this project provides organic farmers with crop lifecycle support system, leading to effective management and sustainable economic development in organic agriculture. The system powered by Azure cloud platform, was developed using Model-View-Architecture and programmed with AngularJS and Ionic. The design followed the computer research framework with incorporate users' requirement elucidation and validation. The system was designed and evaluated using data obtained through the collection of materials from professionals in the field of organic agriculture. The results showed that the system can be used in real-time and foster organic agriculture cultivation.

Keywords: Agriculture, Mobile Application, Organic Agriculture, Organic Farming, Mobile Phone, OrgFarMob

1 Introduction

Agriculture has been a subject of quite extreme importance. Its origin can be traced back to the origin of man. It is a core basis of existence to mankind and several forms of life in the area of feeding, atmospheric oxygen-carbon dioxide exchange, anti-erosion and raw materials for key industries including clothing and textiles (cotton), bio-energy which is gradually replacing conventional energy, defense (corn starch in the production of bombs) and several others [1]. As the demand for food has become increasingly high, the transition to chemical agriculture has become alarmingly high.

We, therefore, find ourselves in a situation where harmful chemical fertilizers, pesticides, and herbicides are gaining alarming acceptance among farmers practicing agriculture on a commercial scale and more recently subsistent farmers [2]. This has led to the contamination of the environment, habitual ruinous, and threat to human health and welfare.

Also, commercial agriculture land practices have led to the destruction of the physical structure of land and biodiversity leading to erosion and climate change [3],[4], [5]. A solution to these negative impacts is organic agriculture. The goal of organic agriculture is to show the deep interrelationship between farm biota, its production, and the general environment. In basic terms, this means organic agriculture is not just concerned with the production of crops, but also the conservation of the true nature of the environment and the production of crops that are biochemically helpful to man and animals and not the other way round. One key area in organic agriculture is the production of crops. Cereals such as rice and millet are excellent sources of carbohydrate and energy while legumes such as beans and soya beans are excellent sources of protein [6]. An interesting fact here is that cereals are the largest suppliers of carbohydrates while legumes are the largest suppliers of protein feeding the global population. The resource for Organic agriculture's emanates from using technologies assigned to sites, scales, and also recycles natural resources. The best means to facilitate this, is through mobile application technology due to the ubiquitous nature of smart mobile phones and hand-held devices. The infiltration of mobile and handheld devices, which is increasing exponentially daily, bring entirely different world of innovation through, enabling in-situ information search, activities and actions [7]. Yet, despite its usage for personal use, mobile phone based agricultural extension for real-time, organic farming has not diffused through.

This study is motivated by the problem of real-time access to information and resources that will enable organic farmers to cultivate their crops and strategize better. A mobile application for farmers and key stakeholders practicing organic agriculture focusing on the cultivation of crops is developed in this research work. The main contribution of this study is the provision of a mobile application for organic agriculture extension services that helps organic farmers to solve the problem of access to information on organic best practices thereby fostering the development of the organic agriculture industry.

The rest of this paper is sectioned as follows: Section II discusses the adoption of information and communication technology in agriculture. Section III reviews related works. Section IV designs and develops the proposed system. Section V implements the system, with results presented in Section VI. Section VII concludes this study.

2 Information and Communication Technology in Agriculture

One of the challenging issues facing Researchers and inventors of new technologies in agriculture is how to promote the uptake of these new innovations. [8] showed the dynamism in the adoption of new technologies. In [9] research, the adoption of

mobile phone helped in saving farmers' energy and time thereby increasing farmers' income. Reporting on mobile phone usage in agricultural extension in India, [10] indicated higher market participation and high value crops through diversification among farmers, thus leading to increase profit margin and reduction in crops wastage in farming activities. [11] reported that easy accessibility to market information and financial transaction of farm produce were the most accessed information among farmers on mobile phone. Yet, investigation by [12] showed traditional typical mobile phone use for calling and sending SMS with a mere 5% use for agricultural information. With the disparity calls are made for awareness among farmers on the need and benefit of proper usage of mobile phone, and farmers knowing that mobile interventions are for agricultural extension services and increase in their income.

