Application of ICT in Crop Production

Ugwuishiwu C. H., Udanor C., Ugwuishiwu B. O.

Abstract - The rapid advancement in Information and Communications Technologies (ICTs) has given rise to new applications that were impossible just few years ago. Agriculture is an important sector with the majority of the rural population in developing countries depending on it. The sector faces major challenges of enhancing production in a situation of dwindling natural resources necessary for production. ICT plays an important role in challenging and uplifting the livelihoods of the rural populace using an agro computer-based information system. This paper proposes an Agro-Information System that enables a farmer to have relevant information about a crop, such as the varieties and other requirements like soil type, temperature, type and quantity of fertilizer, time of planting, time of maturity, planting distance, diseases, pest, pest and Disease control measures, rainfall, sunshine, etc. of that crop. The level of application of this information determines the volume and efficiency of the crop yield. An AIS software is designed and implemented which helps the farmer achieve the afore-mentioned objectives.

Keywords: Agriculture, Crop yield, ICT, Crop requirements, Agro Information System (AIS).

I. INTRODUCTION

There is an ever-increasing use of information in all aspects of human activities including agriculture. Because of the urgent need for research in the proper use of new technologies in Agriculture, knowledge produced by Agricultural scientists must be transformed into computer understandable representation. It is based on this background that this study has been undertaken to illustrate an application of ICT in crop production. Agriculture is the art and science of all business related to growing of crops and rearing of animals for the provision of food, shelter and increasing of the standard of living for mankind [1]. The importance of Agriculture includes provision of food, employment and raw materials for industries, others are, foreign exchange earner, source of income, provision of shelter, regional development and afforestation.

The agricultural sector is confronted with the major challenge of increasing production to feed a growing and increasingly prosperous population in a situation of decreasing availability of natural resources [2]. Farming involves risks and uncertainties, with farmers facing many threats from water shortages, declining soil fertility, erosion, pests, effects of climate change and rapid decrease of fertile agricultural lands due to urbanization. There is a huge gap between information residing in agricultural knowledge centres and rural communities. Information on pest and disease control, especially early warning systems, new varieties, new ways to optimize production and regulations for quality control should help us in arresting these bottlenecks. This gave rise for the need for Information and communication technology in crop production.

Manuscript received September 02, 2012.

Ugwuishiwu C. H., Department of Computer Science, University of Nigeria, Nsukka,

Udanor C. N., Department of Computer Science, University of Nigeria,

Ugwuishiwu B. O., Department of Agricultural & Bioresources Engineering, Nsukka, Nigeria,

A farmer who has access to the most current information about his farming business must always be far ahead of those who lack information. Consider a farmer who has problem to solve in crop protection; instead of walking from section to section of a library, the user is just guided on the screen to the different information stores by pressing few keys with the use of computer [3]. Investment must be promised on the knowledge of what is available, how accessible they are, how they are used and what capabilities exist or a need to be developed in using information technology.

In a developing country like Nigeria, this can be done through the use of mobile phones, traditional media such as community radio or TV, computers, geographical information systems, printed documents, e-mail, CD-Rom, SMS, or Internet, among others, to disseminate information that enable even small-scale farmers who are not literate to use ICTs. Structured System Development methodology was used in developing this information system. This methodology takes objective view of reality; provides elaborate planning guidelines, techniques and case tools. The method includes iterative activities which mean if there is a problem in one stage one can look at the earlier or later stages to rectify the program. Section 2.0 reviews related literature; section 3.0 details a high-level set of requirements that the AIS must satisfy, the architecture of an Agro information system and the database of the system. Section 4.0 outlines the description and the implementation of a prototype for the AIS. Finally section 5.0 presents some concluding remarks.

II. REVIEW OF RELATED LITERATURE

At the beginning, computer technology was developed and seen as a powerful tool for calculation and preparation of documents. At the same time, communication technologies were also being developed for transfer of information from one location to the other. Somewhere along the line, a marriage occurred between the two technologies to give birth to information and communication technology (ICT) sometime referred to as simply (IT) [4]. Agriculture and rural development is undergoing new and rapid changes due to globalization and new technologies that transform the way in which production is organized [5]. There is no universally accepted definition of ICT because the concepts, methods and applications involved in ICT are constantly evolving on an almost daily basis. It happens so fast that it is difficult to keep up with the changes. ICT is defined here to cover any product that will store, retrieve, manipulate, transmit or receive information electronically in a digital form, for example, personal computers, digital television, email, robots etc [6]. E-Agriculture involves the conceptualization, design, development, evaluation and application of innovative ways to use information and communication technologies (IT) in the rural domain, with a primary focus on agriculture [7].

