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ENHANCED PEST INFORMATICS SYSTEM

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Abstract
Pest Management System (PMS) is a computer application in Integrated Pest Management. The term encompasses computer-based storage, retrieval, sharing, and optimal use of pest management data, information, and knowledge for problem solving and decision-making. The pest control industry is continuously experiencing novel technologies and products that will improve the way to manage and prevent pests. The development of an intensive electronic crop pest informatics is highly essential to help bridge these gaps. The aim of this research is to design and develop a voice enhanced Pest Informatics System(PIS). Pest Informatics System was designed and implemented using VModel an extension of the Waterfall model, which offers a means of making the development process more feasible. The tools used for the development of the voice enhanced web-based pest management system are PHP/Laravel, Java Script, HTML and CSS. Result shows that PIS consists of over one hundred pests with their scientific names, descriptions and control measures. It is voice enhanced, therefore can assist visually impaired individuals and aid decision support on farm through listening and not necessarily reading. It is web based which makes it easily accessible, compact, educative and enhance decision making. Conclusively, The need to deliver a first hand information to farmers as at when due is critical to good yield. Access to compact information about pests is of great significance to farmers. Enhanced pest informatics system is a smart tool that creates mobile extension services to farmers using a stress free and friendly approach. User's evaluation result confirmed that the tool is flexible, user friendly, reliable, efficient and robust.
Keywords: Informatics, Information System, Pest Management, Repository

1.0 Introduction

A pest management system (PMS) is a repository of all known pests with information on their status in the country. It provides a platform and tool for undertaking regular pests scouting projects as part of an early warning system. PMS makes it possible to combine information from many different sites in a seamless fashion (Waheed et al,

2003). PMS is an improved method of information communication technology for farmers. It helps farmers in accessing pest management information and expertise (Nirjan and Neha, 2016).

Knowledge and information are key to correct pest management decisions. Carlo et. al. (2021), emphasized that data plays a vital role in agriculture. Farm management information system (FMIS) enhance decision making [Dik and Travieso, 1986; Dongyool et al, 2022]. It assists expert systems to obtain knowledge, and use of this knowledge by those who have not yet achieved expert status, is of great value to decision-making (Wafa M.H., 2020). The purpose of FMIS is to enhance compliance to agricultural standards, and maintain high product quality and safety, it also proffers solutions to agricultural precisions (Fountas et al, 2015). Integrated pest management (IPM) is a system that emphasizes appropriate decision making, and it is information intensive. It depends heavily on accurate and timely information for field implementation by practitioners (Bajwa and Kogan, 2000). Additionally, it is critical to strengthen the communication links between researchers and extension professionals and their clientele to expedite multi-way exchange of information and technology transfer. In addition, researchers and extension specialists need the most up-to-date information to design new projects and set future research goals and directions.

Development trends in computing has huge potential to bridge the existing gap between present research system and farming. There are no true IPM decision support system online at this time, but many of the resources are available and waiting to be embraced after proper integration [Coop 2000; Gilman and Green, 1998]. The use of computing technology is integrated to provide a range of technologies or technological devices to enable the agricultural extension system gather, store, retrieve, adapt, localize and disseminate wide range of information to farming community (Singh P. et al, 2018). The pest control industry is continuously examining novel technologies and products that will improve the way to manage and prevent pests (Meenu and Ayushi, 2020; Jones, 1989). Insufficient engagement of farmers in PMS technology development and frequent lack of basic understanding of its underlying ecological concepts is a gap that needs to be filled (Jean-Phillipe, et al 2021). Indigenous knowledge on good practices and local innovations are not documented. Information has to be presented in proper format to be effectively used by farming communities. (Singh et al, 2018). The transfer of research and extension information to farmers plays the key role in Agricultural development (Leung, 1998; Bajwa and Kogan, 2000). The aim of this research is to design and develop a voice enhanced pest informatics system.