There is a growing usage of Information and communication technology (ICT) in rural Africa in the last three to four years [13]. The growth in ICT creates avenues for African farmers to upgrade their knowledge and livelihoods [14], [15]. According to the work carried out by [16], the level of usage of mobile phone, its usefulness and challenges was examined among the farmers in some rural part of Africa: At the end of this study, it was found out that 40% of farmers' phone bills were spent on farm activities while 17. 32% were spent on gaining more knowledge and marketing farm produce. In Mali and Burkina Faso, ICT usage for an agricultural extension has been resolved historically been from the top-down. [17]. Recently mobile phones have become an important tool for communications in rural Africa.

3 Related Works

Mobile gadgets provided an avenue for real-time interaction between several systems and people or other mobile devices. This interaction guarantees an efficient and timely manner of rendering and getting information; a major condition in an effective Mobile-Agriculture application. Several solutions have been deployed by several authors through the use of mobile phones. Abishek et al [18] developed a mobile and web application that conveyed farm produces from the location to the final destination. The application enables farmers and consumers to do transaction on the farm products without middlemen. They revealed that the application will boost farmers' morale to be more committed to farming. Chen et al. [19] further developed a system that is portable and able to handle agricultural information with a high degree of versatility using mobile GIS. Their research outcome showed that the system can process information promptly and can capture the GPS coordinate of the farmland. Marimuthu et al. [20] introduced a persuasive technology method to orientate farmers about the advantages of technology-supported farming. The developed method consists of a website part and a mobile app part. The mobile app is connected to the website with enough facts on marketing and farming subsidiaries such as dairy, organic products, and farm machinery. Farmers were able to learn about crops, how to market their crops, how to market their products and by-products, and how to get support from field operations. Shirsath et al. [21] suggested a decision support system based on a smartphone app and data mining. The system enabled

farmers to identify the best matching crop in farming hence, increasing the productivity of their fields and also increase the gross domestic product. Venkatesan et al. [22] on the other hand, proposed a framework for efficient organic farming using a mobile phone application with an in-built mobile module for automatic application of pesticide. While Castro et al. [23] focused on mobile application implementation that enables farmers to plant crops. A time-series moving average algorithm was used and assessed by agriculture professional, IT professionals, and the right consumers through the usage of ISO/IEC 9126 software engineering standard. Assessment outcome revealed that the model accomplished the major goals. Kerns and Lee [24] designed automatic software based on the Internet of Things technology that will help farmers with the increasing productivity in farming. The system consisted of a mobile application, a service platform, and IoT devices with sensors. [25] further developed an Android-based mobile application for the production and management of organic manures based on Intelligent Computer-Aided Instruction. The proposed system helps small and medium-scale farmers. Shikalgar [26] presented an advisory, information, and financial system deployed on a mobile platform for farmers. The system helped farmers to be aware of necessary pieces of information as regard government schemes and strategies. The system helped farmers to have access to timely advice and alerts on crops, and most recent and up-to-date information on government plans and strategies that have to do with agricultural domain were also accessible. In [27], a market space for marketing organic farm products was introduced leveraging automated geo-location services.

Considering the outcome of the related study, the mobile platform has shown a remarkable increase in its usage towards agriculture. This study thereby leverages on existing advantages in its mobile applications for organic farming, OrgFarMob, an extensions logical framework solution to agricultural extension farmers.

4 Design Methodology

The purpose of developing mobile app for agricultural extension services is to render applicable answers and outcome which is supported by pragmatic philosophy regarding its functionalities [28]. This has to do with a serial step of build and process method coined from design research aspect [29] [30] as opposed to design science research methodology strategy. The main focus of this research is on organic farming mobile. The process is initiated with inductive method to a clearer understanding of the nature of difficulty within the scope of agricultural extension services and a guide in collecting requirement [28].

Before going into comprehensive narration of the proposed methodology, the steps taken in the build and process approach will be stated first. The building process was founded on the aspect of framework for computing research methods which is in accordance with the functional approach used in Holz et al., [28]. The area that is needed and relevant to this study is used. Consideration is given to the following:

4.1 Computing Research Framework

- What are things we stand to accomplish?

    a. (To seek for more knowledge) - the authors seek to gain more understanding in the aspect of adoption and application of ICT mobile development in organic farming in Nigeria and the whole world at large.
    b. (Implement functional IT app) - the authors will start the development of a mobile app, orgfarMob, to provide information and resources on the cultivation of crops for organic farmers.

