

An Evaluation of Web Based Expert System as a Catalyst for Maize Production in Kenya

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Abstract

Maize is the most important and staple food in Kenya. The Kenya Maize varieties comprise of white semi-dent grains and have been bred and selected for a wide range of climatic conditions and altitudes above sea level. The Worldwide web has played a major role in the field of expert systems. A web technology allows the knowledge engineers and domain experts to build expert systems that will have dynamic knowledge base capabilities [Marwaha et al. 2002]. With the use of the internet Domain Experts can update the knowledge at a centralized location (Server) and the users can access this knowledge on Web user Interface (Client). The use of expert system as tool in agriculture sector in Kenya has not taken off. Expert systems use knowledge to solve problems that normally would require human intelligence. Expert system has a lot of benefits especially to farmers, farming officers and Agricultural institutions. In this paper the Information was gathered through questionnaire administration in selected areas of small and large scale farmers. The questionnaires were presented in such a way that it will provide the degree of usage of the web based expert system in maize production. The validation of the results were carried out using paired- t .This paper further shows the underutilization of web based expert systems in agricultural sector in kenya and Proactive methods should be devised to improve Maize production using expert systems, which will in turn improve productivity hence increase income to the farmer, reduce losses due to, poor choice of variety, diseases prevention and pests control.

Keywords: expert systems, Inference engine, Knowledge Base, Domain expert, MySQL, Web.

1. Introduction

According to Edward Feigenbaum , expert system (ES) is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution. An expert system is computer software that attempts to act like a human expert on a particular Subject area. It uses knowledge from Domain experts for problem solving and also clarifies some uncertainties where normally one or more human experts would need to be consulted. These expert systems represent the expertise knowledge as data facts or rules in the computer. These facts and rules are used to solve problems. As shown in figure 1 Expert system uses knowledge from expert while Conventional computer programs relies on mere data to perform tasks using conventional decision-making logic which contains little knowledge and basic algorithm for solving that specific problem boundary conditions . In Conventional programs Knowledge and processing are combined in one sequential program, while in an expert system Knowledge base is clearly separated from the processing (inference) mechanism i.e. knowledge rules are separated from the control which means ddomains in which knowledge can be easily separated from the manner in which it is to be used as opposed to cases where representation and control are merged (Davis and King (1977). Another very important unique feature of web based expert system is that the explanation is a part of it that is used to explain its reasoning; Conventional systems do not usually explain why input data are needed or how conclusions were arrived at. The ability of expert system to explain the reasoning process through back-tracking and to handle levels of confidence and uncertainty provides an additional feature that conventional programming does not handle. The transfer of expertise from an expert to a computer and then to the user involves four activities:

- Knowledge acquisition from experts or other sources.
- knowledge representation in the computer.eg as Logic, semantic nets, Frames and Scripts
- Knowledge inferencing, resulting in a recommendation for novices.
- Knowledge transfer to the user.

Most online expert systems are developed via specialized software tools called shells. These shells are equipped with an inference mechanism and require knowledge to be entered according to a specified format. They typically come with a number of other features, such as tools for writing hypertext, for constructing friendly user interfaces, for manipulating lists, strings, and objects, and for interfacing with external programs and databases. These shells qualify as languages, although certainly with a narrower range of application than most programming languages.

1.1 Components of Expert System

A typical expert system will contain the following major components knowledge base (KB), Working Memory (WM), Inference Engine (IE) and User Interface (UI).

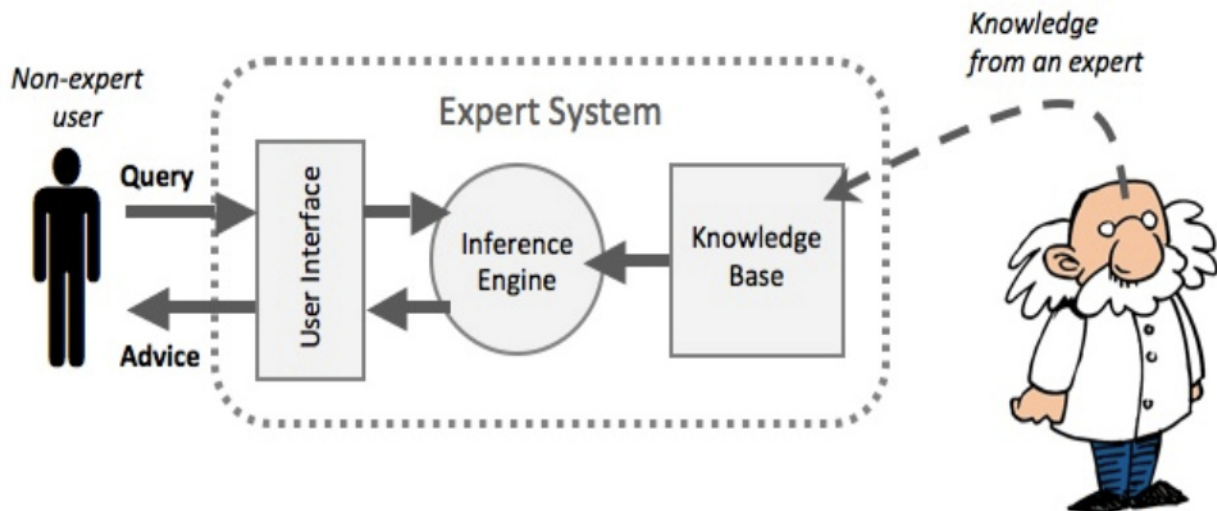


Fig 1 –Components of expert system

1.2 Web based Maize expert System Architecture

The web based expert system is based on the multi tier model (n tier model) of the web application [Sven Ziemer 2002]. This model allows several components to be built by many specialized experts. Each of these components can exist on different computers anywhere on the internet. The most important components in an expert system are the knowledge base and inference engine, separations of concerns is a key element when designing an expert system. The following represent the components of this architecture.