2.0 Literature review

2.1 Potential Roles of Computing Technologies in Pest Management System

Integrated pest management has proven to be the most effective system approach to pest management which has benefited significantly from computer applications. IPM Programme Development Officer, FAO, categorized the various fields of IPM in which Information Communication Technologies (ICTs) are been applied (Xia & Yunlong, 2003). The fields of IPM where ICT is applicable include identification of insect pest,

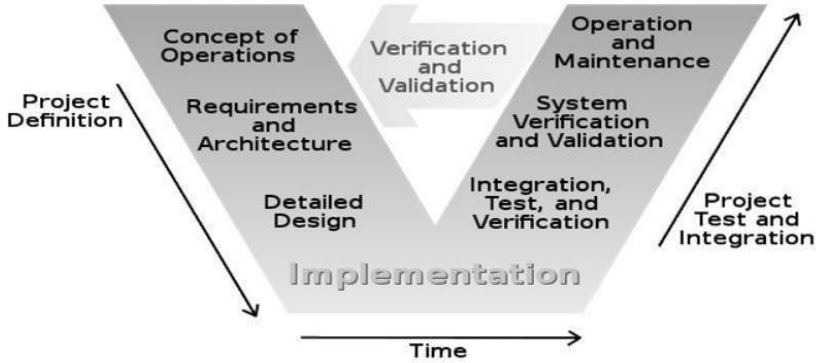
IPM related information dissemination and sharing, internet-based pest management decision tools and also supports updated training to extension functionaries and farmers. The identification of insect pests had been immensely eased for farmers using ICT innovations, especially the application of machine learning to pest detection and classification. Machine learning techniques like artificial neural network(ANN), convolutional neural network(CNN) and so on. IPM related information dissemination and sharing is based on informatics system, which is essential to extension farmer. It can also support in helping researchers and extension scientists to analyse data and help in scientific papers writing (Bartlett, 2002). Wafa, (2020) stated that the incorporation of the obtained data from different resources can be used to fulfil the sustainable development requirements. The internet service made it possible to disseminate documents to other researchers, scientists, extension worker, farmers and other people through E-mail attachment (Rosenfeld et al., 1993). It can also be disseminated by posting on a websites for public viewing. Extension agents view the web as an information resource with great potential for just-in-time communications (Boone, 1998). Take for instance, in India internet is just deployed in rural area through internet kiosks or smart phone this can be very effectively utilized as tool for scientists. The ICT has a number of characteristics which make it very appropriate for this purpose. It is fast, persistent, detailed, open and interactive and some of these characteristics proves ICTs to be very effective. The use of Online discussion platform and websites offers a great connection between experts, it thus acts as an expert service, which gives it an added advantage. Farmers, government agencies, NGOs as well as other private agencies who advise and train farmers need more knowledge and skill than was required under earlier extension systems. ICTs in IPM programme can be used to support pest management decision making and also to support IPM Training (Bartlett, 2002; Power, 2000; Power and Kaparthi, 1998; UCIPM, 1998). The use of ICT to support Pest management decision making can be supported by ICT in identifying the pest species, its damage and life history, establishing economic injury thresholds, monitoring, scouting and predicting population, Selecting and applying control technique as well as evaluating treatment effectiveness. Initiatives such as IPMNet, Africa IPM Link and IPM CRSP have developed ICT channels for disseminating information, such as websites, online databases and discussion forums, email list servers and multimedia CD-ROMs. This decision support systems provide users with all the information to select suitable pest control strategy which includes pest identification, pest life cycles, sampling and decision-making criteria, sampling threshold calculations, and pest distribution models linked to weather monitoring systems offering environmentally friendly bio-control methods, as well as available pesticides and their safety risks and impact on the environment.

In India, broadcasting started through ‘Akashvani’ (All India Radio) in 1957 which provided education to farmers on new crops, insect pest disease management, soil and water management, other research were carried out to educate farmers on pest crop management (Thamizhpparithi et al., 2007; Farm & Home programme, 2006; Maurer and Scherbakov, 1996). Establishment of Community radio station in Krishi Vigyan Kendra of India was a step to provide special attention on crop production technology and insect pest management as well as location specific weather forecasting, helping