- What are sources of data needed?

    c. (Study) - the authors will search literatures on organic farming and the adoption of ICT in agriculture.
    d. (Pay attention to details, interview) - the authors will interact with organic farming practitioners Nigeria to seek for their view and equally gain more information from them.
    e. (Design and Model) - the authors will develop the system using Model-View-controller architecture which will be integrated with cloud infrastructure while UML will be used to model the activities of the OrgFarMob actors using Use case diagram.
    f. (Collection location) - the authors will source for and gather right information and design data from the field and conceptual analysis.

- What is the data collected use for?

    g. (To discover old and new trends) - the researchers tend to use the gathered information for more understanding in organic farming and the adoption of ICT in organic farming.
    h. (Create framework, prototype) - the authors will firstly design a logical architectural framework for orgfarmob extensions. After which, in iterative manner, the orgfarmob extensions application will be prototyped.

- Is the objective/ goal of this study realized?

    i. (Result evaluation, infer conclusion) - the authors, who by now, have better understanding of organic farming extension services and implemented functioning prototype, will be able to assess and iteratively modify the design and build (mobile app implementation).
    j. (Fish-out limitations) - the writers will infer from the design and development method the limitations and/or how existing work can be extended or criticized.

Based on the guideline contained in the framework for computing research approach, this research work was executed using information gathered from organic farmers associations, and one-on-one interaction with the organic farmers.

The Unified Modelling Language (UML), Meta-model features are set up diagrammatically. Many diagrams can be used for a specific objective depending on the way one is looking at the system. The diverse ways of visualizing are referred to as “architectural views”. These architectural views help in the organization of knowledge, and diagrams permit the communication of knowledge. Invariably, knowledge is embedded in the model or set of models which is concentrated on the problem and solution. Figure 1 showcase the architectural view of the study. The development model is mainly subdivided into two major divisions which are the mobile user platform and the remote infrastructure.

The remainder of this section gives a comprehensive detail of how the study was carried out. It involves six subsections namely data collection, architectural framework, Flow Chart of the Graphical User Interface, Sequential Logic of the Developed System, Use Case Diagram, and Logical Framework of Proposed System;

4.2 Data Collection

The data was obtained through the collection of materials from professionals in the field of organic agriculture, a review of organic farming practitioners in Nigeria and around the globe using the internet and one-on-one interaction with organic farming practitioners. Interview was conducted with the president of NOAN who lavishly supplied information on currently practiced organic farming practices in Nigeria. The information gathered from him actually form the basis and focus of this research. The mobile application developed was limited to the organic practices that are being adopted presently in Nigeria because the aim was to ensure wide adoption of the practiced organic principles. We also interacted with OAPTIN (Organic Agricultural Practitioner in Tertiary Institution in Nigeria,) to gather information from their experiences in the field. Each of their members specializes in production of one or two crops which they have been doing over the years. Sharing their experiences also helped us in realizing the goal of this research.

4.3 Architectural framework

For optimum performance and the best user experience, the adopted architecture for the given mobile application is the Model-View-Controller architecture which was integrated with cloud infrastructure. This was modified to fit into standard mobile application framework. The proposed model is made up of two major subdivision namely the mobile user platform and the remote infrastructure.

The mobile user platform is made up of three sections namely the Presentation, Business, Data, and Data storage. The mobile user platform takes into account the configuration, security, and communications aspects which is the bedrock of the robustness of the mobile application. The presentation layers comprise of the user interface and the logic layer which is the tool for moving around the user interface m. This tier displays information related to best practices in the organic cultivation of the given crop and the e-extension forum interface majorly. It communicates with the other tiers by sending human gesture input and receiving data output from the other

layers. The business logic layer is solely used for exchange of information between the user interface and project database. The concern of the structure of the mobile application is heavily placed here. It works out the inference of the user input involved with the application. The final stack of the three-layered architecture is the data access layer that is solely made up of database servers. The information update takes place here and the server communication concern also lies here.

4.4 Flowchart of the graphical user interface Citations

The GUI consists of three modules namely the Tutorials Module, E-Extension Module, and About Module. Users can learn about the organic cultivation of organic crops by querying the database. The overall system flowchart is shown in Figure 1.