- i). **The Knowledge Base (KB) level-** Which will contain the knowledge about maize varieties, diseases and insect pests
- ii). **he Database Server level:** This layer is implemented using MYSQL database, and contains specific information about maize variety and the several adaptation regions in Kenya
- iii). **The Reasoning Engine level:** This accepts farmer input, queries and responses to questions through the web interface. The knowledge in the knowledge base derives conclusions based on user input.
- iv). **Server side application level:** This is built using Hypertext preprocessor (PHP) and JAVA. PHP is one of the favorite server side scripting because of its user friendliness attributes and extensive functionalities and also the compatibility to any type of database server. It is also operating system independent.
- v). **Web server level:** This is built using Apache; Apache Http is the most popular server on the internet today. Its primary function is to deliver web content to users.
- vi). **Client side application level:** This is implemented using HTML, (Hypertext markup Language), XML (extensible markup language), WML (wireless markup language) AJAX (Asynchronous Java Script and XML) CSS (Cascade Style sheet) and JavaScript. It major function is to provide an interface to the users.

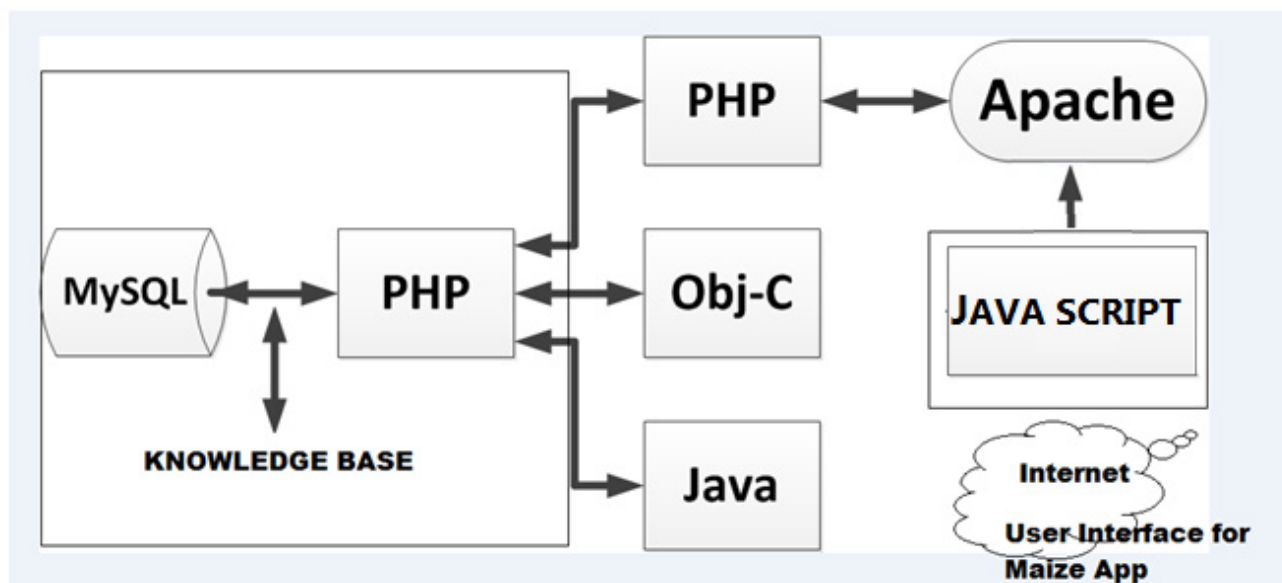


Fig 2- Web based expert system architecture

2. Maize Selection and Variety

This section gives the various properties that exist in maize in the selected regions.

Variety. This refers to a taxonomic subdivision of a maize type grown in Kenya. According to Kenya seed Company [<http://www.kenyaseed.com>]. The various varieties include the following

Altitude: The height of a thing above a reference level, especially above sea level or above the earth's surface. (A high location or area). The classification is as follows(according to altitude)

- **Highland Maize varieties**
- **Transition Altitude Maize varieties**
- **Dry land Maize varieties**
- **Lowland Maize Varieties**

Highland maize variety

These varieties are bred and recommended for medium to high altitudes (1500-2100m) where day temperatures seldom exceed 28 ° C during growing season and where the night temperatures drop to as low as 8° C. Rainfall requirements ranges from 800-1500mm. Where similar conditions prevail in the highlands of Tanzania, Uganda and Ethiopia these varieties are recommended.

