IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 8, Issue 10 Ver. II (Oct. 2015), PP 13-19
www.iosrjournals.org

Extension Officers' Requirements in an Artificial Intelligent System for Diagnosis of Maize Disease, Kenya

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Abstract: *A study was conducted to determine the most frequently used agricultural diagnostic information source by extension officers, the content of information which both the extension officer would like to receive for full satisfaction on diagnostics, the formats and form the extension officers would like to receive the information and the ICT tools, channels and features which extension offers have high self- efficiency with for the development an ideal artificial intelligent system. The study was conducted in Uasin Gishu County, Kenya where the population targeted was extension officers within the county. The research design was a case study in Uasin Gishu County and a case of maize diagnostics, which formed the representative area and crop for Kenya farmers, respectively. All extension officers were interviewed and data obtained analyzed using SPSS.*
The study revealed that extension officers gathered information mostly from seminars conducted by the government; they were interested in accessing full information on diseases and pests including their scientific and common names, symptoms, management options and prescriptions. Thus, a system was to be developed that would require an administrator to search, collect and input diagnostic information on new diseases and pests into the system. The information accessed by the extension officers in relation to disease diagnostics is to be included in the actual system development. The final content of information given to the extension officers by the system must be in a printable format and must be accessed through Webpage and internet based application.
Keywords*: Artificial intelligent system, Diagnostic, Extension officers Requirement, Uasin Gishu,*

I. Introduction

System requirements are one of the key prerequisites to system development. The development of a computer aided artificial intelligent system for agricultural diagnostics is no exception. Currently, agricultural diagnostic services are provided by extension officers. However, some players might have different alternatives to the extension sources. Extension officers have to move from one farmer to the other as they observe the affected plants and make diagnostic and management decisions. This has proven to be very time consuming and costly. The current ratio of extension officer to farmers is 1:1500. This makes it impossible for extension officers to reach all farmers.

Extension services are largely funded by the government and complemented by NGOs who serve their specific projects. Reduced budgetary allocation to agriculture and poor road infrastructure within the rural areas; have challenged efficiency and effective delivery of diagnostic services. It was therefore necessary to explore alternative approaches for providing agricultural diagnostic services, in a global arena characterized by the development challenges and advancements in ICT innovations.

Substantial financial resources have been allocated to improve ICT infrastructure in the country. These improvements include, enhanced ICT connectivity through the laying of fiber optic cables, aggressive development of mobile phone networks by service providers such as Safaricom, Airtel and others and adoption of usage of mobile phones (80% ownership and adoption) in many sectors of the economy. It is therefore important to automate services in the different sectors of the national economic.

Automation of services requires a good understanding of the various socio-economic factors affecting extension officers and the ICT tools, channels and features perceived as useful and easy to use. This study reviewed current diagnostics information sources by extension officers, the available ICT tools, channels, features and technologies for accessing and sharing information.

The ICT tools were mobile phones, computers, television and radio. The ICT channels were Frequency Modulated (FM) waves, GSM, internet and television waves. Expected outcome was an improved likelihood of adopting the system. The findings of this study guided the development of automated computer aided artificial

intelligent information systems for agricultural diagnostics in Kenya, previously not reported in published scientific literature.

1.1 Problem Statement

Despite the deployment of extension officers to offer agricultural diagnostic services to farmers, the number of extension officer to farmers still stands at 1:1500 farmers. In addition, there are challenges encountered including: inadequate budgetary allocation to agriculture, which eventually trickles down to the low budgetary allocation for operations and movement of extension officers to offer diagnostic services to the farmers. Moreover, Kenya is characterized by poor road infrastructure which raises the cost of ware and tare and making some areas inaccessible to extension officers.

On the other hand, service providers in the telecommunication industry have expanded their networks to over 80% of the country. The government has facilitated internet connectivity through installation of fiber optic cables to major towns. The government policy of provision of computers to every child joining class one, is projected to transform the destiny of future generations in terms of ICT education and application in all sectors of the economy.

A study was therefoe designed with the aim to establish the technological efficacy of extension officers to guide the development of a computer aided artificial intelligent system for agricultural diagnostics.