farmers to adopt Integrated Pest Management [Chiranjeev, 2000; Niran & Neha, 2016]. Another initiative was Kisan Call Centre with a tollfree number 1800-100-1551 where farmers can call and get information regarding disease and insect pest management. In same manner ICAR institutes and SAUs had also started consultation to farmers giving them location specific insect pest and disease management. Doordarshan as well as other private television channels are nowadays showing agriculture based programs like Krishi Darshan, Kheti Bari, Batein Kheti Kee and many other programs on different topics of agriculture including Integrated Pest Management. A whole new channel has 'Kissan' is devoted only on agriculture information. Agricultural Research Information Centre (ARIC) provides a central source of information on the nature, location and status of current research project conducted in the country (Thysen, 1998). M. S. Swaminathan Research Foundation, under "Village Knowledge Centre" provides variety of information in fostering agricultural and rural development through the use of ICTs. All the afore mentioned approaches helps in enhancing agriculture especially farmers through information technology (Trede and Miller, 1993). Ikisan limited was an initiative launched by ikisan portal and information kiosks primarily to disseminate information on agricultural and IPM practices. Farmers can access this portal free of charge. Similarly, E-chaupal, and Gyan Doot by the Indian Tobacco Company (ITC) in MP and SEWA in Gujarat providing agriculture information related to insect-pest management similarly many such agencies in India and other developing continents are working in this regard. Other institutes like National Institute of Agricultural Extension Management (MANAGE) have developed a system which diagnoses pests and diseases for rice crop and also suggests control measures, IIHR, Bengaluru has developed grape Expert system, Mushroom Expert system, cabbage Pest Expert Systems. All these expert systems were developed to monitor crop growth and there by improve their yield. Central Silk Board, Bengaluru has developed an expert System for the management of insect pest management in Sericulture. AGREX, centre for information Kerala gives timely and correct advice to the farmers. Similarly, much Agricultural university has well developed farm advisory system for agriculture information with information related to pest diagnostics using pictures and pest management practices. National Centre for IPM (NCIPM, New Delhi) is the main centre to look into insect pest management needs of different agro- ecological zones of the country. It conducts eco-friendly IPM research and development programmes for sustainable agriculture. Services like pest surveillance and advisory project, chickpea and pigeon pea production through intensive application of IPM and major insect pest problems of rice and other agricultural pest were provided through internet. The major significance of these is to broaden farmers' knowledge based on the afore mentioned crops, it gives a good knowledge base. Having gone through the overview knowledge of the existing systems, the identified gaps revolve around the fact that pest identification informatics are difficult to come by. Also, existing pest identification informatics are not voice enhanced, which will assist farmers that are not lettered but understands English, and Production of information and output reports are not available in a much faster way or are difficult to get.

3.0 Methodology

This employs the system development approach to PIS. It gives an overview of system lifecycle. It produces a consistent frame work of tasks and deliverables needed to implement a system. The development method explored in this study is the V-model which may be considered as an extension of the waterfall model, it offers an approach of making the development process more feasible. The V model shown in figure 1



represents a software development process. The V-Model demonstrates the relationships between each phase of the development life cycle and its associated phase of testing. The horizontal and vertical axis represents time of project completeness (left-to-right) and level of abstraction, respectively.

Figure 1: V-model Forsberg et. al.. (2005)