MAIZE VARIETIES			
VARIETY	YIELD PER ACRE (BAGS)	ALTITUDE RANGE (M)	DAYS TO MATURITY
H6213	52 x 90kg	1700-2100	160 – 190
H6212	52 x 90kg	1700-2100	160 – 190

H6210	50 x 90kg	1700-2100	160 – 190
H9401	48 x 90kg	1700-2100	160 – 190
H629	48 x 90kg	1700-2400	160 – 190
H628	46 x 90kg	1500-2100	150 – 180
H627	44 x 90kg	1500-2100	150 – 180
H626	42 x 90kg	1500-2100	150 – 180
H625	40 x 90kg	1500-2100	150 – 180
H614	38 x 90kg	1500-2100	160 – 190
H624	32 x 90kg	1000-1800	140 – 180
H623	28 x 90kg	1000-1800	140 – 190
H516	28 x 90kg	1000-1800	100 – 140
H515	26 x 90kg	1000-1800	120 – 150
H513	24 x 90kg	1000-1800	100 – 150
H511	23 x 90kg	1000-1800	100 – 150
PH4	20 x 90kg	0 – 1200	90 – 120
PH1	15 x 90kg	0 – 1200	75 – 120
DH01	15 x 90kg	800-1200	100 – 120
DH02	15 x 90kg	800 – 1200	100 – 120
DH03	15 x 90kg	800 – 1200	100 – 120
DH04	19 x 90kg	800 – 1200	100 – 120
Katamani Composite	15 x 90 kg	1000-1900	75 – 120
DLC1	13 x 90kg	1000-1900	75 – 120

Table 1- shows the Highland maize varieties

Transitional altitude maize varieties

These varieties perform well at altitude between 800-2400 m above sea level.

Recommended growing areas in Kenya:

These are Highland hybrids grown particularly in Trans-Nzoia, Uasin Gishu, Nakuru, Laikipia, Kisii, Narok, Bungoma, Kakamega, Nandi, Kericho Tea zones of central Kenya, Nyahururu, Southern Highlands of Tanzania, Mt. Elgon slopes, slopes of Mt. Kenya, Bomet, Nyeri, Kiambu and Meru tea zones.

VARIETY	AVAREGE YIELD/ ACRE (90Kg)	PERIOD TO MATURITY (DAYS)	SPECIAL ATTRIBUTES
H 624	32	120-130	Tolerant to Grey Leaf spot, leaf blight and rust Excellent husk cover Flint kernel

Table 2 – Shows transitional altitude maize varieties

Dry Land Maize Varieties.

These varieties perform well at altitudes between 500 and 1300 m above sea level.

Recommended growing areas in Kenya:

Arid and Semi-arid areas of Makueni, Machakos, Kangundo, Siaya, Kibos, Busia, Kibwezi, Kitui, Karachuonyo, Nyando, Kisumu Bondo and some parts of Butere
 DH 04 can also perform well in Early to medium transitional zones and lowland areas of Kirinyaga, West Pokot, Bungoma, Homa Bay, Kerio Valley, Kagio, Mwea, Makueni, Kitui, Marakwet, Baringo and Koibatek.

Low altitude maize varieties

These varieties perform well altitude between 12 and 100 m above sea level.

Recommended growing areas in Kenya:

The lake region and the Coastal strip.

Transition altitude maize varieties

These varieties perform well at altitude between 800-2400 m above sea level.

Recommended growing areas in Kenya:

These are Highland hybrids grown particularly in Trans-Nzoia, Uasin Gishu, Nakuru, Laikipia, Kisii, Narok, Bungoma, Kakamega, Nandi, Kericho. Tea zones of central Kenya, Nyahururu, Southern Highlands of Tanzania, Mt. Elgon slopes, slopes of Mt. Kenya, Bomet, Nyeri, Kiambu and Meru tea zones

Medium altitude maize varieties

These varieties perform well at altitudes between 800 and 1700 m above sea level. H 520 can however perform well up to 2400 above sea level.

Recommended growing areas:

These are Highland hybrids grown particularly in Trans-Nzoia, Uasin Gishu, Nakuru, Laikipia, Kisii, Narok, Bungoma,

Kakamega, Nandi, Kericho. Tea zones of central Kenya, Nyahururu, Southern Highlands of Tanzania, Mt. Elgon slopes, slopes of Mt. Kenya, Bomet, Nyeri, Kiambu and Meru tea zones

Medium Altitude agro-ecozone (1000-1700m)

Some of the varieties in this category include H513, H 515 and H 516. These varieties are commonly grown in coffee growing belts maturing in 4-5 months. The favorable rainfall is between 750- 1000mm.

Transitional Zone

The altitude in this zone falls between 1000-1700m where the temperatures ranges from 12C to 30C and has rainfall similar to that of high altitudes. Hybrid 624 is a typical example in this category.

Lowland agro-ecozone: PH 1 and PH4

Pwani hybrids are fairly short varieties resistant to lodging and more tolerant to moisture stress. and recommended for altitude range of 0-1250 M. above sea level with 400mm of rainfall. It has an added advantage of good husk cover hence reduced crop loss though bird and weevil attack. It is also suitable under inter-cropping systems.

Dry land agro-ecozone: Katumani composite B

This is a fast growing open pollinated variety, which is fairly short and produces short cobs. It is a drought escaping variety flowering within 60-65 days and maturing within 90-120 days.

The variety performs well within altitudinal range of 1000-500M above sea level and is a variety for marginal rainfall areas. The variety requires 250-500mm of rain, and has performed extremely well in arid marginal areas in many parts of Africa particularly in Somalia, Ethiopia, Sudan, Tanzania and Namibia.