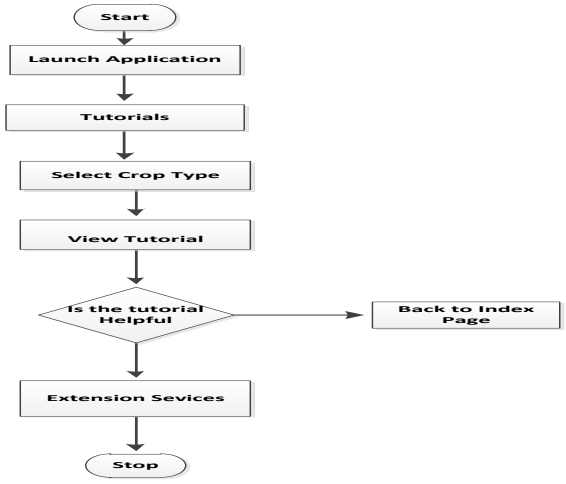


Fig. 1. Flowchart of Orgfamob

4.5 Sequential Logic of the Developed System

The sequential logic of the system developed shows the interaction between the users which are the organic farmers, the application, and the cloud infrastructure as depicted in Figure 2. This shows the core features of the application which is mainly information dissemination and real-time connection with the professional extension service agents

4.6 Use Case Diagram

Two main actors were identified in the organic agriculture extension services mobile application software. The actors are the user and the administrator. The use case model diagram indicates the functions of the actors identified as shown in Figure 3.

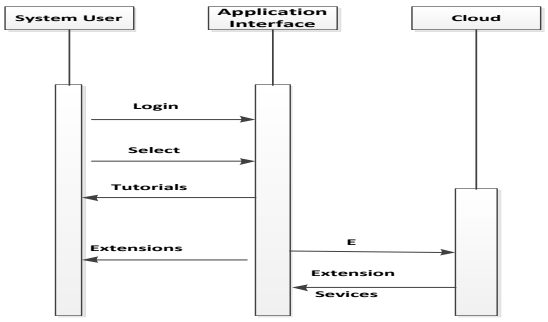


Fig. 2. Orgfamob Sequence Diagram

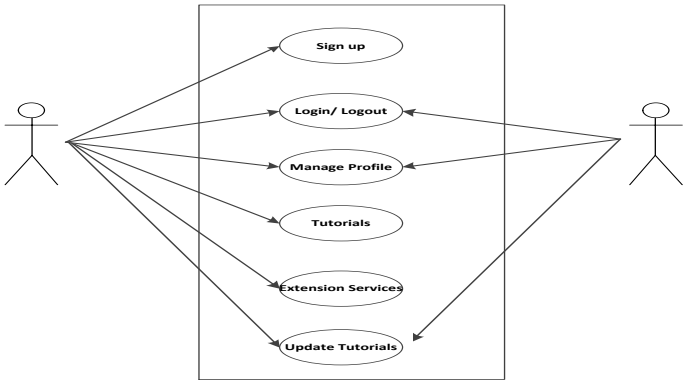


Fig. 3. Orgfamob Use Case Diagram

FARMER INTERFACE			
Scientific Knowledge Base	**Chat Management**	**Analytics Delivery**	**Update**
Orgfarmob Service Delivery Framework			
Knowledge Resolution Engine	**Communications Engine**	**Knowledge Processing Engine**	**Third Party Data Processor**
Scientific Intervention	**Knowledge Aggregation**	**Extension Service Providers**	

Fig. 4. OrgFarMob extensions logical framework

4.7 Logical Framework and infrastructure

The OrgFarMob extensions service delivery system is built over a multi-tier service delivery framework that provides stakeholders with the flexibility to scale up the services if required. This framework offers organic farmers a collaborative environment where they can access a wide range of services. The logical framework shown in Figure 4, offers organic farmers a collaborative environment where they can access a wide range of services. The orgfarmob extensions service delivery system is built over a multi-tier service delivery framework that provides stakeholders with the flexibility to scale up the services when required. The programming language used for project work is AngularJS, NodeJS, and PHP. The database used is the MySqlLite which is the standard SQL engine for mobile devices. The cloud platform used is the azure engine. It is a very powerful and flexible platform that is robust. It is also a very secure platform which allows for privacy and confidentiality of message that is passed through this platform. The mobile-based application for organic agriculture extension services can run on android mobile phones.

5 Results and Discussion

The result of the stages involved in developing the mobile application are depicted in Figure 5 to 9. The index screen of the OrgFarMob E-extension is depicted in Figure 5 (a) and Figure 6(b), and this indicates the user side which is the tutorials and the admin side of the e-extension services as elucidated from organic farmers and the association engaged.