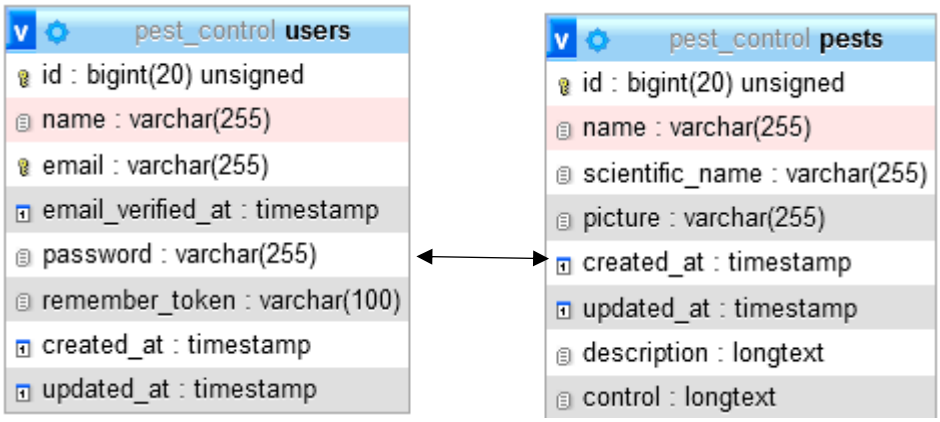


Figure 2: Entity Relationship Diagram for Pest Control Database

Figure 2 represents the database entity relationship diagram of pest control, which has two important tables pest_control pests table and users table. The pest_control users table holds the records of all pest information in the database while the pest_control user table holds the record of the administrator of the software. The pest_control users table contains entities id, name, scientific-name, picture, created-at, updated-at, description, control which represent pest ID, pest name, the scientific name of pest, the pictorial

representation of each pest, the date the pest record was added to the database, the date of pest record update if any, the documented facts about each pest and control measures of each pest respectively. pest_control users table entities include computer administrator's ID, administrator's name, email, email verification date, adiministrator's password, remember-token, date of administrator's registration and date of information update. Each of the details represents administrator's information.

Architectural Design

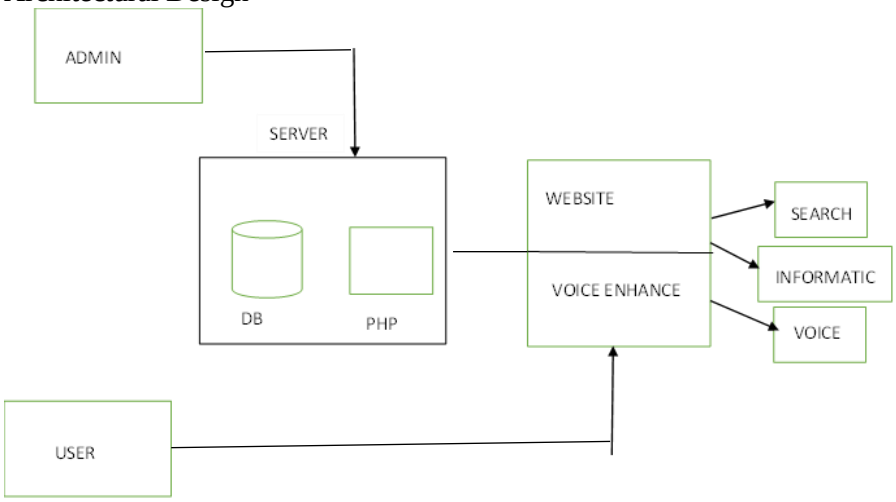


Figure 3: System Architecture of Voice Enhanced Pest Informatics System

The figure 3 above depicts the software architecture of enhanced pest informatics system. The admin interacts directly with the server for software upgrade through the PHP integrated development environment and updates data through the database server. These two runs to give a robust voice enhanced website, through which users performs pest search, informatics and audio operations.