Dry land agro-ecozone (DLC1)

This is another open pollinated variety which is recommended for arid and semi-arid regions. This variety flowers earlier than Katumani Composite B by about 4-7 days and is shorter but more prolific. Under unfavorable conditions the variety performs better than Katumani Composite B. The variety is best suited where rainfall duration is short and amounts to less than 350mm. The variety is a good substitute for Katumani where rainfall is erratic.

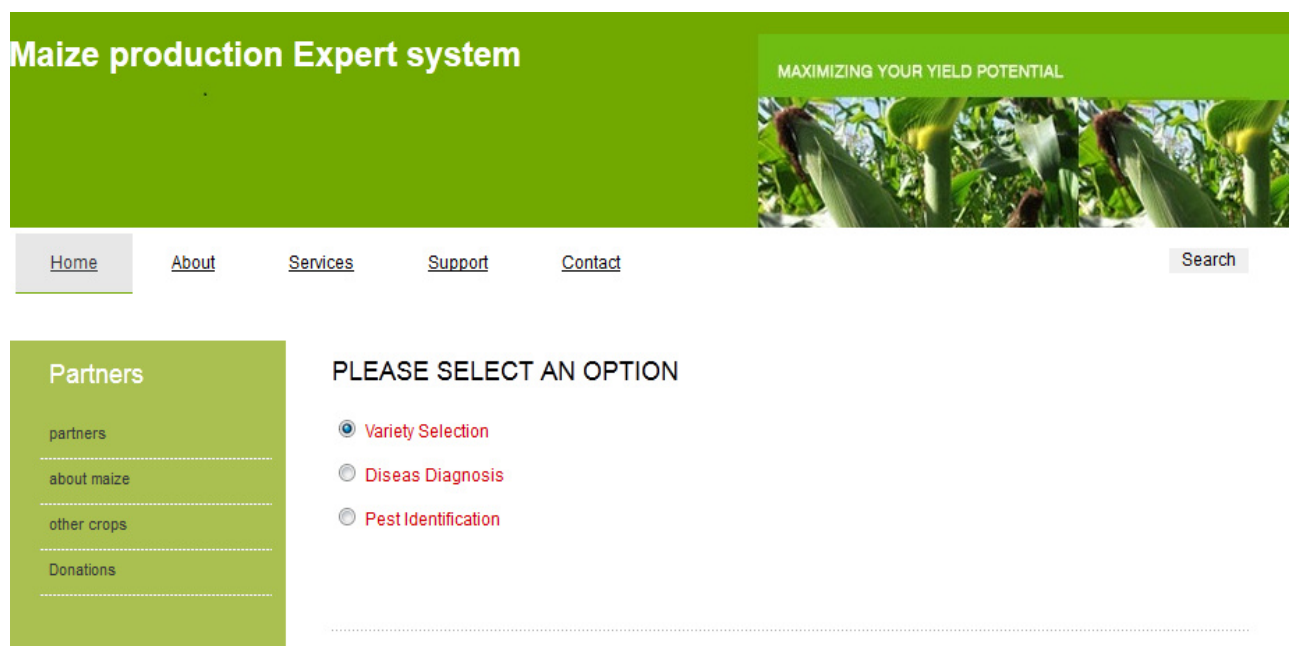


Fig 3- A web based expert system interface for option selection-**variety selection**

This interface in Figure 3 ask the user to select an option from a list, say variety which in turns gives details on selected option based on the county -

```
SELECT {OPTION}
```

This query is used as a base step to select the type of information the user wants. This will return the relevant information based on the selection, As the system continuous the previous question/option asked and the answer selected by the current user is added to the question –Answer History.

