CHUKA UNIVERSITY



Faculty of Science, Technology, and Engineering

Department of Computer Science & ICT

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Agricultural Consultation Through Knowledge-Based Expert Systems in Kenya**.**

By:

Victorine Jeptoo Kipruto

Reg. No.: Eb3/27692/16

Under Supervision Of:

Ms. Jane Kiruki

**AGRICULTURAL CONSULTATION THROUGH KNOWLEDGE-BASED EXPERT SYSTEMS IN KENYA.**

**CHAPTER ONE: INTRODUCTION**

**1.1 Background of the study**

Farm produce is the core thing that most Kenyan people rely on, especially from rural areas and also a major contribution to the Kenyan economy. The level of agricultural production in Kenya has been low such that it fails to feed all Kenyans. Normally, farmers need consultation in different farm department which include soil management, crop production management, pest and disease management, integrate fertilizer and water management and crop economics among many other departments.

There is a need for farmers to look for various consultations before making any decisions. Unfortunately, there is no expert that gives out enough consultation to farmers since farmers may not be in a position to know all the information to manage the agricultural production process. If the expert personal are there, then they are not available every time for farmers. Farmers need to access information about land management at large any time to ease the production process.

A knowledge-based system is one of the Artificial Intelligence branches that denote knowledge in the form of artificial to work on a problem in a defined area of concern. It represents human knowledge that provides a solution to complex problems using computer programs. In Kenya today, a Knowledge-based system has drawn attention in many fields and many individuals are working on it to help people in different fields.

**1.2 Problem Statement**

Agricultural consultation in Kenya is usually done manually by either government organizing an agricultural show, organizing seminars for farmers or farmers look for expert personnel to inquire about their needs in order to make valid decisions. This sometimes is a problem as it may take time and also many farmers are reluctant to consult from an expert as they may not be available every time for them. This makes it an unreliable way to seek consultation adequately.

The introduction of an expert system is the key to solving this problem. This is an assistant that farmers can reach easily and effectively anytime they have a need. The system will be able to advise farmers effectively and help them make a valid decision in as far as agriculture is a concern.

**1.3 Research goals/objectives**

* To introduce Modern agricultural practices in Kenya.
* To give information on what farmers use to get consultation from currently
* To give ICT tools that farmers can get a consultation from with the help of the Knowledge base system
* To show how farmers can use the knowledge base system to get answers to their problem.

**1.4 Scope**

With this research, it is intended to cover all possible agricultural consultations starting from that of land preparation to the economic level of farm produce using the Knowledge-base system. Farmers will be able to look for consultation on their own anytime they have a need.

The overall structure of the Knowledge-base system will be covered in

this research which includes its environment. The environment that will be discussed is the environment for development and the environment for consultation. It will include the functions of each environment and how it works to validate knowledge to the farmers.

The role and importance of the expert system will be captured also. This will entail the role of an expert system in the agriculture department. How this system will be generated and how to use it is another factor that must be availed in order to guide the users of the system.

**1.5 significances of Agricultural consultation through Knowledge-Based Expert Systems in Kenya.**

Agricultural consultation through Knowledge-Based Expert Systems will ensure that farmers' needs are fully satisfied at the right time. This is due to the fact that farmers will be able to access this system anytime they require to make a decision. It will, in return, increase farming produce to the farmers since the system will advise them on the best measures they can undertake.

This knowledge-base system will also update the farmers on the latest happenings such as a new pest attack that’s trending and also gives the solution for the farmers to undertake preventive measures. It will keep farmers up to date and gives advice on what to do.

**CHAPTER TWO: LITERATURE REVIEW**

This research is based on the agricultural sector to its economic level contributions to Kenya. Agriculture being the source of livelihood to many people and the source of revenue to many counties, it has taken some improvement, though minimal.

* 1. **Agriculture in Kenya today**

Agriculture dominates the economy in Kenya. This is due to the high fertility land and favorable rainfall in Kenya, therefore, many Kenyans make their living by investing in agriculture. However, most of the output is for subsistence use rather than being marketed (Irungu, K. R. G., Mbugua, D., & Muia, J. (2015)). Agriculture is also the best and the largest contributor to gross domestic product (GDP) in Kenya. It includes forestry, fishing, animal production, and farm production.