In several developing countries, ICTs represents the fastest growing industries and are assuming growing macroeconomic importance. One of the major reasons of the current underdevelopment and poverty problems in African is lack of a sound technological base on which sustainable development can stand [8]. At present, ICT is restricted to only the urban centres of the countries, yet statistics has it that about 70% of the citizens of developing countries are living in rural areas.

Application of ICT in crop production though a relatively new phenomenon, evidence of the contribution of ICT to agricultural development and poverty alleviation is becoming increasingly obvious. [9] Some common problems in adoption of ICT in rural segments such as ICT illiteracy, unavailability of relevant and localized contents in their own languages, uneasy and unaffordable accessibility and other issues like awareness and willingness for adoption of new technologies among the rural peoples can definitely be handled with the application of ICT. [10].

Rural area is synonymous with agriculture because what affects rural development affects Agriculture. Thus for technology to have serious impact in developing countries, it must be made available to the rural area [11]. Information technology capabilities relate to the knowledge and skills required to effectively utilize communication equipment and correctly receive and transmit information up and down the channel of administrative command [12]. The author also mentioned that IT capabilities consist of the resources needed to generate and manage information. ICT is also local intermediaries serving farmers who lack basic access to up-to-date information on best farming practices, market conditions, pest and disease control, weather forecasts, and a range of other issues [2].

Application of ICT in Agriculture involves focusing on the enhancement of agricultural and rural development; this involves application of innovative ways to use ICT in the rural domain. The advancements in ICT can be utilized for providing accurate, timely, relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture [10]. Taken into account of the tides and trends that the research carried out in this area ended only in theory, therefore, this research will base on the design and implementation of an information system for crop production awareness to farmers.

III. THE AGRO-INFORMATION SYSTEM ANALYSIS

This section shows a number of criteria that the design of the system will satisfy. It also discussed the architecture of the entire system and the data design.

A. Requirements Definition for the Agro Information System

The design of this system satisfies a number of sometimes competing criteria. These requirements are:

1. **Security:** The information stored in the system cannot be tampered with unless by the administrator when the need for update arises.
2. **Multi-user:** A number of farmers can access the system simultaneously through the Internet.
3. **Accessibility:** The system can be accessed by farmers from any location using secure internet and or mobile devices.
4. **Availability:** The system is readily available to users through the Internet, mobile phones, and traditional media among others.
5. **Integrity/accuracy:** Every information in the system comes from professionals (those knowledgeable in field) and must have been tested and confirmed through scientific experiment. No alternation to this is permitted unless there is an improved version of the original information.
6. **Verifiability:** Farmer can also verify that the information they got is correct by going back to the site the second time or more.
7. **General:** All farmers must be able to have access to the information system.

B. Architecture of the Agro- Information System

To accommodate the requirements presented in section 2.1 above, architecture of the system was developed as shown in fig.1.0 below. The system architecture defines the key components of the proposed system together with the interactions between these components. The system was modeled in a way that when a user want to view information in the system, the user has to enter a name of a particular crop, from there he selects the variety of the crop, and view the requirements of that variety. The developed system allows many farmers to use it simultaneously while ensuring high availability any time the information is needed. For security purposes, update module can only be accessed by an Administrator using an identity code. Below is architecture of the agro information system.

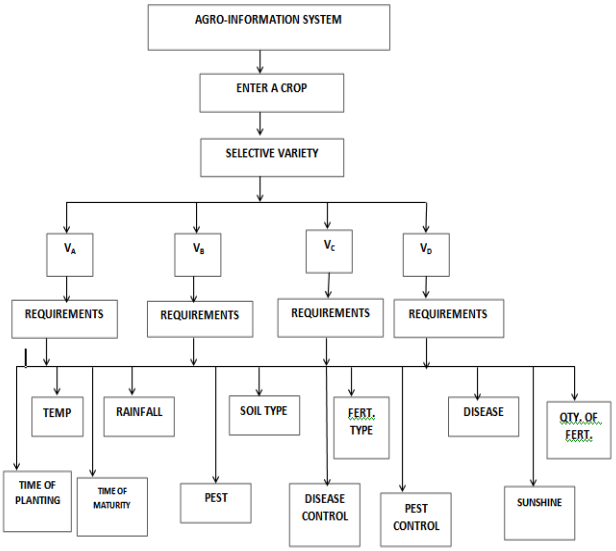


Fig. 1: The Architecture of the Agro-Information System

C. Database

Database has the core service for storing, processing and securing data. The database server provides controlled access and rapid transaction processing to meet the requirements of the client tier. Information on all crop records, crop variety records and each crop variety requirements record resides in this server as shown in Tables 1 and 2. The server is also responsible for authenticating administrators authorization and the system when the need be. The relationships between the entities in the Tables mentioned above are also shown in fig. 2.0.

