Agricassist App: A User-Interactive Android Application for Crop Production and Tillage Decision Support in Awgu

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ABSTRACT

A user interactive android based mobile application (AgricassistApp) was developed to provide a decision support tool and necessary networking for agricultural investors and farmers engaged in crop production. The App features sections for: welcome and sign-up, identification and classification of the user, different types of crops grown in the area and user's decision for one of them, details of agronomic and technical information required for tillage and cultivation of the selected crop. AgricassistApp possesses other features for effective networking such as the agro and government news features, the chat feature (audio and video), the timeline feature and the agro service feature. Risk chart regarding decision to cultivate any selected crop at a given time is also provided. Dart programming language with Flutter software development kit (SDK) in Android studio were used to develop the structure of the software and to host related sourced data in a database. Such important data and agronomic practices related to some crops of high economic importance commonly cultivated in Awgu covering from planting up to post harvest activities were sourced through survey, physical measurement and literature. The crops investigated included: yam, cocoyam, cassava, sweet potato, oil palm, fluted pumpkin (Ugu), African Rosewood (Oha), bitter leaf, okra, garden egg, black beans (Akidi), wild mango (Ogbono), African star (Udara) and maize. Rainfall amount, temperature and soil moisture are obtained in real time from application programming interfaces (APIs). These, together with other types of data are displayed for decision support to each user regarding any particular crop selected. Soil pH, soil fertility (NPK) and soil tractability were measured while available water bodies (for irrigation) and nearby markets were determined through survey. Best agronomic practices were obtained from literature and oral interview of farmers. This work presents how all of these were developed, structured in the mobile application and made available for the public on Google play store.

Keywords: Mobile application, DSS, Crop production, APIs.

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INTRODUCTION

Following the proceedings from a meeting held at the International Telecommunication Union in 2016, the explosive growth of mobile communications and the global distribution of various mobile devices such as smartphones, tablets and PCs have fundamentally transformed the daily lives and modus operandi of businesses across the globe. According to the International Telecommunication Union (ITU), 7.08 billion mobile connections were in existence as at 2015 [1]. In the same vein, the demand for smartphones grew by 13% in 2015 and by 2017 more than one-third (1/3) of the world's population were expected to own a smartphone. The proliferation of smartphones is due to the fact that they have become the dominant tool for communication, entertainment, information, daily life and business. The following are technical advantages that have made these gadgets a vital tool: the sizable smart screens, readability and adaptability; comparably high-resolution cameras that can compensate for visual purposes in other devices such as; cameras and camcorders; the Global Positioning System (GPS) for special navigation exercises; the super microprocessors; file storage capacities, music player, radio tuner function, video player, etc. Specialized software and mobile applications explore these technical features [2].

Serrano et al. [3] defined mobile apps as software programs designed to run on smartphones, tablets and other devices. However, Karetsos et al. [2] asserted that the development of agricultural mobile apps in comparison with apps related to other sectors is limited. These applications cover a wide range of activities from the field (e.g. tillage technology) to the agricultural market (e.g. buying and selling of products and raw materials).

Taechatanasat et al. [4] opined that stakeholders and farmers struggle to make sound agricultural management decisions with large amounts of information (e.g. environmental, crop-related and economic data). Because turning this data into actionable knowledge is difficult, platforms like decision support systems (DSS) are needed to help make informed and accurate decisions. The aim of this work is therefore to develop a user interactive, android based mobile application with a database and system to provide decision support to farmers or investors who may be considering agribusiness in or around the study area.

Related Previous Research

Mobile applications developed by different researchers for different purposes in different countries have been listed out by Agricdemy.com [5]. Ferrandez-Pastor et al. [6] developed a low-cost automated network platform using the Internet of Things (IoT). The platform aims at optimizing the efficiency of agricultural production, quality boosting of produce, reducing environmental impact and optimizing the use of natural resources such as energy and water. Wolfert et al. [7] led a research team and they were able to ascertain the impact of big data in E-agriculture and laid emphasis on the current use of big data in providing farmers with predictive insights into agricultural operations and to make real-time operational decisions. Liakos et al. [8] reviewed the current level of machine learning techniques in today's agriculture. The machine operates on real-time AI computer programs that can generate rich resources and ideas needed to assist farmers make the right decisions. Lopez-Riquelme et al. [9] developed a real agricultural application based on the FIWARE cloud. This application can reduce the amount of water for irrigation works. Their work therefore shows that using FIWARE cloud services in an agronomic context is very useful. Bonfante et al. [10] proposed a LCIS DSS irrigation support system to improve water use efficiency in precision agriculture based on IRRISAT® (remote sensing), W-Mod (simulation modeling) and W-Tens (situ soil sensor). Studying the case of corn, they found that the first two approaches were the best for making irrigation water use more efficient. Ajah et al. [11] developed a database and decision support system for mechanization of small holder farms in Aninri LGA of Enugu State.