Even though the agricultural sector is growing rapidly, it faces a lot of challenges that strain further development of this agriculture sector. This is especially in commodities like coffee, pyrethrum, sugar and exploiting livestock and potentials of fisheries. The challenges need to be addressed to enable the growth of the agricultural sector. Some of the challenges include crisis in food pricing, allocation of inadequate resources, low technological level applied in agricultural practices, attacks by pest and diseases in both animals and crops, losses incurred due to incorrect timing, high cost of inputs, decline in soil fertility, inappropriate regulatory and legal framework, inadequate infrastructure and inability to get ready for natural disaster and limited capital to access resources (Kassam, A. H., Mkomwa, S., & Friedrich, T. (Eds.). (2016).).

These challenges clearly show that Kenya has inadequate human resources in as far as agriculture is a concern. Insufficient allocation of resources has led to a reduction in agricultural operation or less output of agricultural products. Furthermore, the incorrect timing due to the wrong prediction of rainfall makes farmers incur a lot of losses since they waste a lot of inputs and get fewer outputs (Kassam, A. H., Mkomwa, S., & Friedrich, T. (Eds.). (2016).). The attack of livestock and plant pests and diseases is another major problem that becomes the reason why farmers undergo some losses. A decline in soil fertility is another factor that farmers need to address as it leads to unhealthy growth of crops hence low yields.

In summary, all these challenges are brought by a lack of information by farmers. There is no well-structured platform that farmers get information from to deal with all these challenges (Irungu, K. R. G., Mbugua, D., & Muia, J. (2015).). The role of technology, if employed in the agricultural sector, will be to pass information adequately to farmers and advise them on the best measures they can undertake. There is a need to transform agricultural practices into modern practices to increase farm output.

**1.2 Agricultural extension service in Kenya**

This is the body that facilitates information, knowledge, and technology to agricultural sectors in Kenya. It links agricultural producers with economic dealers such as marketers, financial institutions, agro-input-dealers and agro-processors (Gido, E. O., Sibiko, K. W., Ayuya, O. I., & Mwangi, J. K. (2015).). With their effort to reduce poverty and promoting food security, agricultural extension faces a lot of challenges. This includes insufficient human resources, the problem in the delivery of advisory services to farmers and unavailability of enough funds for agricultural research (Tata, J. S., & McNamara, P. E. (2018).). This makes their service to be unreliable to farmers. Therefore there is a need to address these issues in order to help farmers effectively.

The challenges that face the agricultural extension service is directly proportional to what agriculturalist face at large. The fact that there is no enough funding makes the information delivery slow and sometimes it may not be delivered at all (Mbo’o-Tchouawou, M., & Colverson, K. E. (2014). ). This hinders farm practices as the farmers will rely on what they know yet there is a better way of doing agriculture. In case the farmers need to know about a disease that is affecting either animals or crops, they may get information when it’s too late for them to act hence rendering them to losses. Furthermore, the body lacks sufficient human resources to deliver the information to farmers hence making information delivery inefficient (Kiptot, E., & Franzel, S. (2015).)

**2.3 Models of communication in the agricultural sector in Kenya**

Communication is a key thing in every aspect of our lives today. In agricultural extension, communication involves extension officers, farmers and researches, therefore, it’s a major thing that should be reviewed. Sharing of information and knowledge requires a reliable system where information seekers can get correct information and the researchers to be able to share the information. This is used to determine the production in the agricultural sector (Kahenya, W. D., Sakwa, M., & Iravo, M. (2014).)

**2.3.1 Concept of communication in agriculture**

The communication sector in agriculture deals with the management and planning of information in relation to agriculture. This body ensures that the information delivered is reliable and effective such that the end result will impact agriculture positively. Agricultural information is the exchange of natural resource and agricultural information industries vie an efficient and effective media such as magazines radio, television, telephones, newspapers and web media to reach farmers and other agricultural products dealers (Babu, S. C., Ramesh, N., & Shaw, C. (2015).)

Agriculture extension is an educational concept approach to deliver information to farmers. This, however, is expensive to both the agricultural extension body and to the farmers themselves due to some payment that is required to hold seminars or agricultural educational shows. (Mukembo, S. C., & Edwards, M. C. (2015).). Furthermore, farmers' concern may not be fully satisfied as it is seasonal and comes once in a while.

The challenges faced by this also is the fact that they have not been able to reach rural areas. This leads to these people not being served and they feel rejected and neglected therefore they do everything according to their understanding, which is the traditional methods (Singh, R. P. (2016).). Therefore, there is a need to look into how these people can be reached. By the implementation of the knowledge base system, it can solve this as it is been facilitated by a smartphone and the farmer can get all the consultation and there need is sorted faster.

**2.4 Artificial intelligence implementation in agricultural sector in Kenya**

Agricultural processes in Kenya are slowly being digitized and it is evolving in three categories, robotics, crop and soil management, and predictions. Soil dilapidation and deforestation in Kenya is one of the major threats that need attention. The use of sensors and sampling of soil to collect data makes way for the successful use of AI (Eli-Chukwu, N. C. (2019). ).