1.2 Justification of the Study

Technology acceptance model is based on two factors namely: perceived usefulness and perceived ease of use. Upon compliance with these requirements, the adoption and usage of the technology is increased. This study aimed to understand the perceived ease of use to guide the development of an artificial intelligent system. The perceived usefulness will be determined after the development of the system.

1.3 Objective of the study

To determine the requirements of extension officers in an artificial intelligent system for diagnostics and management of pests and diseases affecting maize in Kenya.

1.3.1 Specific Objective

a) To determine the most frequently used agricultural diagnostic information source by extension officers and how socio-economic factor plays.
b) To determine the content of information which the extension officers would like to receive for full satisfaction, on agricultural diagnostics.
c) To determine the formats and form the extension officers would like to receive and send the information.
d) To determine the ICT tools, channels and features in which the extension officers have high self-efficiency.

1.4 Research question

What are the requirements of extension officers in an artificial intelligent system for maize disease diagnostics and management?

Specific Research Questions

a) What are the most used agricultural diagnostic information sources by extension officer and how does socio-economic factor play?
b) What is the content of information on diagnostics considered satisfactory by extension officers and how does socio-economic factor play?
c) What is the format and form that extension officers would like to receive the diagnostics information?
d) Which ICT tools, channels and features extension officers consider easy to use and they are used to working with?

II. Literature review

Extension officers play a very important role in the provision of diagnostic services to farmers. Extension approaches in Kenya include: Focal Area Approach; Farmer Field; Commodity-based approach; and Multidisciplinary Mobile Extension Teams. Despite the various extension approaches employed by the private and public sector, several challenges still exist. These challenges include: under-staffing and reduced funding for operations and maintenance in the public sector extension and dissemination of conflicting messages; unnecessary competition; duplication of efforts; and general lack of synergy among the private sector extension providers.

These challenges have led to limited access to credible extension services in most parts of the country. Currently, the national extension staff to farmer ratio stands at 1:1,500 (Africa Science News Saturday, 16 November 2013). An agricultural system can only be considered sustainable when it satisfies producers' needs and preserves the natural resources for current and future generations. Its development should rest on three pillars: economic feasibility, social fairness and environmental sustainability (Carlos, 2006). This study sought to enhance provision of services by developing a computerized artificial intelligent information system that meets economic feasibility, social feasibility and environmental feasibility within the agricultural sector of Kenya.

"Maize is the most important staple food in sub-Saharan Africa and is the main food crop in Kenya, representing 3 percent of Kenya's gross domestic product (GDP) and 21 percent of the total value of primary agricultural commodities. Maize thrives in regions where the rainfall average falls between 900-1700 mm, but can grow in as little as 500 mm or as much as 2500 mm rainfall. Grown on an estimated 1.4 million hectares in Kenya by large-scale farmers (25 percent) and smallholders (75 percent) it is both a commercial and subsistence crop."(World Bank, 2012). Heavy losses through pests and diseases, to maize farmers, have been witnessed in the past. These losses are witnessed throughout the maize value chain. Diseases related to nutrient deficiencies reduce the maize plan vigor right from germination to maturity, hence reduced productivity. Pathogenic diseases also affect the maize plant during growth, hence reduced productivity at maturity. Entomological diseases affect both the maize plant during growth and the maize grain after harvesting leading to heavy productivity reduction and post harvest losses. To guide artificial intelligent system which will bridge the gap, this study sought to understand the extension officer requirements in such a system with an intention to apply them on the actual system development.