MATERIALS AND METHOD

In this section, all resources/materials and methods adopted in the development of the mobile application are presented.

Study Area

This study was conducted in Awgu Local Government Area of Enugu State, South East Nigeria (Figure 1). Geographically, this area lies between latitudes 06^0 00’ and 06^0 19′ North of the equator and between longitudes

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07^0 23’ and $07^0$35’ East of the Greenwich meridian.

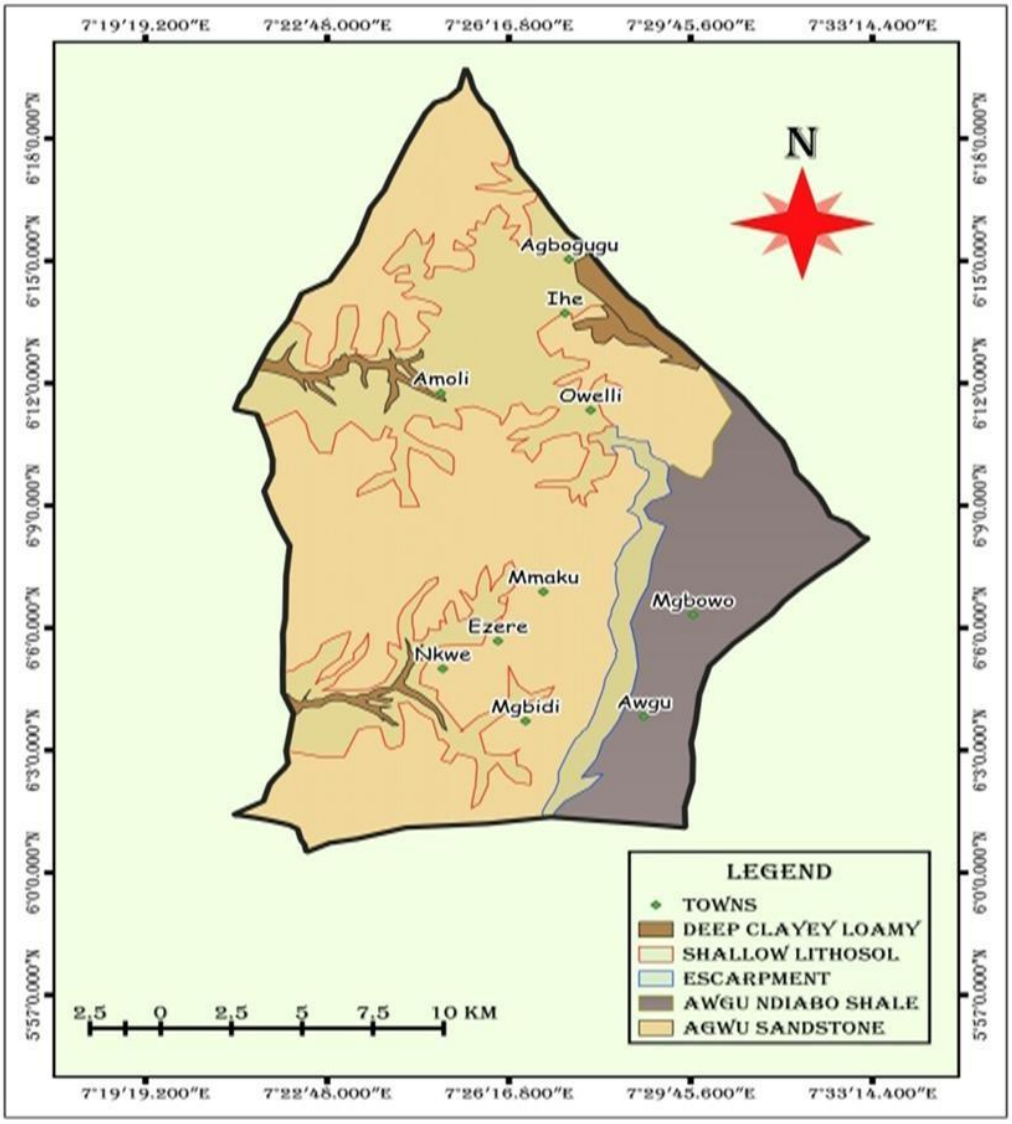

Fig. 1: Geology and soil type on the map of the study area. Source: [12]