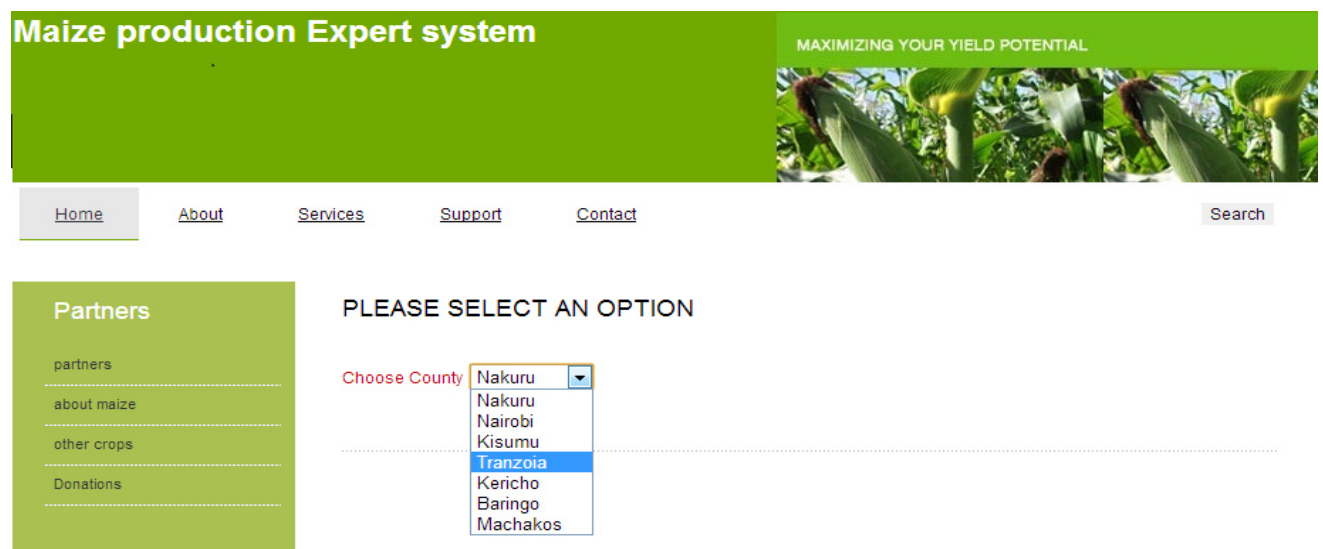


Fig 4- shows selection interface option for County

This interface gives an option to select area of interest i.e. county. It queries the MYSQL database as follows

```
SELECT * FROM County  
WHERE countyname { selected_County}  
ORDER BY {Variety_ID}
```

The above query is used to select the county which will give the varieties and detail about this region including the maturity details

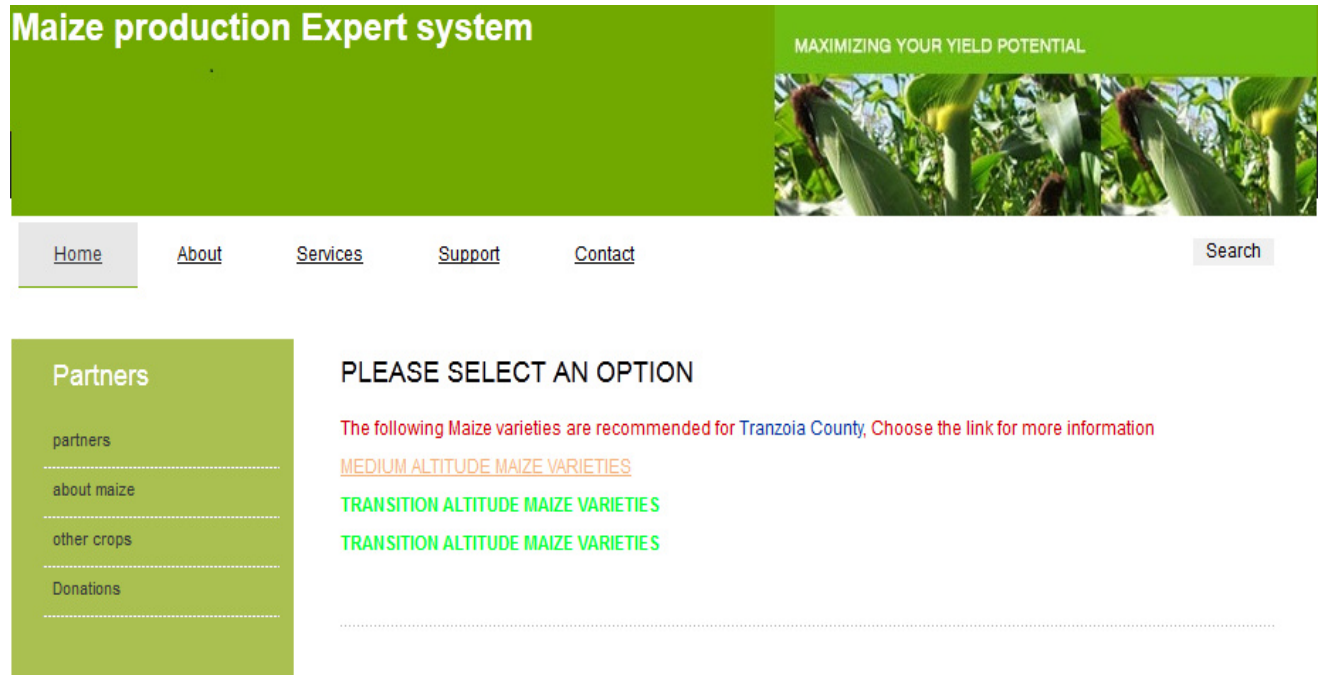


Figure 5-An interface for the queried selection and a recommendations i.e. medium altitude

The results of the query will give information in the following format; the same procedure will apply for the other options i.e. Maize diseases and Pest identification