2.1 Conceptual Framework

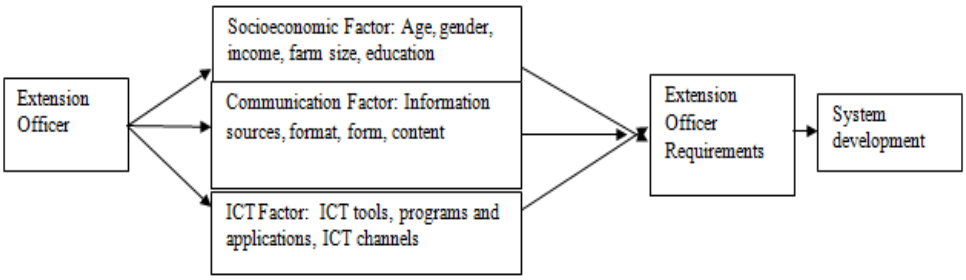

Figure 1: Conceptual framework (source: author)

III. Methodology

The study was conducted in Uasin Gishu County, which is one of the forty seven counties in Kenya and the second largest maize producing county. It is located in the former Rift Valley Province extending between longitudes 340 50' and 340 57' East and latitude of 00 3' South to 00 1' North. The total area of the county stands at 2,955.3 km^2 (1,141.0 sq mi) whereas the total population of the county stands at 894,179 people and 202,291 households according to 2009 census. http://www.scribd.com/doc/36672705/Kenya-Census-2009.

The county has eighteen extension officers. The area was selected for the study because of its high maize production, high numbers of experienced maize farmers and extension officers and frequency of maize disease and pests occurrences in the area. The county has six sub counties with each sub county having three extension officers.

The population targeted by the study was the extension officers within the county. The research design was a case study in Uasin Gishu County and a case of maize diagnostics. These formed a representative area and crop for Kenya farmers.

Purposive sampling was used to identify the extension officers. All extension officers were interviewed hence total population in the case of the extension officers. Primary data was collected using structured interview guides with closed ended questions and analysed using SPSS version 16. Descriptive statistics was used in the analysis.

IV. Results and discussions

4.1 Demographic information of the Extension officers

Eighteen extension officers were interviewed. The study revealed that 50% of extension officers were female and 50% male. Thirty three percent (33.3%) of the extension officers were between 41 to 45 years of age, 33.3% are of 46 to 50 years. Extension officers between the age of 36-40 years and those between 51 years and above formed 16.7% each. A majority of 27.8% of the extension officers were holders of a masters degree, 22.2% with diploma, 16.7% with postgraduate diploma, another 16.7% with college certificates and 11.1% with

Bachelors degree only. 5.6% (1/18) of the extension workers did not disclose their level of education during this study.

4.2 Sources of diagnostics information for extension officers

The study revealed that all (100%) of the respondents got information from seminars, 77.8% also depended on their knowledge, 55.6% depended on agro-vet, 50% depend on journals, other sources of information was at 27.8% (Agricultural officer 11.1%, extension officer 11.1%, and institutes officer 5.6%).

Internet, radio and mobile applications were each being used by 11.1% of the respondents. The aim of understanding the sources of agricultural diagnostics information was to identify the various sources of new information which was driving diagnostics and to incorporate these sources into the computer aided artificial intelligent system for agricultural diagnostics. The study findings revealed the need to deploy a systems manager charged with the responsibility of searching and collecting diagnostics information on new pests and diseases from seminars, agro-vets, journals and extension officers and inputting into the artificial intelligent system.

4.3 Satisfactory Diagnostic Information Content

The results of this study revealed that extension officers require all information related to the pests and diseases. There was 100% agreement, for all the information content by the extension officers. This clearly indicates that during the actual system development, information accessed by the extension officers in relation to disease diagnostics must include the name of the disease, scientific name, all the symptoms, management options, and therapeutic products, how to apply the therapeutic product and where to purchase. This will ultimately influence the database design. The database must be designed such that it can accommodate the entire information requirement. It can therefore be concluded that the information content required by the extension officers in regard to disease diagnostics should include all aspects of disease symptoms, management option and the prescription.

4.4 Preferred information form and format for receiving diagnostics information

Fifty percent (50%) of the respondents preferred receiving information in print form and printable format. Print form included written and pictures. Five point six percent (5.6%) preferred receiving the information through email which also includes written and visual forms, thirty eight point nine percent (38.9%) preferred receiving the information through a printable mobile and computer web based interfaces. Twenty two point two percent (22.2 %) preferred receiving information through a mobile SIM based applications.