Design Approach

Dart programming language and Flutter software development kit (SDK), both in Android studio software were used to host sourced data and to structure the application. Weather application programming interface (API) for rainfall, temperature and soil moisture data collection in real-time were employed on the app. To ensure reasonable allocation of resources, news API powered by firebase from the backend for daily local news on agriculture was employed. Information on available markets and water bodies for possible year-round farming were obtained through questionnaire and stored in the database at the backend. A mobile phone was used to test-run the performance of the application before uploading on the Google play store for public accessibility.

Types and Methods of Data Collection

Agronomic Practices for Various Food Crops

For AgricassistApp the following indigenous food crops were investigated: yam, cocoyam, cassava, sweet potato, palm fruit, fluted pumpkin (Ugu), African rosewood (Oha), bitter leaf, okra, garden egg, black beans (Akidi), wild mango (Ogbono), African star apple (Udara) and maize.

The selection of the crops was based on the results from the field data (questionnaire), which revealed they were the most common crops of high economic importance in the study area. The agronomic practices and

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requirements for each of the crops were sourced from literature and results of oral interview. The investigated agronomic practices and requirements for the above listed food crops include: crop requirements, pre-planting operations, planting operations and postharvest operations.

Other Soil Properties

Soil type for the ten villages in Awgu LGA was determined using satellite imagery while textural classification was used to analyze the soil particle size distribution. Soil pH was measured insitu using an ABS aluminum alloy pH meter (pH value measuring range: 3.5~9.0) for the ten villages in Awgu (Fig. 2). To ensure accurate pH level for the soils, three sample points were tested for three different farms on each of the ten locations. The average pH range of the total ten sample points for each location was taken as the overall pH range of that location.

Fig. 2: Soil pH tester displaying reading on site

Soil nutrient (NKP) was measured insitu using NPK meter ($range_a$: 0 – 1999mg/kg) following similar sample points as pH. Figures 3 and 4 show images of the NPK meter in its box container and during field testing respectively.

Fig. 3: Soil NPK meter

Fig 4: On-site reading of the NPK meter

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Soil Tractability

The tendency of machineries and soil engaging tools to operate on the agricultural field with the soil providing adequate shear resistance to minimize tyre slip as the implement tills the soil without sinkage is known as tractability. Ani et al. [13] established a tractability condition of 60.08% of field capacity, based on soil moisture for disc ploughing on loamy sand soil of Ilorin agro-ecological zone. Assuming that the sandy loam soil of Ilorin possesses the same characteristics as that of Awgu, AgricassistApp makes prediction for suitable field workday (SFW) or tractable and non-tractable day using the soil moisture API.

RESULTS AND DISCUSSION

Components of AgricassistApp

AgricassistApp consists of four main components (Figure 5) and six subcomponents. The main components are: sign-in / sign-up screen, welcome address screen, select location screen and the home page screen displaying the subcomponents such as location details, government news, timeline menu, chat menu, agro news menu, agro services menu and agronomic practice menu.