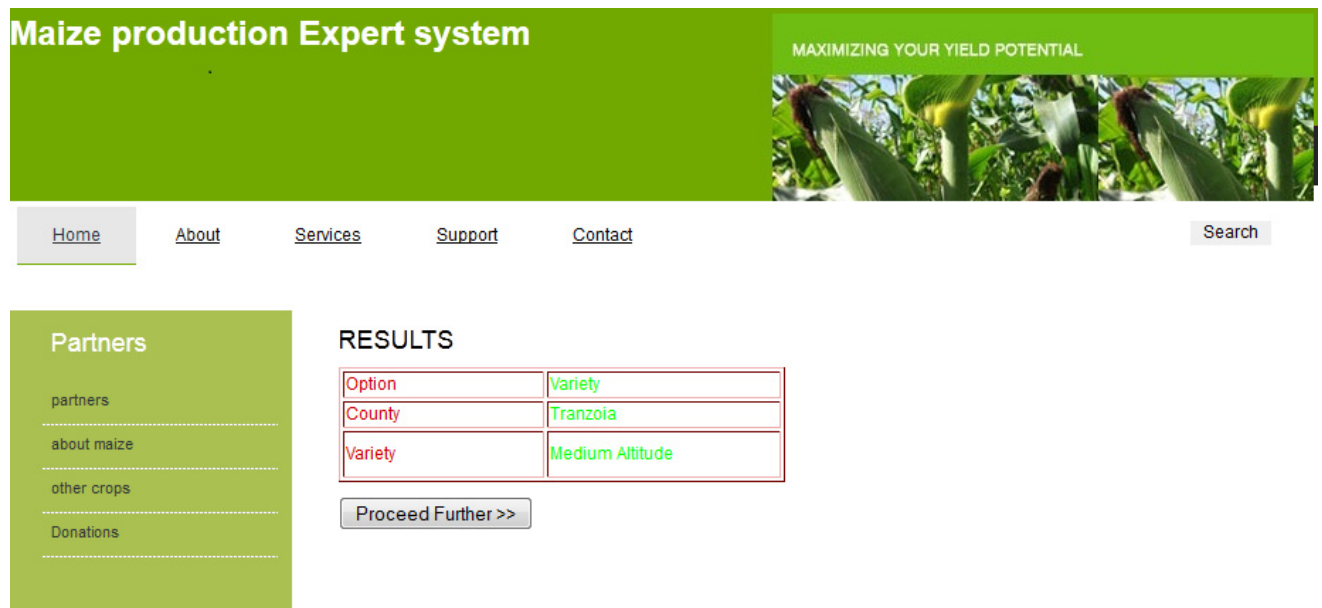


Fig 6-An interface that shows Questions answer History and an option to proceed further



Maize production Expert system MAXIMIZING YOUR YIELD POTENTIAL

Home About Services Support Contact Search

Partners

- partners
- about maize
- other crops
- Donations

MEDIUM ALTITUDE MAIZE VARIETIES
 These varieties perform well at altitudes between 800 and 1700 m above sea level. H 520 can however perform well up to 2400 above sea level.

Other Recommended growing areas:
 These are Highland hybrids grown particularly in Trans-Nzoia, Uasin Gishu, Nakuru, Laikipia, Kisii, Narok, Bungoma, Kakamega, Nandi, Kericho, Tea zones of central Kenya, Nyahururu, Southern Highlands of Tanzania, Mt. Elgon slopes, slopes of Mt. Kenya, Bomet, Nyeri, Kiambu and Meru tea zones

VARIETY(Specific)	AVAREGE YIELD/ ACRE (90Kg)	PERIOD TO MATURITY (DAYS)	SPECIAL ATTRIBUTES
H 520	32	120-130	<ul style="list-style-type: none"> • Tolerant to leaf rust and Grey Leaf spot • Tolerant to lodging • Excellent husk cover
H 516	28	100-110	<ul style="list-style-type: none"> • Good husk cover • Tolerant to lodging • Tolerant to ear rot, rust, Grey Leaf spot, stem and leaf blight.
H 515	26	100-110	<ul style="list-style-type: none"> • Tolerant to lodging • Tolerant to leaf blight, leaf rust and Grey Leaf spot
H 513	24	100-110	<ul style="list-style-type: none"> • Partially tolerant to maize streak virus.

Fig 7- The resulted query for Medium Altitude Maize Varieties

3. Methods and materials

Expert system elicitation methods were done through both direct and indirect methods. The interviews were done directly to farmers in both rural and urban areas both small and large scale farmers. Three sets of questionnaires were used for investigation. The first category of questionnaires was set in relations to the small scale farmers using 15 questions. The second category of questionnaires was administered to large scale farmers with 20 questions, while those administered at the maize seed production companies were 23 questions.

The questions asked targeted the degree of web based expert system usage for maize production in Kenya. The data obtained were analyzed statistically using descriptive statistics based on percentages. The percentages responded to the targeted enquiries; T is calculated as the ratio of the total of actual response Ra to the overall total of those that responded to all the enquiries Ro. That is $T (%) = (Ra/Ro) \times 100$. (1)

The validation of the results was carried out using paired-t to determine whether there is a significant difference between the degrees of expert system usage and the specific areas used in this study.

4. Results and discussion

Twenty five questionnaires based on expert system usage in small scale farmers were distributed out of which twenty two was returned (88%). Out of twenty five questionnaires distributed to large scale farmers eighteen (72%) were returned while for maize seed production companies fifteen out of forty was returned 37.5%, from these results the small scale farmers and large scale farmers have the highest questionnaires returned while the seed companies have the lowest.

The figure 8 shows the trend in which farmers have been using real human experts rather than expert systems in the past three years. Most of these farmers are not aware of expert system and what it really does.