Fig. 5. (a): Index screen

Fig. 6. (b): Lower part of the index screen

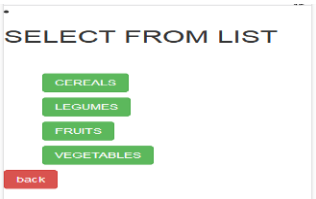
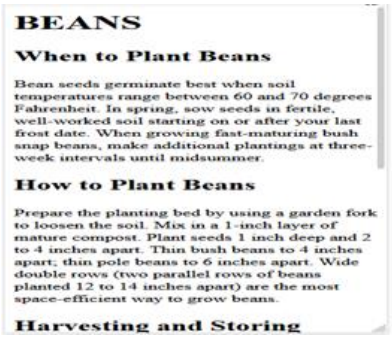


Fig. 7. Selection screen

From security and users experience (UX) viewpoint, all users must register to obtain their unique username and password, allowing for future predictive services and analytics. Figure 7 depicts the spinner which consists of the list of organic products where the user can select from based on their interest. Field run indicates that users were able to select from the spinner and Orgfamob generated results based on the chosen products as shown in Figure 8 and 9; for Beans and for Cabbage



BEANS

When to Plant Beans

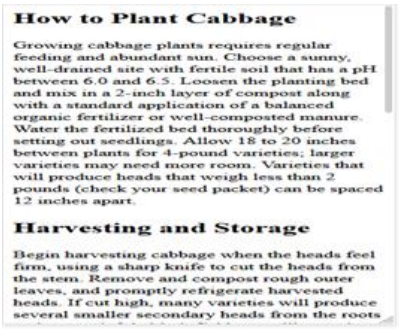
Bean seeds germinate best when soil temperatures range between 60 and 70 degrees Fahrenheit. In spring, sow seeds in fertile, well-worked soil starting on or after your last frost date. When growing fast-maturing bush snap beans, make additional plantings at three-week intervals until midsummer.

How to Plant Beans

Prepare the planting bed by using a garden fork to loosen the soil. Mix in a 1-inch layer of mature compost. Plant seeds 1 inch deep and 2 to 4 inches apart. Thin bush beans to 4 inches apart; thin pole beans to 6 inches apart. Wide double rows (two parallel rows of beans planted 12 to 14 inches apart) are the most space-efficient way to grow beans.

Harvesting and Storing

Fig. 8. One of the tutorials page (for beans



How to Plant Cabbage

Growing cabbage plants requires regular feeding and abundant sun. Choose a sunny, well-drained site with fertile soil that has a pH between 6.0 and 6.5. Loosen the planting bed and mix in a 2-inch layer of compost along with a standard application of a balanced organic fertilizer or well-composted manure. Water the fertilized bed thoroughly before setting out seedlings. Allow 18 to 20 inches between plants for 4-pound varieties; larger varieties may need more room. Varieties that will produce heads that weigh less than 2 pounds (check your seed packet) can be spaced 12 inches apart.

Harvesting and Storage

Begin harvesting cabbage when the heads feel firm, using a sharp knife to cut the heads from the stem. Remove and compost rough outer leaves, and promptly refrigerate harvested heads. If cut high, many varieties will produce several smaller secondary heads from the roots

Fig. 9. A tutorials page (for cabbage)

The organic farmers were excited to discover that they can have an application that can serve as reminder of the practices they have learnt. The idea was applauded by OAPTIN and they promised to give support for publicity and visibility of the application. Already, we were invited to give talks on the mobile applications at farmers workshops; many were excited and continued to keep in touch.

6 Conclusion and Future Work

An organic farming mobile agricultural extension services (OrgFarMob) is presented here. The organic agriculture sector is of considerable economic importance, as well as providing a valuable and nutritious food source. However, many farmers interested in organic agriculture have little or no access to information regarding best practices. This leads to low performance of this agricultural sector which hinders the establishment of medium to large scale production especially in rural areas. With the introduction of the organic agriculture extensions services mobile application, farmers are now able to fully understand and produce organically certified crops in a sustained environment. This study has examined the feasibility of the mobile digitization of organic extension services and would help in the faster fostering of the transience of agriculture from harmful chemical-based farming to a healthier and more efficient organic-based farming scheme. For future recommendations, we intend to extend the service to all organic farmers in local languages.

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