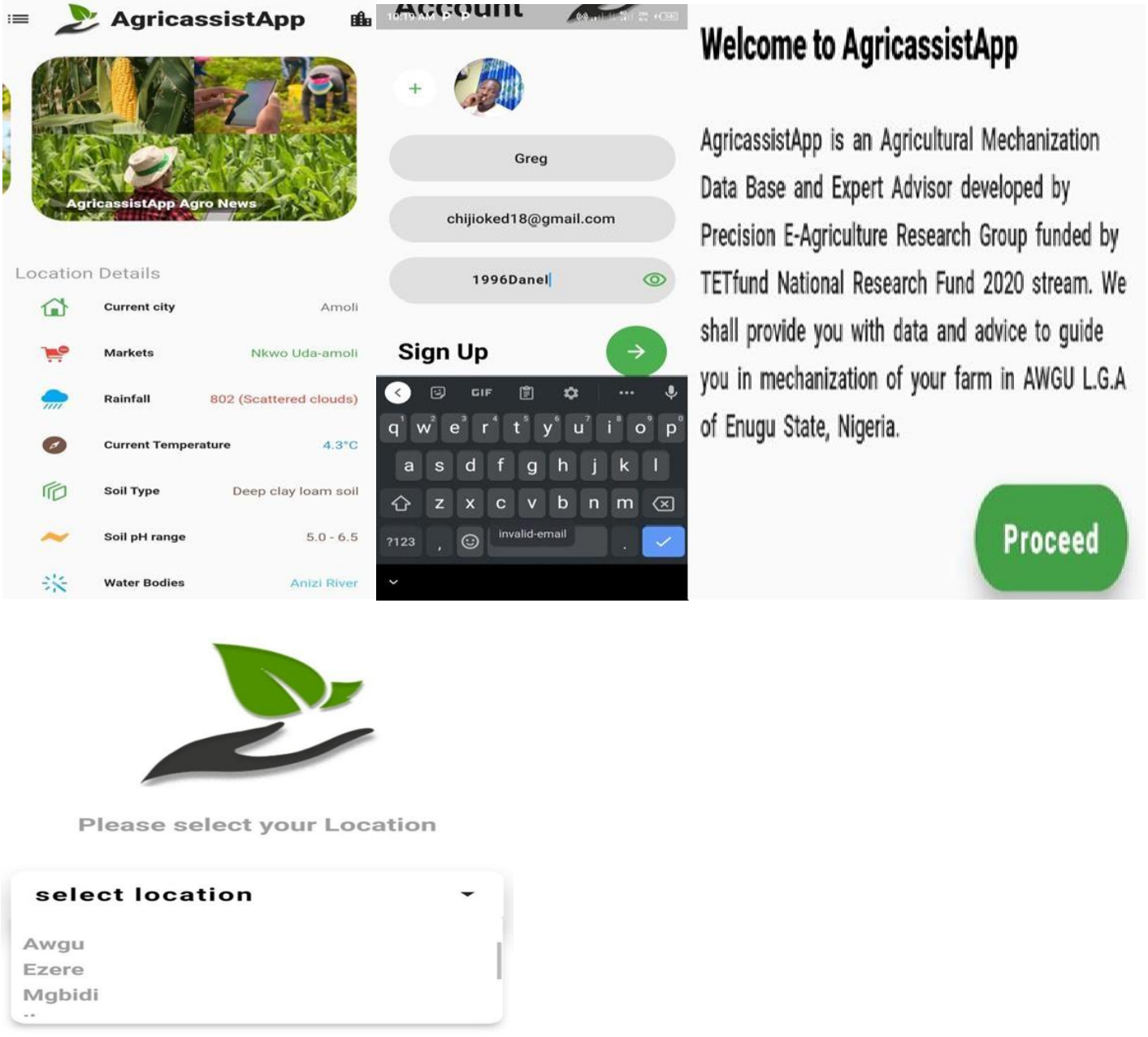

Fig. 5: Key components of AgricassistApp (a) Sign up (b) welcome page (c) select location (d) homepage/location details

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Sub-Components of AgricassistApp

The sub-components of AgricassistApp, are actually the homepage features which include the following:

Location Details

This is a detailed list showing the general features of any area selected from the locations provided in the drop-down list of the select location page (Figure 6). All data gathered from site visitation and literatures are stored at the back end and are made available to users on this screen.