The level of AI usage in Kenya has left out investing in the agricultural sector. Unfortunately, with the new technology chipping in in Kenyan economy, AI is viewed as complicated and it led to the loss of a job to people in Kenya. The AI in the agricultural sector has been utilized in monitoring soil, weather conditions and plats. This has affected this field positively and lead to health agricultural practices. Oteri, O. M., Kibet, L. P., & Ndung’u, E. N. (2015).).

With the use of AI, farmers can be able to know deficiencies of nutrients and the defects in soil and also get advisory techniques on how to restore soil defects. AI is also useful in giving information on weather forecast which helps in deciding on plating seasons and in early detection of blight to avoid loses due to the destruction of plants. All this, farmers can do on their own, which is effective and saves time.

**2.5 Expert system implementation**

An expert system has been a very useful tool for some of the developing countries such as Kenya. Its application in the agricultural sector is on the management of crops, fertilizer managements, diagnosing of pests and diseases, management of farms, and economic part of crops. The knowledge-base system is very useful in giving advice to farmers. The information includes both from the expert persons and from the research that is conducted (Ali, B. A., Sapuan, S. M., Zainudin, E. S., & Othman, M. (2015).) The major field that expert system has been useful is in the management of crops and diagnosing of pest and diseases.

In the management of crops, it is useful for giving advisory services concerning a certain crop. It tries to help farmers to make a decision concerning a specific crop. This system focuses on one crop only, which contains the climate suitable for the crop, the level of PH required, pruning process, scheduling of fertilizer together with irrigation management and treatment of disorder and unhealthy growth of a crop. (Kumar, V., Lehri, S., Sharma, A. K., Meena, P. D., & Kumar, A. (2016).).

A knowledge-based system is now the main domain in diagnosing pests and diseases in crops and animals. It has really helped farmers in the management of crops pest and diseases. It makes use of computerizes disease predictors whose basis is the weather. This is very helpful in blight attack which affects crops such as potatoes, beans, and apple scab. It has enabled farmers to be able to take preventive measures in advance (Shahzadi, R., Ferzund, J., Tausif, M., & Suryani, M. A. (2016).).

The implementation of the knowledge base has become very useful; however, all this system only focuses on one aspect of agriculture which every part has its own knowledge base system. What if the system offer assistance on all areas, that is, whenever the farmers need any kind of consultation, they can get it from one system at a go. This is very helpful as the farmer can get additional updates like the new disease that’s attacking the crops or animals

**2.6 Information system**

Information system is a system that can be either manual or automated comprising of machines, people or methods for collecting, processing, transmitting and disseminating information as cited by Nge’ no Eric Kiplangat, (2013). It deals with the distribution of information technology in institutions, society, and organizations. The component that facilitates all this is the hardware, including phones, personal computers, software that tells the hardware what to do and the data that is changed to information that is being shared. For this information to be shared, there must be a network that facilitates the communication of the information. Therefore, the role of the information system is to take data, transform data to information and transform it into organizational knowledge.

**2.6.1 Agricultura information system**

This is a system that facilitates agricultural information from different sources to the targeted personnel, farmers. Agricultural information system contains subsystems, components for information processes, system operations, and system mechanism. The major people that interact with this system are the researchers, extensions and the farmers. Since the system contains very summarized information, it makes it a reliable source of information. ( Laudon, K. C., & Laudon, J. P. (2016))

There is no readily available source of information for farmers and hence there is a concern to identify a readily available source that farmers can use it easily, affordable and a convenient source. This will help information providers of agriculture to judge the best system that they can use to disseminate knowledge to farmers. This can be categories according to gender, level of education and individual exposure.

A study cited by Ng’eno Erick there is no human who can claim that they have enough information. This is very applicable to farmers as they are always required to deal with a new problem that arises in their daily duties which becomes complex and so they must seek external advice to make an appropriate decision.

He also cited that if African governments make a new approach to the distribution of information and its management, they would have made the information to be clearly understood by farmers so as to increase farming outputs. Mass media is the best way of making farmers know the new technologies that can help them to get information from. Extension agents are responsible for delivering repackaged information to farmers as long as agriculture is concern.