Table ia: All Crops Tables

Field name	Field type
Crop	Text
Botanical name	Text
Type	Text
Crop code	Text

Table ib: When a user adds a new crop into the table, a record will take the following form

Field name	Field type
Crop	Tomatoes
Botanical	Lycopersicon
Type	Vegetable
Crop code	Cp001

Table iia: Varieties Requirements Table

Field name	**Field type**
Varcode	Text
Cropcode	Text
VarName	Text
Soil type	Text
Fertilizer type	Text
Temperature	Text

Table iib: A record in table will consist of the following:

Field name	Field type
Varcode	Var001
Cropcode	Cp001
VarName	Ife plum
Soil type	Well drained sandy loam
Fertilizer type	N.P.K. 15:15:15
Temperature (^{o}c)	10-14
Quantity of fertilizer(kg/ha/yr)	550
Field name	Field type
Crop	Tomatoes
Botanical	Lycopersicon
Type	Vegetable
Crop code	Cp001
Quantity of fertilizer	Text
Time of planting	Text
Time of maturity	Text
Disease	Text
Pest	Text
Disease control	Text
Pest control	Text
Rainfall	Text
Sunshine	Text
Time of planting	Jan-April
Time of maturity	9 months
Disease	Eusarium wilt (Root Rot)
Pest	Grasshopper
Disease control	Treat soil with copper
Pest control	Had picking
Rainfall(cm)	49-90
Sunshine	Very high

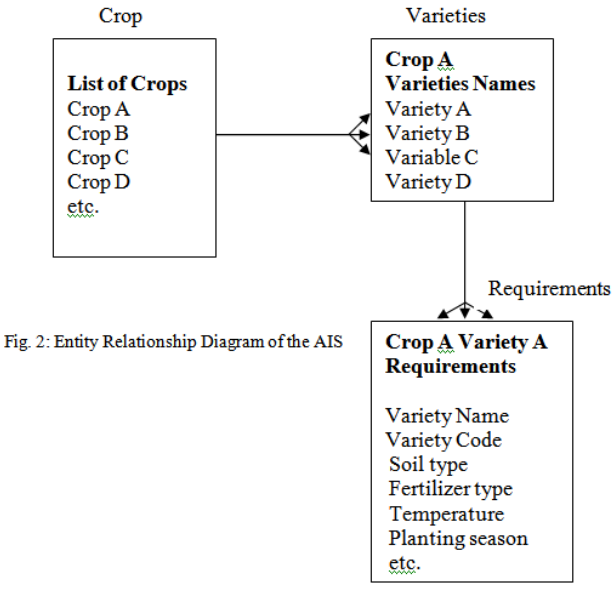


Fig. 2: Entity Relationship Diagram of the AIS

IV. AGRO-INFORMATION SYSTEM IMPLEMENTATION

The system architecture defines the key components of the proposed system together with the interactions between the components. The overall functional structure of the frame work is summarized as follows:

A farmer who wants to introduce a brand new crop into his farm menu or who has already been farming on a particular type of crop can access the information about the crop by running through the information system stored in the computer as follows:

When the system is open, click on run, main menu form will appear comprising FILE, VIEW, and UPDATE module.

A. File Subsystem

When you click on file, sub menu named "open" and "Exit" will appear, when you select open, another submenu will show "crop and variety". When you select crop, an input box will appear prompting you for a crop name, when you enter crop name that exist in database, a form named "AIS crop and variety" shown in one of the three forms in figure 3 will appears which contains the crop you have selected, its varieties and requirement command button.

When you click on "varieties of this crop", varieties of the crop you have selected will appear, you select a variety, and then click on "see requirements", the requirements of the variety you have selected will appear as shown in one of the three forms in figure 3 as "Red Banana" and this is the final output.

When you select the variety submenu instead of crop submenu, you will still go through the same process since any variety should be under a crop name. Assuming you do not want to open neither crop nor variety and select Exit, the program will close.