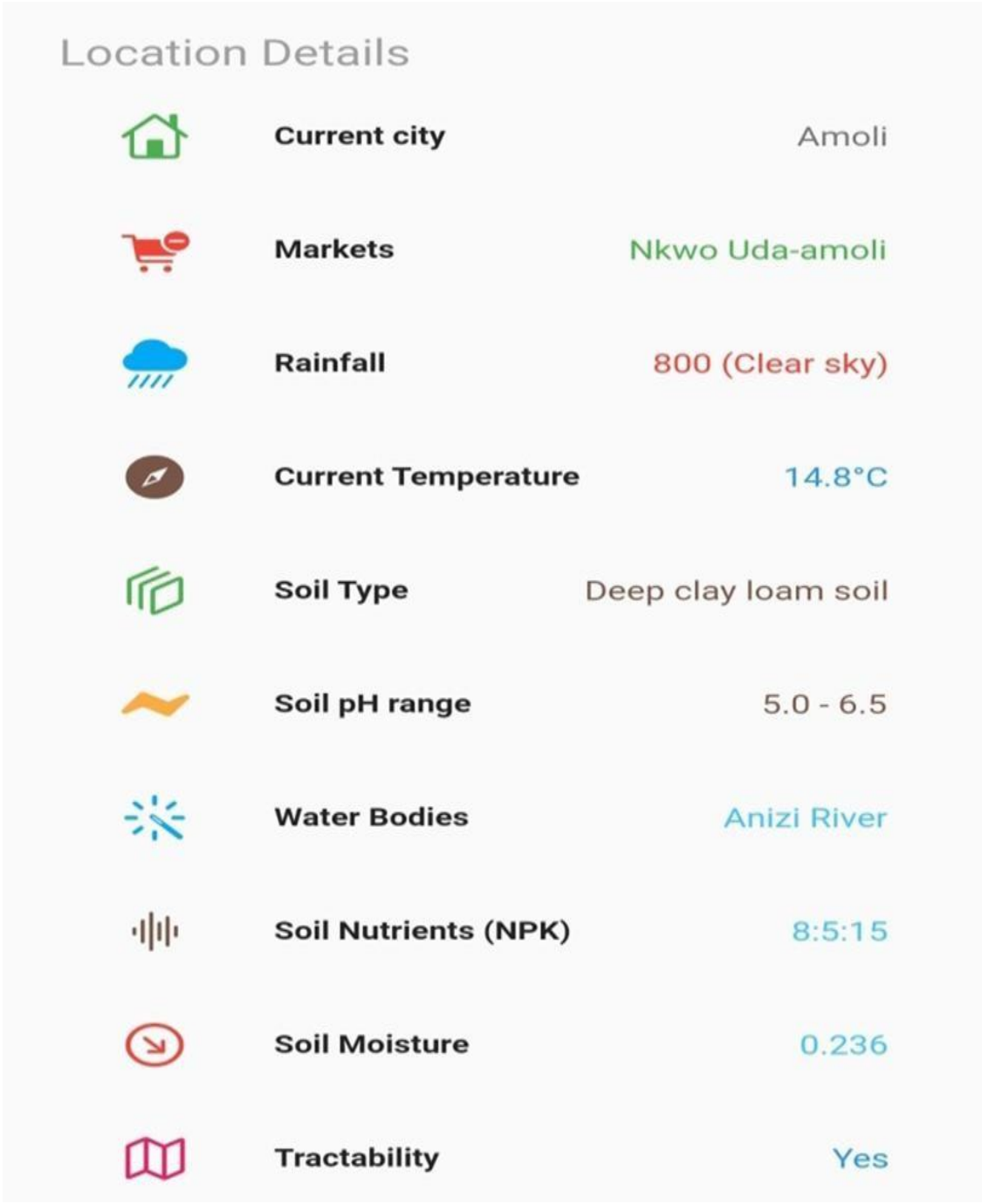

Fig 6: Location details display

AgricassistApp Local News

This menu was provided to bridge the gap between the farmers and the government. It provides information on government incentives and all forms of assistance on provision of agricultural inputs to farmers (Figure 7). Updates are provided in detail from the back end of the app and made accessible to all farmers at a single click.

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Fig. 7: Local news feature [14]

Timeline Menu

This menu was created to display pictorial image of the crop production in progress from various users of the app (Figure 8).

Fig. 8: Timeline function of AgricassistApp [15], [16]

Chat Menu

This is one of the special features of AgricassistApp which was set up to enhance the dissemination of information among registered users. For better performance, the Zegocloud API was employed for this purpose to provide voice and video call services to users. Figure 9 shows how users navigate to the chat page of AgricassistApp to view online users.

Fig 9: Online registered users of AgricassistApp [17]

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Agro News Menu

This menu was designed to provide daily news update particularly related to agriculture in Nigeria (Figure 10). The Serpi news API was employed for this function.