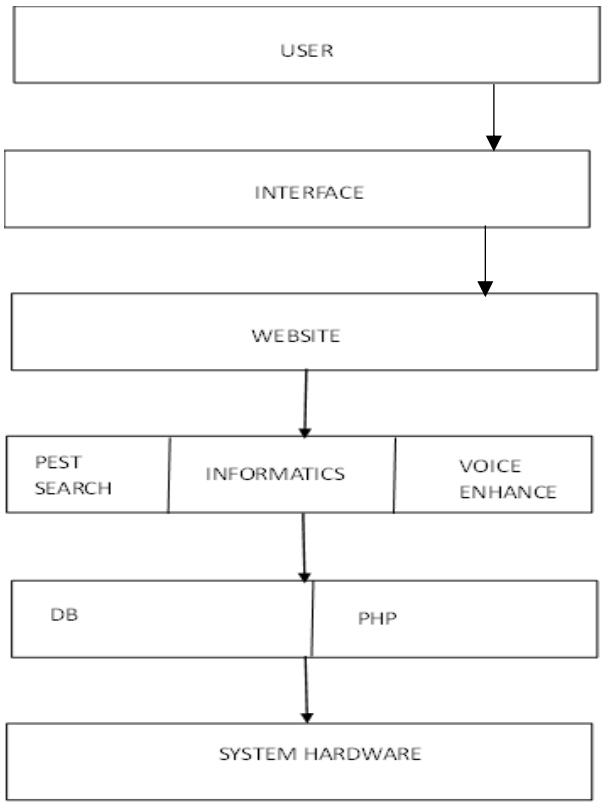


Figure 4: Data Flow Architecture of Voice Enhanced Pest Informatics System

Figure 4 represents data flow architecture of voice enhanced web-based pest control and management information system, it shows the layered relationship between the component parts of the voice enhanced Smart Tool for Pest Disease and Control Informatics. The lowest level is the hardware layer which has to do with the system components that users and admin interacts with. Next to this layer is the developed software which is based on PHP and Mysql development tools. The software is capable of performing informatics roles, this lies on level three, the software features were deployed on a website on level four, levels five and six are user interface and users respectively. The programming languages used in developing the system include PHP/Laravel, Java Script, HTML, and CSS. MYSQL was used for the database management system of the model.

4.0 RESULT AND DISCUSSION OF FINDINGS

A voice Enhanced Pest Informatic System (VEPIS) for pest disease and control informatics was developed. The VEPIS constitutes over one hundred pests with their scientific names, description and control measures, the developed software is voice enhanced which gives it an edge over existing pest informatics system. The voice enhancement feature made the developed VEPIS smarter and useful for visually impaired farmers, other farmers and agricultural practitioners because all they need is to

listen to the description and control measures, they don't have to read from the device all the time. The following are the menus on the tool.

1. Home Page
2. Pest details
3. Search page
4. Admin login
5. Admin Dashboard
6. Admin Search
7. Edit Pest details

4.1.1 Home page

Figure 5 is the entry point of the software where all pages are listed and paginated in the developed VEPIS.

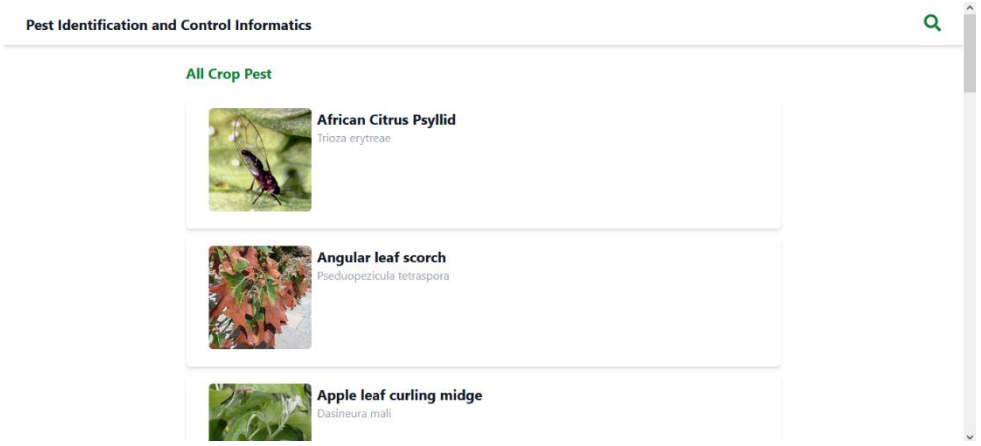


Figure 5: Home Page of the developed VEST

4.1.2 Pest Details Page

Figure 6 depict the description of the pest as well as the control or preventive measures that could be carried out, it also has a speech synthesis feature that allows the software read all the text on screen. This feature enhanced the informatics smart tool. All that is required from the farmer is to listen.