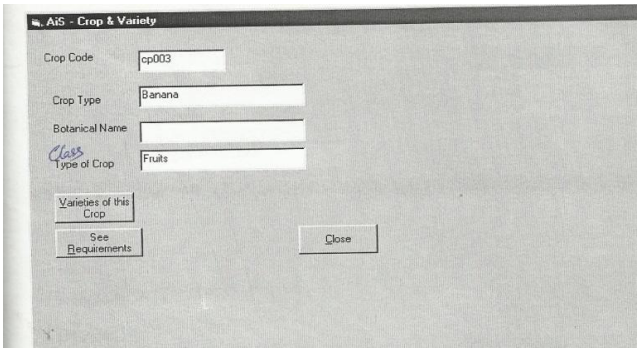
B. Update Module

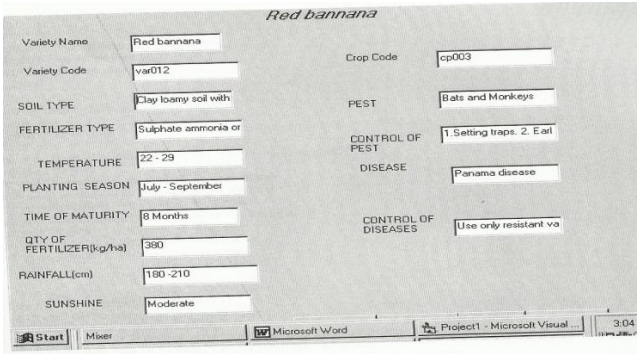
It is only the administrator that is authorized to make changes in the system either by adding a new crop or variety, or by editing an already existing crops and varieties in the database. To add more crop(s), click on update and select 'add', form named crop and variety will appear where you fill in the crop and click on update command button', if it is variety you want to add, select variety, add the crop and click on exit to close.

To make changes on the existing crop, click on 'Edit', click on 'crop', enter a crop name in an input box that appears, click 'ok', a form named crop and variety appears where you can make all changes on the crop, its variety and even on the requirements of the variety you have selected. You click on close to exit the program. You can also use variety code to edit variety by clicking on "edit submenu",variety, enter variety code in the input box and click "ok", a form named AIS variety appears and you make your changes.

C. View Module

When you want to see all the existing crops and varieties and their codes, you use this menu. If you want to view all the exiting crop types and their codes, you click on view, select crop types, a form containing all the exiting crops will appear. You exit by clicking close. If it is all varieties that you want to view, then select view, click on the variety and all the exiting varieties of all the exiting crops differentiated by using variety's crop codes will appear and you exit by clicking on close bottom. The following (fig. 3) are some of the forms in the Agro information system.





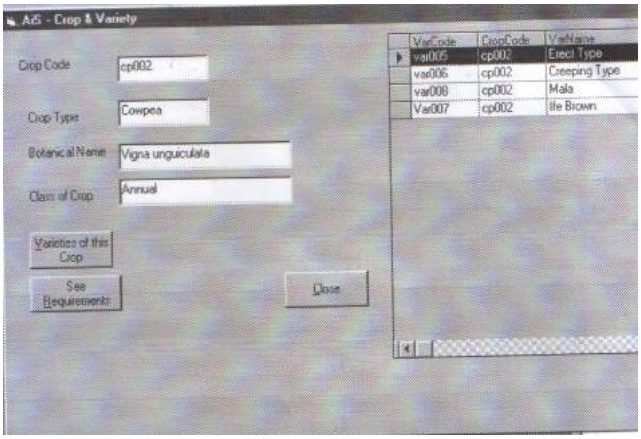


Fig. 3 Some Major Forms of the Developed System

V. CONCLUSION AND FUTURE WORK

Since we have seen the relevance of agriculture to mankind, there is no doubt that we should improve crop production through technological advancement and information dissemination. Technology has emerged as a significant alternative to the conventional means in dissemination of reliable and trusted information

This paper detailed the requirements, design and implementation of a generic agro information system, where farmers can update themselves anytime, anywhere using a number of electronic devices including private computer networks, web and mobile phones. The AIS is sufficiently robust and comprehensible that farmers will get better return on their investments after using the system. The application of this system reduces the cost of administration as the constraint of time; resources and distances are reduced by the instant communication possibilities of these technologies.

The findings of this study brought to the fore, the limitless possibilities and various ways of using ICT in an aspect of agricultural administration and practice known as crop production.

Future work will incorporate market information. This will be a big plus to the research because awareness of up-to-date market information on the prices of commodities, services and consumer trends can improve farmers' livelihoods substantially. Such information is instrumental in making decisions about future crops and commodities and about the best time and place to buy and sell goods. This information can be broadcast to the rural populace through electronic media such as radio, TV and mobile phones.