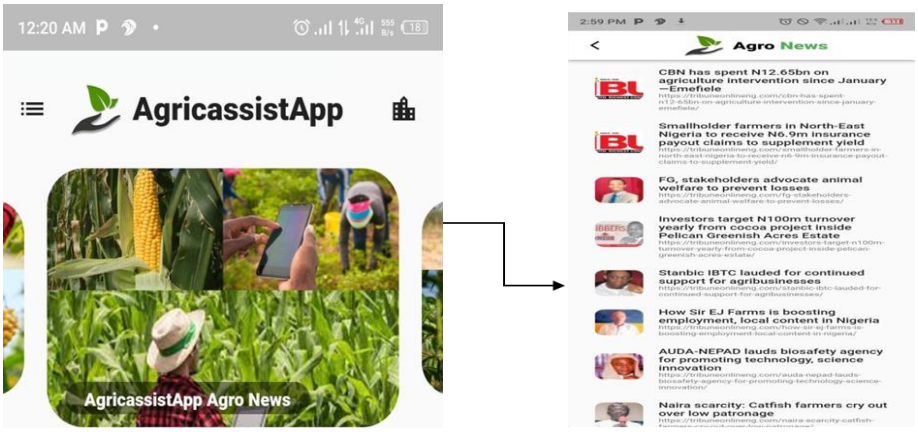

Fig.10: News updates from the Serpi news API [18]

Agro Services Menu

AgricassistApp recognizes the need for skilled and unskilled labour in agriculture and as such this menu was provided to close the gap between agro service providers and the farmers (Figure 11).

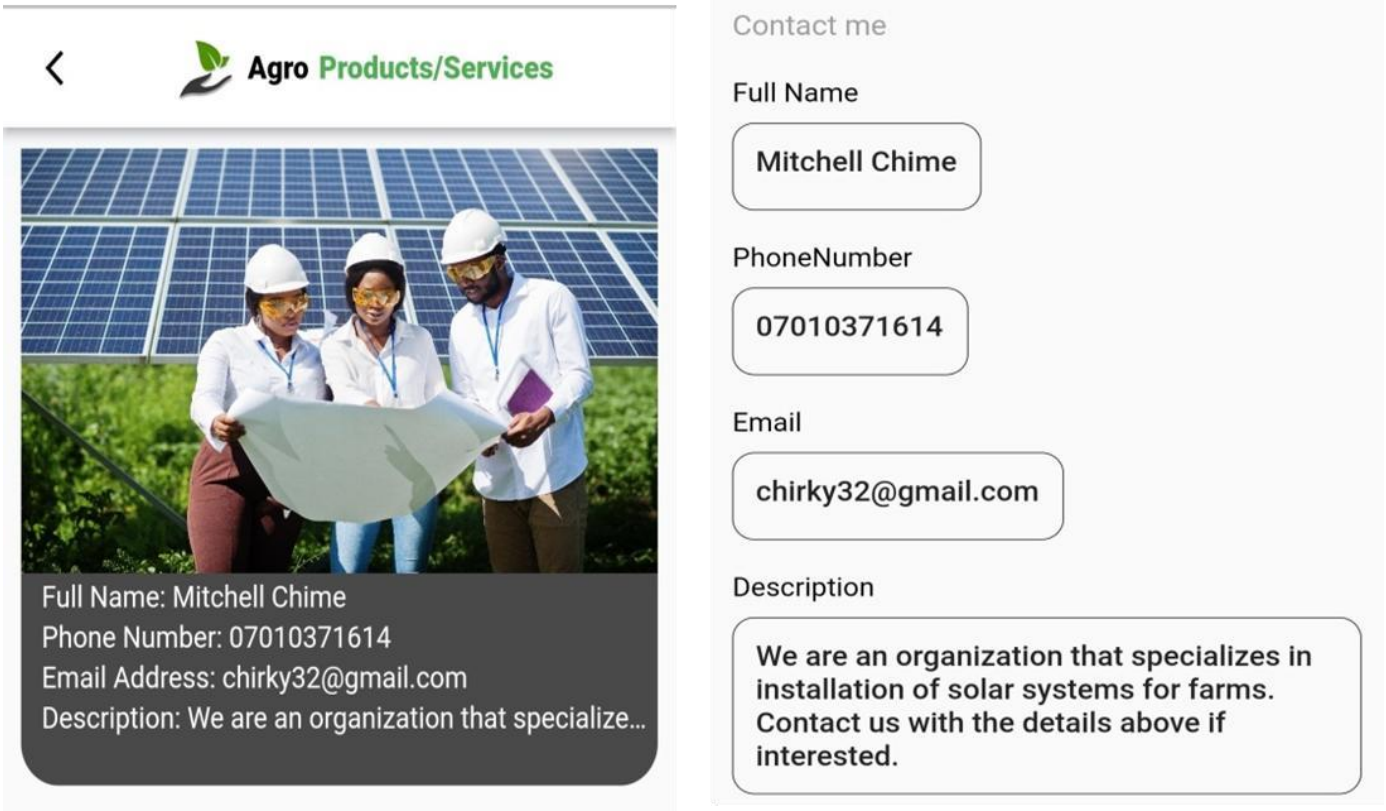

Fig.11: Solar system installation service [19]