**2.6.2 Agricultural information system in Kenya**

Agricultural information systems in Kenya have been very helpful in the sharing of information on both the international community and the national level in the agricultural sector. Kenya Agricultural Information Network (KAINet) is an organization that was formed to promote access and exchange of information among agricultural stakeholders. Its main role is to manage information, disseminate it and exchange it to members in-network in Kenya (Nzonzo, D., & Mogambi, H. (2016).). Its role at the national level is to respond to the recommendation in order to build the information system for Kenyan national agricultural science and technology in accordance with National Information and Communication Policy and Kenya Government Strategy for Revitalizing Agriculture (SRA).

KAINet solved a problem that was facing researchers whereby their work was not reaching the target personnel and so KAINet became a facilitator of this. It provides a platform for access to information concerning agriculture nationally, gives information that aids description, identification, and location electronic resources that are networked (Nzonzo, D., & Mogambi, H. (2016).).

Stakeholders of KAINet include Jomo Kenya University of Agriculture and Technology (JKUAT), the Kenya Forestry Research Institute (KEFRI), Kenya Agricultural Research Institute (KARI), the Kenya National Agricultural Research Laboratories (KARI-NARL) and the Ministry of Agriculture (MoA). These bodies join together to come up with KAINet that links their information with other people’s information worldwide (Nge’ no, E. (2013).).

The challenges faced by this body are the limited time for training and the lack of an efficient tool to reach the farmers to share their information. This is due to the low human and infrastructure resource to disseminate knowledge to farmers (Nge no, E. (2013).).

A knowledge-base system is a solution to this since the researchers will have to put the information into the system whereby the information will be readily available for farmers to use and satisfy their needs

**CHAPTER THREE: RESEARCH METHODOLOGY**

* 1. **RESEARCH DESIGN**

Research design is a blueprint for handling problems for effective study. In our case, descriptive design best suits this study as there is a need to describe in detail what the farmers undergo as they deal with their day to day activities. Farmers undergo problems as they try to make a decision where consultation is required.

Another research design is qualitative research that will facilitate the research design. As cited by Ogolo, 2013, qualitative research covers a number of techniques with an aim of describing, decoding, translating and giving the meaning of a phenomenon that occurs naturally. In this research, qualitative research is suitable to be applied to show the view of the farmers on how they are able to get satisfactory consultation whenever they have a critical problem and the challenges they face during this process.

Since the qualitative research is best for collecting non-numeric data, qualitative data collection was suitable because the study subject and includes the interpretation, discussion and description of collected data on farmers who deal with different agricultural practices. This helps in solving the problem effectively.

* 1. **RESEARCH TOOLS AND PROCEDURES**

The collection of the data is very important for the success of this research to be successful. Information collected was done in two counties, Uasin Gishu and Kericho. In Uasin Gishu, there is a number of agricultural practices such as animal products and farm products like maize, wheat, vegetables, flowers, and fruits. In Kericho, there is tea plantation.

The tools used include face to face interviews, and mobile phone interview, observation, and reviews of documents. Face to face interviews was successful to 8 farmers who were available and the rest 5 farmers were not available due to white color jobs during the time of interview hence a phone call was the only way out. In addition, research had an opportunity to observe different practices that are carried out on the farm.

Another research was conducted to capture activities of offices of agricultural extension and to capture the information on what they use to disseminate information to the farmers. A number of interviews were conducted and were successful in both counties. 8 agricultural extension officers in UasinGishu county and 9 in Kericho county were interviewed.

A number of documents were also reviewed to capture what farmers use for consultation and how they get help whenever a need arises. This was important in capturing information about other places that the researcher would not reach. It includes places like Kisumu county. This helped in getting the problems that other places undergo for easy comparison and getting a general overview of problems faced by farmers.

During the collection of this information, the researcher had carried a notebook in order to capture information as it is. The information was recorded also to facilitate the review of information. This facilitates the full observation of the problems that farmers undergo whenever they need to make consultation before making any decision final report to the research.

* 1. **SYSTEM REQUIREMENTS**

From the research that was conducted in the two counties, what users would like to use for consultation was also captured. Since most people have a mobile phone, farmers preferred to use their mobile phones to inquire about their issues. In addition to this, some farmers, especially those with color jobs preferred to use either their computers or smart phone. In addition to this, farmers were asked if they are able to access the computer. The result was that there is a computer at a milk cooler in both counties with computers that farmers can access.

This helped in ICT requirement choice in deciding which tool should be used. In this case, the knowledge base system should make implemented in mobile phones and as a web-based system such that all farmers will have access to it.

The general component of the expert system is the information system which in our case will be the web base where all the information that farmers need consultation about are loaded, decision support system that helps farmers in making well informed decisions and diagnosing system that analyses images of plant and a video showing animal behavior to find the problem and give them a valid advice.