Therefore, the three significant information receiving form and format are print (written and audio visual) which included, email format and WebPages. It should be noted that USSD coded information and SIM based application are both mobile interactive technologies and they constitute a third form. USSD and SIM applications are also written but are not printable. This information will guide the development of the user query interface and the form of delivering results by the system to the extension officers and farmers.

It was therefore deduced that the extension officer would prefer to receive written and visual information. It is also clear that the extension officers would prefer the information in a format which is printable. It may be concluded that the final information content given to the extension officer by the system must be in a printable format.

4.5 Preferred information form and format for disseminating diagnostic information to farmers

The study findings revealed that 66.7% of extension officers preferred to deliver agricultural diagnostic information in printable and written formats. Other forms of delivery included Verbal phone call and verbal face to face formats with a preference rate of e 11.1% each. However, only 5.6% of the respondents preferred the webpage as a mode of delivery. WebPages can be also used as a user (delivery) interfaces to farmers for the printable written and visual formats. It is therefore important to use web based interface to deliver agricultural diagnostics information to farmers. This is because the preferred form and format is printable, written and visual. The web based user interface would be a convenient and appropriate mode for delivery of agricultural diagnostics information in a remote manner/format/location.

The results also revealed a strong and positive correlation between web-based information format and printable format (R^2=1.000) and email format (R^2=1.000). This is a clear indication that farmers who prefer web based information form and format also prefer email and printable format of information.

4.6 ICT tools

Table 1: ICT tools owned by extension officers

ICT tools owned	Frequency (N=18)	Percent
Mobile phone (if yes)	18	100.0
Radio (If yes)	18	100.0
Television set (If yes)	18	100.0
Smart Phone (If yes)	7	38.9
Computer (if yes)	5	27.8

ICT tools considered during this study are all common with the extension officers except computers. Only 27.8% of the extension officers own a computer. On the other hand, all extension officers own mobile phones not all of them own smart phones, 38.9%of them own smart phones.

The study findings revealed that all extension officers owned mobile phones, radios and TVs. However, not all of the respondents owned smart phones, this indicates that application based diagnostics system would not be appropriate to the entire extension officer apart from the 38.9% who owns the smart phone. It is important to note that the mobile phones referred to had basic feature with internet features. The results of analysis of data presented in Table 3.10 revealed a significant positive correlation between extension officers who owned smart phones and those who owned computers (R^2=0.523).

4.7 Computer Uses

Although the study findings revealed that 27.8% of the extension officers owned a computer, respondents were asked to respond to what features they use in their computers. 27.8% use their computers for document preparations (Microsoft office) such as word documents; excel file and PowerPoint presentations among others and for accessing internet (internet explorer and other web engines). 22.2% also use their computers for sending and receiving emails. It can be deduced from the data that the respondents who use computers are 27.8% and 22.2% of them use it for internet access and sending and receiving emails respectively. It is notable that 22.2% is a significant portion of the population, hence their requirements must be considered in the system development.

Accessing email and browsing the internet are features which fully depend on the internet. Browsing the internet involves the access of WebPages. Some emails are also accessed through web pages. The user interface must therefore be web-based for computer users since the computer owner's use their computer to access internet and to prepare documents. The web-based user interface will also be applicable to mobile phone users since all respondents had mobile phones which could be used to access internet.

The results showed the following three main findings: strong positive and significant correlation between accessing internet and document preparation (R^2=1.000), strong positive and significant correlation between sending and receiving email and accessing internet (R^2=0.862), strong, positive and significant correlation between document preparation and sending and receiving email (R^2=0.862).

The results show that computer users currently use their computers for three major purposes. These are accessing the internet (web-pages), sending and receiving email (Internet based) and document preparation (print and visual files). It is worth noting the overlap which exists on the users which shows that it is the same user who actually uses their computers for the three reasons. It can be deduce that the extension officers, who already have computers, would require a diagnostic system which is web-based. The content of the web based system should be in print and visual forms and should also be in a printable format.