Agronomic Practice Menu

In this page is contained the various food crops under consideration and details on their agronomic practices (Figure 12). Its button is the “check for more details” button that is displayed upon a successful search for location weather details. This function is designed this way to ensure an accurate risk assessment chart displayed beneath the agronomic practice for every crop selected at any point in time.

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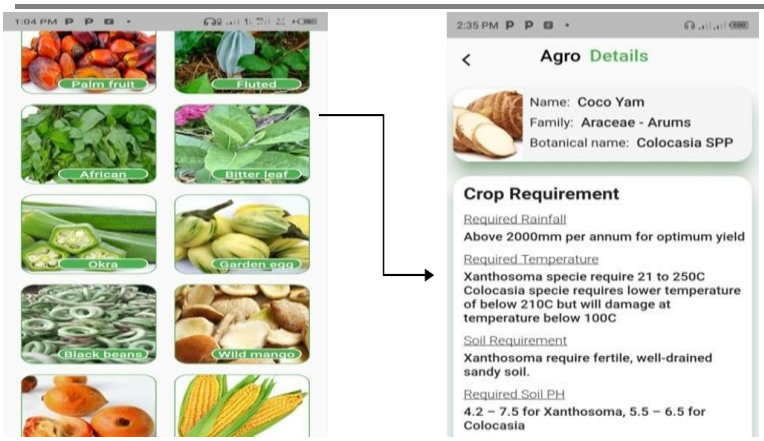

Fig. 12: Outcome of the agronomic practice page [20]

Structuring and Data Hosting of AgricassistApp Software

For structuring and hosting of data, future expansion and integration of the app by individual and public agencies, AgricassistApp was designed using a modular design process. The current design consists of four main modules: a frontend user interface (UI) module, an API, a middleware communication module, and a backend module (Figure 13).

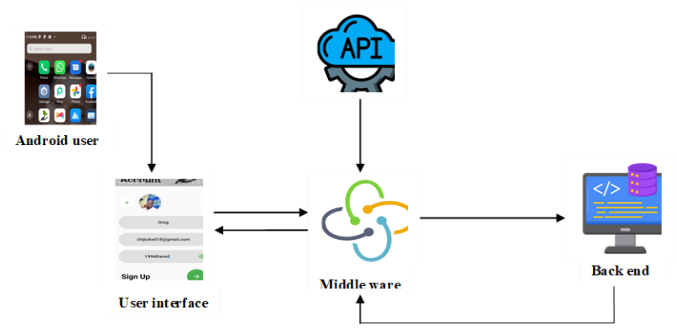

Fig. 13: Frontend, middleware, API and backend modules of AgricassistApp

In figure 14, a user chooses a location and updates are provided in real-time from the API deployed at the back-end through the middleware, the middleware receives all actions from the user and passes them to the backend, which responds to the user's request and sends an appropriate response through the middleware back to the user on the frontend.

DISCUSSION

On deployment, AgricassistApp works in such a way that on clicking the app icon on a smart phone, fresh users sign-up while existing users sign in. Their login details (profile picture, e-mail, nickname and password) are stored in the database of the system software. On successful login, a welcome note revealing a brief summary of the app is displayed. Beneath this page a "PROCEED" button provided at the bottom-right corner of the page. On proceeding, user is expected to select a preferred location from the locations provided on a drop-down list. The "NEXT" button at the bottom-right corner of this page is activated as soon as user selects a location. Clicking on the next command button will take user to the home page of AgricassistApp. On the home page, location details such as; temperature and rainfall intensity of the selected location are provided in real-time alongside details on available water bodies for irrigation, available local market, soil type, soil nutrient, soil PH and tractability of the selected location are displayed as a result of the programmed interaction between the database and the API. Floating above this page are the menus for news update from the API, menu for breaking news powered from the back-end, chat function menu and the timeline menu. A "Check for more details" menu is provided beneath this environment and on clicking, a grid list of food crops in Awgu is displayed. On selecting any of the crops, a user will be provided all information necessary to make a decision whether to go ahead or not to cultivate that crop at that particular time, haven taken into consideration all the factors of production. Furthermore, a risk assessment displayed in form of a chart is provided based on analysis of soil

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water content and hence the suitability of the land for machinery traffic; and a user has the choice to either bear the risk and continue or wait for suitable work days in the future as the weather improves.