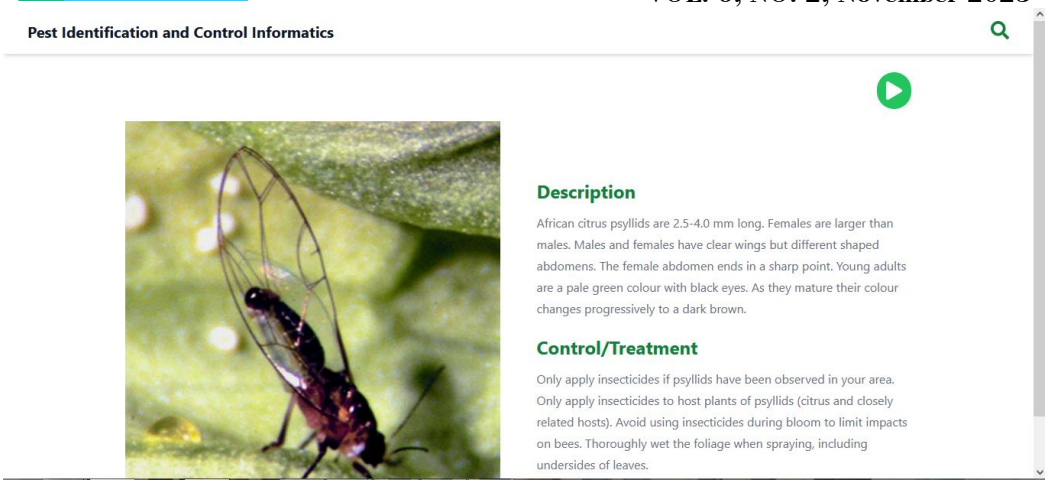


Figure 6: Pest Details Page

4.1.3 Search Page

Figure 7 allows the user of the system search through the system quickly without having to wait for the page to reload. The first few letters of the search term can be typed in the textbox, and with the press of enter key, related terms will be displayed on the screen. This displays related pests, while the user is left with the choice of clicking on preferred term.

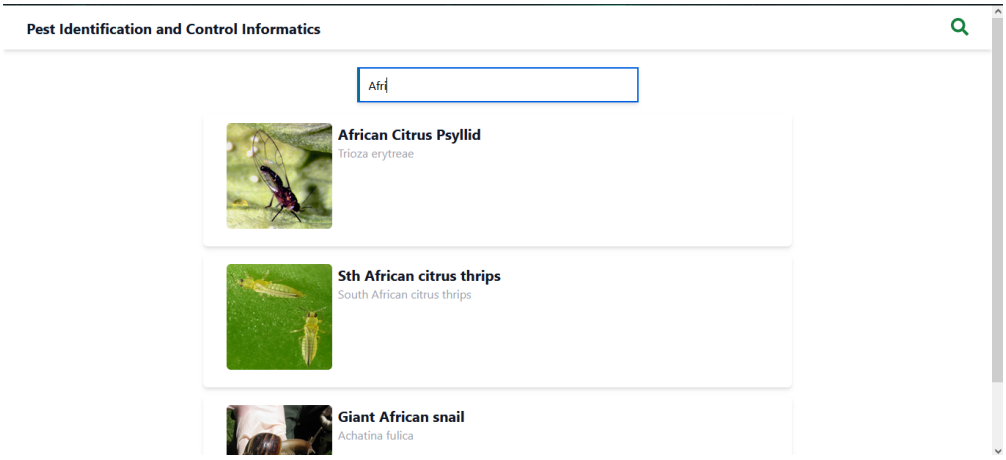


Figure 7: Search Page

4.1.4 Admin Login Page

Figure 8 is the page where authentication of the admin side will be carried out to ensure that software is secure from third parties. Admin personnel is expected to input his registered email and password details, which is matched with the registered details in the database. Authorization of this grants the admin full access to the back end of the system.