4.8 Mobile phone Usage

Extension officers were asked to choose the functions and features which they use their mobile for. Several choices were presented to the extension officers. All the extension officers use their mobile phones to make calls, none of the extension officers was using their mobile phones for document preparation, 27.8% use their mobile phones for making transactions such as M-Pesa, 55.6% use their mobile phones for accessing the internet, 44.4% use their phones for accessing applications, 94.4% were utilizing the SMS facilities, 11.1% were utilizing the social media access and communication applications(face book up) , 33.3% were accessing and sending the emails and 22.2% were accessing social media websites(face book website). An interesting finding of this study was the fact that, verbal phone call was not preferred as a means to communicate diagnostics information to both the extension officer and farmers. Though making phone calls is the most utilized feature in mobile phones at one hundred percent (100%), it cannot be put as a requirement for the system information delivery form and format. The use of mobile phones to access internet (web-pages) is preferred by 55.6% of the respondent hence web based system interface is recommended for the system.

4.9 Use of input commands

Extension officers were requested to choose from a set of input/query technologies that they would prefer incase a system existed for them to retrieve information. The input options included Webpage, SMS, mobile application and USSD codes.

The study findings revealed that the Web based interactive input method was preferred at 55.6%. Mobile application was also preferred at 33.3%. USSD coded input method was not preferred. This implies that web based input/query forms would be appropriate for the proposed artificial intelligent system for diagnostic and management of maize diseases system.

The study findings revealed (R^2=0.791) a very strong negative but significant correlation between web based and mobile applications input/querying technologies. This implies that, those with smart phones and can install applications would not prefer a web-based query system, while those with basic phones who are the majority at 60.2% prefer web-based application. It therefore means that web-based interface was still the preferred option since those with smart phones have the ability to access web-based interface in addition to the ability to install applications.

4.10 ICT channels access

Respondents were presented with different ICT channels. The aim of this section was to establish a platform to transmit agricultural information which would easily be accessible to extension officers. The study findings revealed that Internet and GSM were available to all extension officers (100%). FM and TV waves were also available (83.3%) to some extension officers. The GSM channel can be used for phone calls and sending SMS. It also provides internet channel (Safaricom internet services). This therefore means that GSM and internet channels would provide a wider geographical coverage than FM and TV waves. The implication of these observation was that the artificial intelligent system must use both GSM and internet channels to transfer agricultural diagnostics information.

The results revealed a strong, positive and significant correlation (R^2=1.000) between access to GSM and internet channels among extension officers in the study. There was also a very strong positive and significant correlation (R^2=1.000) between TV waves and Radio waves. There was, however very weak negative correlation (R^2=-0.126) between all ICT channels and education. The other important observation was that GSM and internet channels had wider coverage. Additionally, channels with GSM also have internet. The artificial intelligent system to be developed therefore was to operate through internet channel.

V. Conclusions and recommendations

1. Based on the study findings, it was concluded that extension officers;
   a) Obtain agricultural diagnostic information mainly from seminars conducted by the government and from journals.
   b) Prefer access to full content of agricultural diagnostic information regarding the names of pests and diseases, symptoms, diagnostic features as well as treatment and prescription.
   c) Prefer to obtain agricultural diagnostic information in printable form through a web page and can be availed as hard copy.
   d) Prefer ICT tools given the form and format requirements is mobile phones and computers.
   e) Posses high self efficacy on the use of computers for document preparation(Microsoft office) and web browsing (internet access).
   f) Posses high self efficacy on the use of mobile phones web browsing(internet access), short message services and calling services.
   g) Have coverage and access of internet and GSM(WAP) channels ICT channels.

2) Based on the above findings, it was recommended that:

   a) There was need to develop an artificial intelligent system for diagnosis and management of maize diseases in Kenya.

   b) A system manager was required to search, collect and input information on pests and diseases obtained from seminars and published literature into the system, during actual system development and to update the content.

   c) Information accessed by extension officers in relation to disease diagnostics must be included.

   d) The electronic database designed must accommodate all requirements for agricultural diagnostics information.

   e) The final information content given to extension officer by the system must be in a printable format and must be accessed through Webpage and internet based applications.

Acknowledgement

We recognize the contribution of the University of Nairobi for the financial and administrative facilitation of this study.

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