Matrices for Evaluating AgricassistApp

The key metrics used to evaluate the efficiency of AgricassistApp during testing include:

API Accuracy

An application programming interface (API) is a link for two or more computer programs to communicate with each other. It is a type of software interface, offering a service to other pieces of software [21]. For AgricassistApp, the weather API, voice and video call API, and news API were employed.

To evaluate the API accuracy of the app, the weather API was taken into consideration as this is more crucial to the farmer. Temperature values for four other cities in addition to current city of the user was checked using the app and the values were compared with values from four other weather APIs as shown in Table 1. Results as could be seen in Table 3 showed that the values of temperature as obtained from the four different APIs are comparable.

Table I Temperature Readings of Different Locations from Four Different Apis At 2pm To 2:15pm On 30th Nov 2022

S/No	Locations	AgricassistApp AP I	Other APIs			
			AccuWeather	Weather crave	Gismeteo	Tomorrow.io
1	Nsukka	33.6^{0}C	32^{0}C	32^{0}C	33^{0}C	33^{0}C
2	Lagos	32^{0}C	32^{0}C	31^{0}C	32^{0}C	30^{0}C
3	Jos	28^{0}C	28^{0}C	28^{0}C	30^{0}C	27^{0}C
4	Sokoto	32^{0}C	32^{0}C	33^{0}C	34^{0}C	32^{0}C
5	Abuja	32^{0}C	32^{0}C	33^{0}C	36^{0}C	32^{0}C

User-Friendliness

To evaluate the user-friendliness of AgricassistApp (Figure 14), users were approached randomly and briefed about the app after which they were allowed to navigate the app independently as they were observed closely. A user-friendliness score was assigned based on the features the users were able to access in either Igbo or English language.

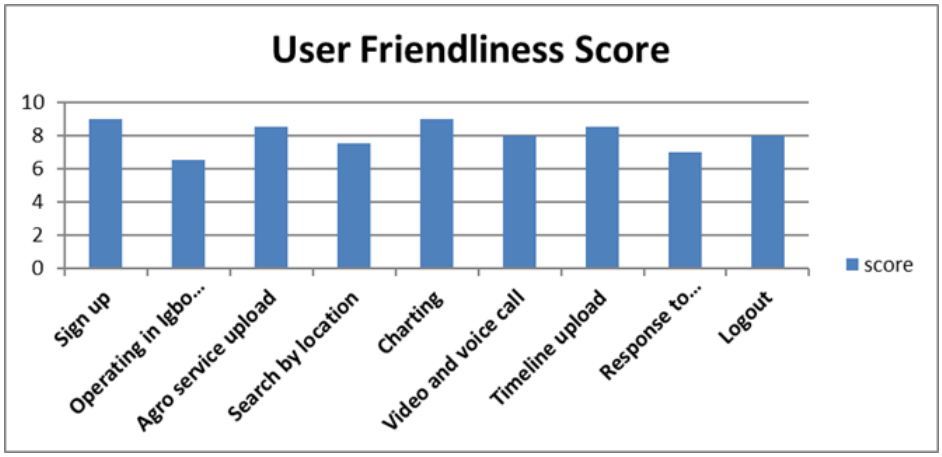

Fig. 14: User-Friendliness chart

CONCLUSION

AgricassistApp was developed, evaluated and presented in this paper. It is an android based multipurpose and

bilingual mobile application for Awgu that provides information on local crops of high economic importance, suitable agronomic practices, weather, soil, available water bodies, nearby markets; as well as platforms for government agric news, general agric news, farmers products available for sale, available agro-service providers, their services and contacts, platforms for farmers to communicate via audio and video and to exchange farm input materials or other information. This application is intended to serve as a decision support and information network tool for farmers and other stakeholders. Users are advised to use the app as an expert guide to enhance their indigenous and local knowledge (ILK).

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