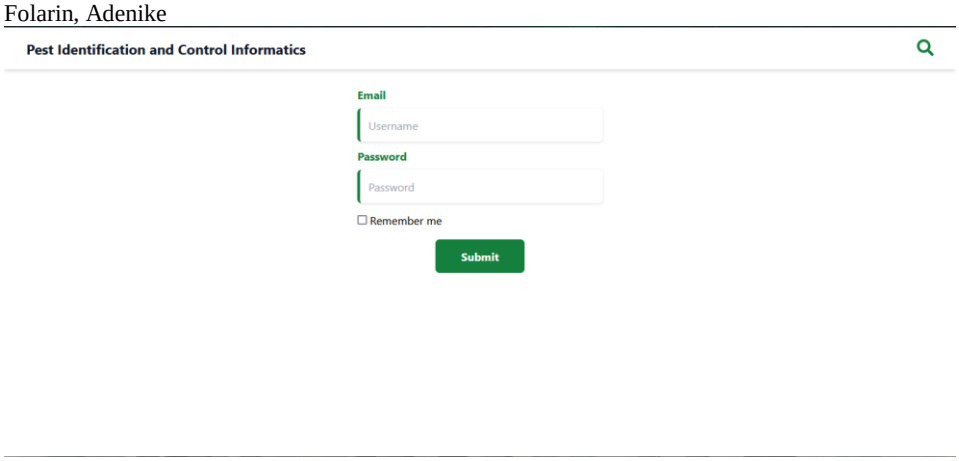


Figure 8: Admin Login Page

4.1.5 Admin Dashboard

Figure 9 is the next page after authentication has been carried out, it gives a brief statistic about the pest in the database. This page also allows the admin to add to, edit or delete the existing records of pest information.

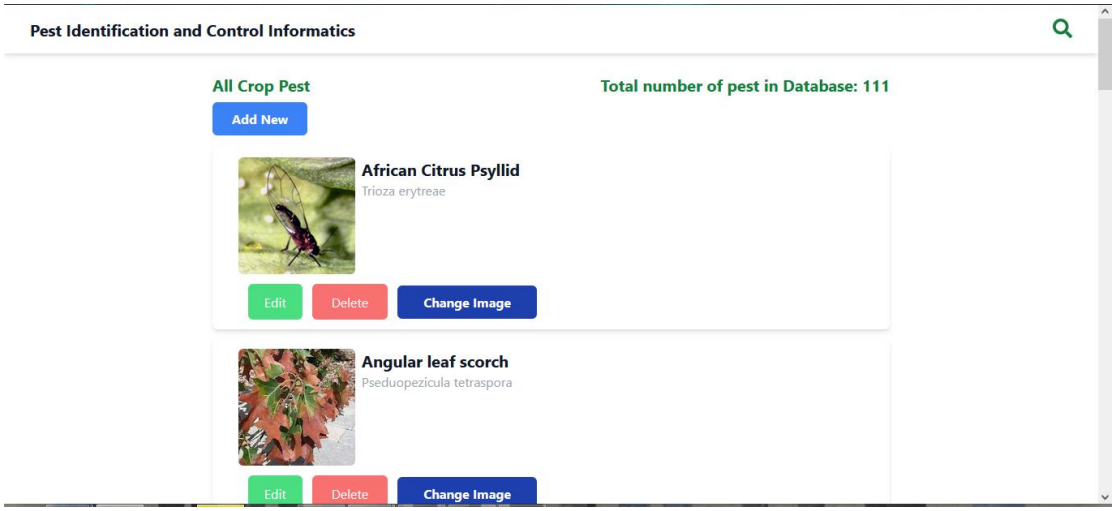


Figure 9: Admin Dashboard

4.1.6 Edit Pest Details Page

Figure 10 allows the admin to modify and update details of a pest in case additional information is acquired or new knowledge is been identified through evidence-based as regard to the pests. This feature made the system information easy to update as research and future work progress on pest characteristics and control measures.