Being a web-based system, a web portal must be developed to facilitate all this purpose. Software packages such as Expert System shell which are ready-made make expert system development easy as they give the user interface command and an inference engine.

**CHAPTER FOUR: RESULTS AND DISCUSSION**

This chapter gives the result of what was collected and discuss their results. It will give the discussion on where farmers get information from, ICT tools that are used by both farmers and the office of agricultural extension.

**4.1 Agricultural information sources**

Farmers and extension officers had different sources where they get information from.

**4.1.1 Farmers agricultural information sources**

During the collection of information, farmers were suggested with the names of different devices that they use to get information from. Farmers can choose more than one device. The following shows the percentage of those sources

Table 1

|  |  |
| --- | --- |
| **Source (if it is yes)** | **Percentage of total farmers** |
| Themselves | 84% |
| Radio | 82% |
| Agro-vet shop | 72% |
| Agricultural extension offers | 61% |
| SMS | 57% |
| Television | 53% |
| Internet | 47% |
| Seminars | 38% |
| Mobile application | 10% |

From the research, 82% of respondents are getting information from a radio presenter, 54%from agricultural extension, 72%from agro-vet shop, 57%are using short messages (SMS), 47% from internet and 53%from television. The highest percentage get information among themselves which amounted to 84% and the lowest percentage use mobile apps to get information on their problems which became only 10%.

From these findings, respondents from radio, television, agro-vet, and SMS users can be transformed into using mobile phones as per there responses. The ones who get information from the agricultural extension body are willing to move to use any source of information as long as the officers are supporting it. This means that extension officers should advocate the use of mobile phones by the farmers and also the officers should be trained well so that they can also train farmers on how to use a knowledge base system to get a consultation and their problem will be solved faster and efficient. During seminars, farmers can be given the importance of doing the consultation on there own using mobile phones or computes.

**Tools used by agricultural officers to pass consultation to farmers**

Extension officers were asked to give what they use to give answers to farmers whenever they are seeking for the consultation. The following were the percentage of the total number of the officers that responded. The offices were allowed to choose more than one tool.

|  |  |
| --- | --- |
| Tools used to pass information (if yes) | Percentage of respondents |
| Phone calls | 72% |
| Seminar | 72% |
| Face to face | 68% |
| Printed papers | 61% |
| Emails | 40% |
| Mobile apps | 20% |
| SMS | 15% |
| Web sites | 7% |

From these results, the highest percentage of 72% are those farmers call and also those who give advice during seminars, 68% give advice through face to face. Only 61% use printed papers to help farmers get consultation from, only 40% uses emails where farmers get consultation through writing an email, only 20% give advice through mobile apps with the help of knowledge-base system, SMS is only 15% where farmers write them short message to get consultation and finally 7% only use website to give advice to farmers.

In conclusion, this can be summed up that all this work can be implemented through a knowledge base system using a web page system where farmers can get a consultation from in an efficient, reliable and affordable way. Printed papers are not a reliable way to give advice as they only addresses one issue at a time, face to face and phone calls can be reliable but the officers may not be available for farmers when they need them. The other sources like web sites and mobile phones can be used to address this by implementing the knowledge base system.

**ICT Tools**

The farmers were asked the efficient ICT tool that they own. This will help in deciding the best mechanism that the knowledge-based system can be implemented. The farmers were allowed to give more than one tool that they own. The percentage results were as follows: -

|  |  |
| --- | --- |
| ICT tools owned | Percentage of respondents |
| Mobile phones | 100% |
| Radio | 92% |
| Smartphones | 50% |
| Television | 34% |
| Computer | 5% |

From the result, all people on the list own a mobile phone that makes it to 100% of people, then 92% had a radio, 50% own a smartphone, only 34% own a television and finally, 5% own a computer. In addition to this, farmers were asked if television and radio were effective whenever they need a need in as far as agriculture is concern and the response was that it is ineffective since they always waiting for relevant topic that is aired which at time it might be aired when they are not in there television watching or listening to there radio.

Most of those who own a radio also owned a mobile phone, this clearly shows that there is radio as a feature that is implemented in mobile phones. Furthermore, these mobile phones can access the internet. Even though the number of people who own smartphones is less, it has the same functionality as mobile phones only that for smartphones can have an application that can be used for consultation. Therefore, this clearly indicates that the mobile phone is a key thing as an ICT tool to pass information to farmers or where farmers can approach whenever they have a need.

From these results, we can conclude that farmers can use mobile phones for consultation as they can easily adapt to it. The fact that these mobile phones have a web application by default, then the knowledge base system can be model with an interface of a web base so that it can be accessed via a mobile phone.