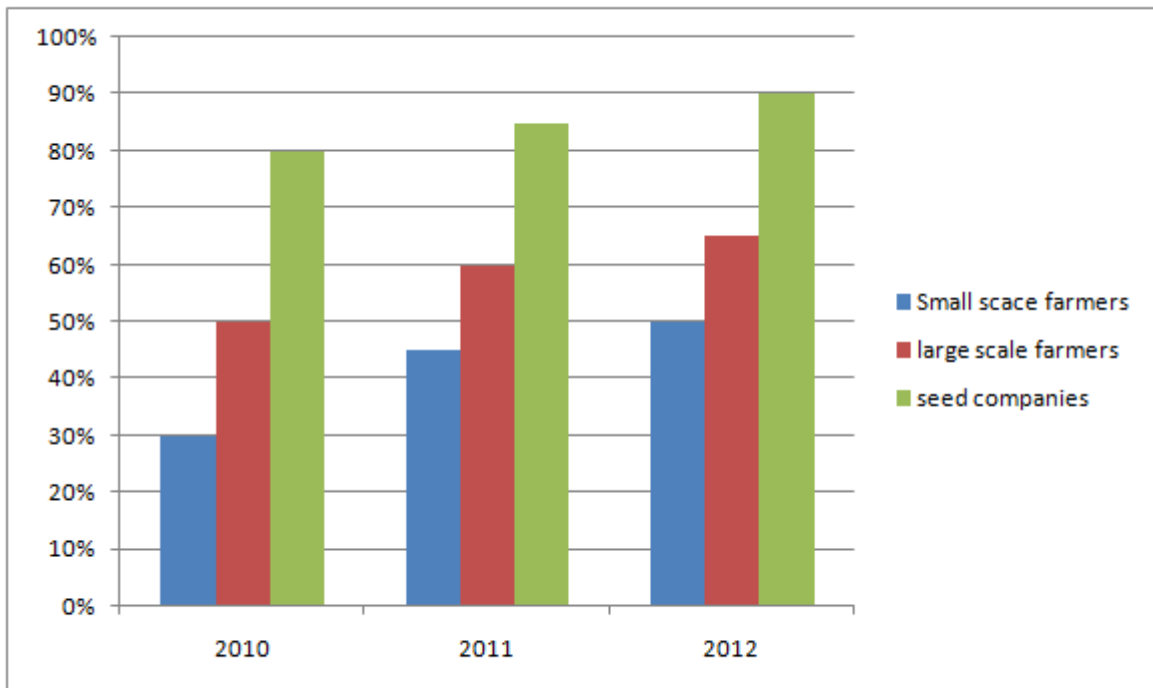


Fig 8- shows the percentage of farmers and seed company that used a human expert instead of an expert system

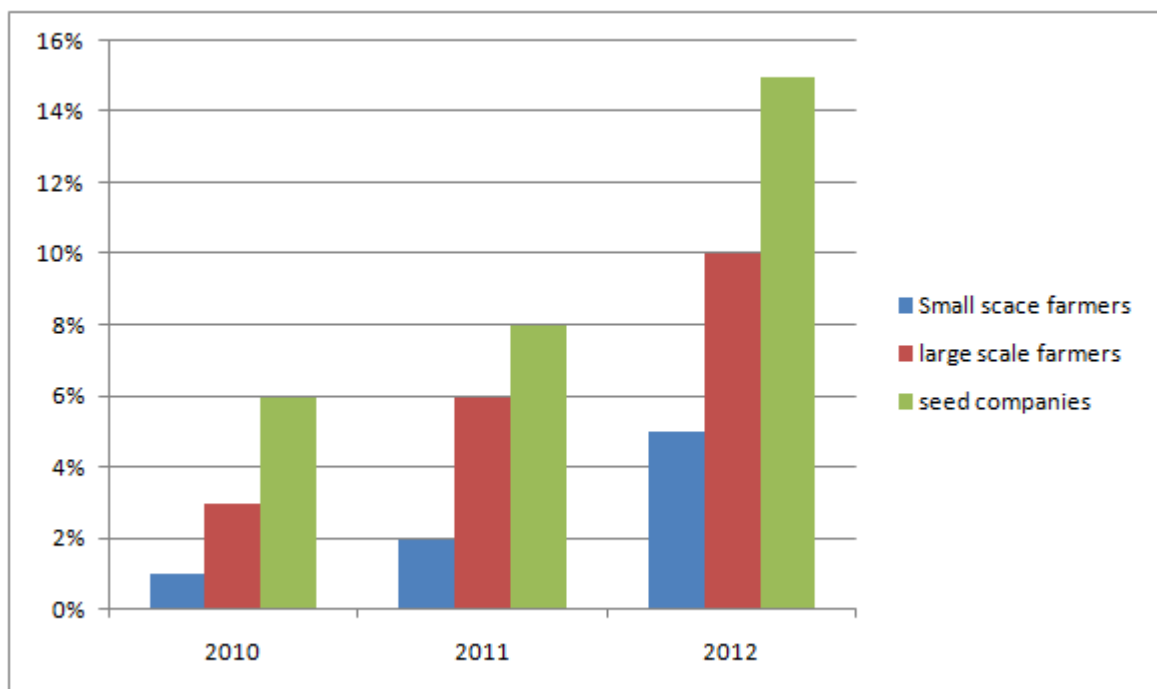


Fig 9 – shows the percentage of farmers and seed company using the knowledge from any web resource or any expert system .