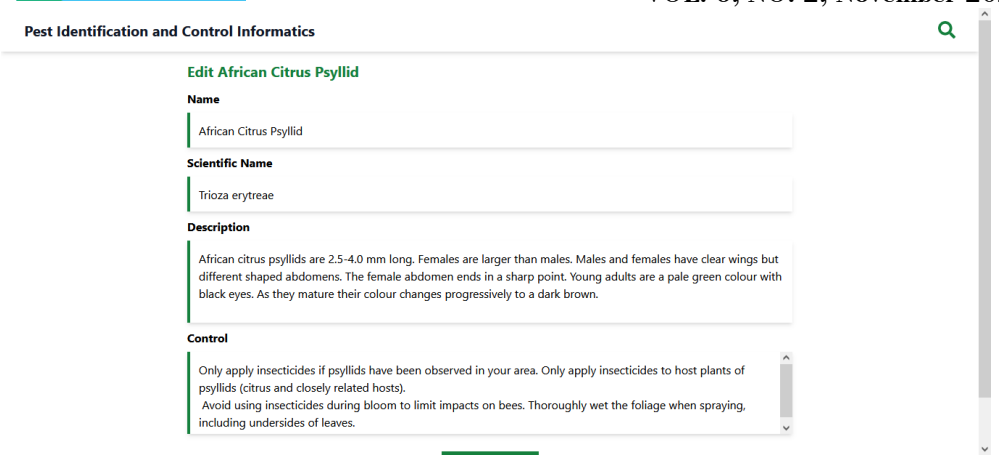


Figure 10: Edit Pest Detail Page

4.1.6 Admin search page

Figure 11 Allows admin search the database quickly. The first few letters of the search term can be typed in the textbox, and with the press of enter key, related terms will be displayed on the screen. This displays related pests, while the user is left with the choice of clicking on preferred term.

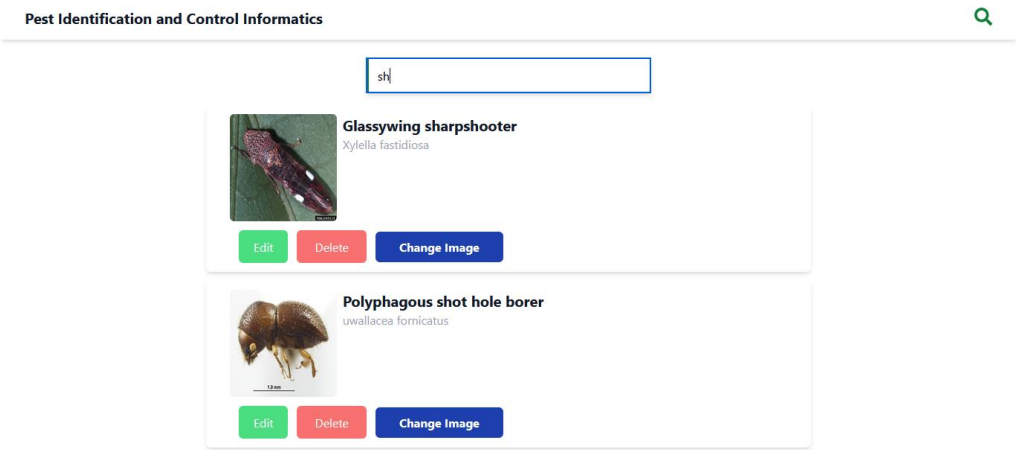


Figure 11: Admin Search Page

4.2 System Evaluation

This study evaluated the performance and effectiveness of the Voice Enhanced Pest Informatics System against a set of pre-defined criteria such as user-friendliness, reliability, efficiency, portability, security, usability, maintainability and gathered feedback from users to assess the system's overall quality and user satisfaction.

4.2.1 User Experience

Users confirmed that the VEPIS developed is truly reliable, and there are several aspects that stand out, particularly the voice enhanced feature. First and foremost, the user interface is remarkably intuitive and user-friendly, making it easy for both intensively learned farmers and others to navigate and understand the system. The clear instructions and explanations for how to use the VEPIS are also greatly appreciated, as they help to ensure that everyone is able to make the most of its many features and capabilities. Users also noted it's descriptive way of explaining pests diseases to aid identification and understanding in all contexts. To further improve it's efficiency users appraised the audio feature of VEPIS which enhance the understanding of pest description and control. It's portability is proven by it ability to run effectively on various platforms both computers and mobile devices. The data on the back end are secured by the admin and can be easily maintained and expanded by updating the existing repository of pests.

5.0 Conclusion

Pest disease is a germane problem to farming, the destruction it creates if not arrested to time cannot not be over emphasized. The need to deliver a first hand information to farmers as at when due is critical to good yield. Information is power and also key, having compact information about pests in terms of description, image representation, and control measures is not common. This research delved into this by sourcing for current information about pests from various archives of pest researches. VEPIS for pest disease and control was designed and developed. This smart tool creates mobile extension services to farmers using a stress free and friendly approach. The tool is flexible because it's information system can be updated as research trend improve on the various pest diseases. Also, more pest details can be added to the system to increase the scope of information in the system.

5.1 **Recommendations**

The use of VEPIS by agriculturists will aid prompt decision making on pests. Feed back from users shows that it will serve as a reliable tool for the support of extension services. It gives detailed and descriptive information of pests using text and audio features.

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