REFERENCE

1. Anyanwu A.C; Anyanwu B.O.; Anyanwu V. A.(1999). A textbook of Agriculture Sciencefor schools and colleges. Fifth Edition 1999. ISBN 975-175-350-1
2. Krishna Kumar P.S. Mapping & Preliminary Evaluation of ICT Applications Supporting Agricultural Development retrieved from www.acdivoca.org/ accessed on 2nd feb, 2012
3. Huggan, R.D.; E.D. Hunt; and M.C. Van den Berg (1994). From research through information… into production In: New information technologies in agriculture, "Quarterly Bulletin of the International Association of Agricultural Information Specialist", Vol. XXIX No. 1-2 pp 18-32.
4. Uguru, F.N.(2001). Information technology: Access capability and use among Administrators of Agro-Technologies Transfer program-mmes in South-Eastern Nigeria Ph.D Thesis.

5. Chowdhury, N. (2001). Appropriate technology, for Stainable Food Security: ICTs. In Pinstrup- Anderson, P.(Ed) Appropriate technology for sustainable food security. 2020 Vision Focus7. IFPRI, Washington DC.
6. *What is ICT retrieved from tutor2u.net/business/ict/intro_what_is_ict.htm* - Cached accessed on 3rd Feb, 2012
7. *ICT in Agriculture retrieved from en.wikipedia.org/wiki/ ICT_in_agriculture* – Cached accessed on 2nd Feb, 2012
8. Odigboh, E.U. and Onwualu, A.P. (1994). Mechanization of Agriculture in Nigeria: a critical appraisal "Journal of Agricultural Technology" 2 (2): 1-58.
9. How ICT can make a difference in agricultural livelihoods retrieved from www.iicd.org/files/ICT%20and%20agricultural%20livelihoods.pdf accessed on 2nd Feb, 2012
10. *ICT in Agriculture retrieved from www.ekrishinaip.in/* - Cached accessed on 2nd Feb, 2012
11. Ugwuishiwu C.H. (2004). Application of Information and Communication Technology in Agriculture. BSc. Project
12. Adeyinka, F.M.(1997).Technology response of firms to telecommunication development in Nigeria .An interim project report submitted to the African Technology studies (ATPS), Ibadan: NISER.

AUTHORS PROFILE

Chikodili H. Ugwuishiwu, is a lecturer and research fellow in the Department of Computer Science, University of Nigeria, Nsukka. She holds a Masters Degree in Computer Science from University of Nigeria Nsukka. She has advanced in her Ph.D work titled: Design and Development of real Time Integrated Crime Information System for Nigeria Law enforcement Agencies in Computer Science Department , University of Nigeria, Nsukka. Her areas of research interest are on Computer Information System(CIS) and Software development. She is a member of Computer Professionals of Nigeria (CPN) with some journal publications.

Collins N. Callings Udanor, received his Bachelor of Engineering Degree in Computer Science & Engineering, Enugu State University of Science & Technology (ESUT) in 1996. He got his Masters Degree in 2004 in Computer Science from University of Nigeria Nsukka. He is concluding his PhD work in Electronic Engineering Department UNN, awaiting final assessment. His research areas include: Agent-based intelligent mobile learning systems, Grid High Performance & Cloud Computing. He has many years of professional hands-on experience in the industry and academic projects. He is versatile in many programming languages, as well as in different hardware platforms. He has developed so many online and mobile applications. He has also authored many academic books and has publications in international journals. C.N.C Udanor currently is faculty member in UNN and also a member of Computer Professionals of Nigeria (CPN).

Boniface Obi Ugwuishiwu, is a senior Lecturer in the Department of Agricultural and Bioresources Engineering, Faculty of Engineering, University of Nigeria, Nsukka. He has Masters` and Doctorate degrees from the Department of Agricultural and Bioresources Engineering., University of Nigeria, Nsukka. His research interests are on Agricultural Farm Structures and Design, Agricultural Waste Management and Environmental Control, Sustainable Agricultural and Bioresources Development, Natural Resources Management, Appropriate Technology and Gender issue. He is a coperate member of Nigerian Institution of Agricultural Engineers *(MNIAE),* Member, Nigerian Society of Agricultural Engineers *(MNSE),* Council of Registered Engineers of Nigeria *(COREN),* and Member, American Society of Agricultural and Bioresources Engineers*(MASABE)* He has over twenty publications in both International and national journals.