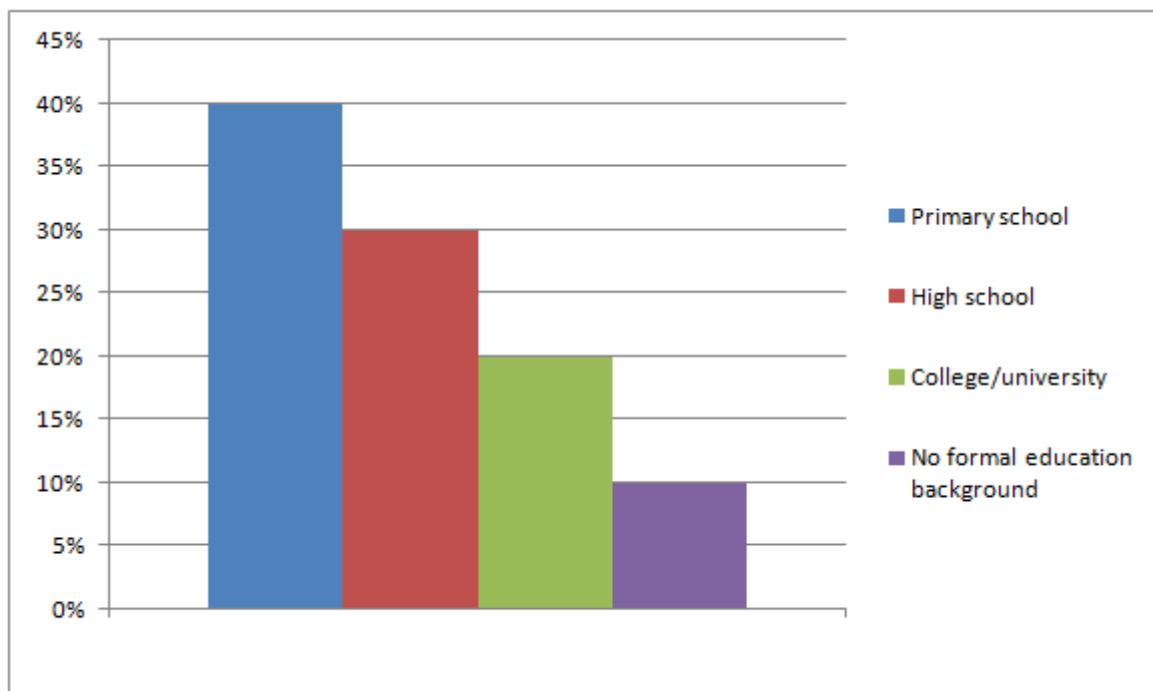


Fig 10 -shows the education background of most farmers

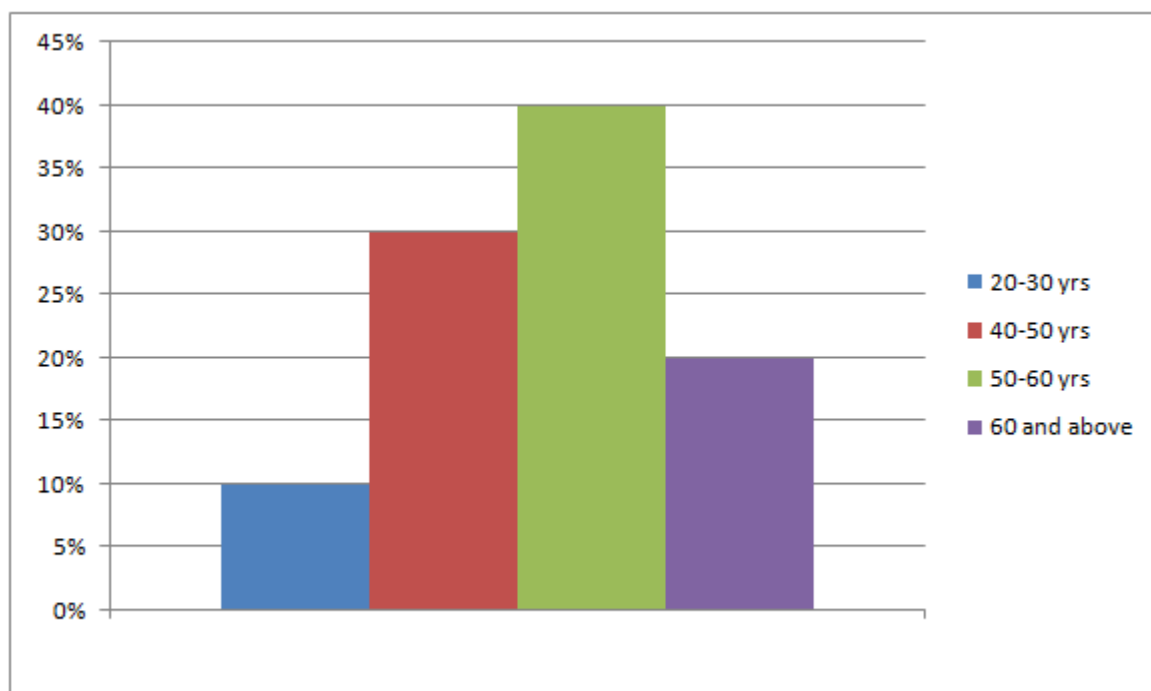


Fig 11 -shows the percentage age of maize growing farmers

5. Conclusion

Information was gathered through questionnaires administration and visitations for specified selected regions and various stakeholders in Kenya including both large scale and small scale farmers. Response to questions asked was based on the usage of expert system for decision making. The evaluation the outcome data was carried

out using statistical tools based on percentage. The finding from the study shows that majority of farmers do not use expert system and others are not aware that such systems do exist. Human expert are also underutilized. This study suggests that proactive measures should be devised to educate the farmers on the importance of using an expert system in quality and high yield maize production.

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