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AN INTEGRATED INFORMATION SYSTEM TO FACILITATE FARMERS IN WHEAT, SUGARCANE AND OTHER CROP DISEASES IDENTIFICATION

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ABSTRACT:- E-agriculture is an emerging area that integrates agriculture and rural development with information communication technology (ICT). In developing countries such as Pakistan, economy largely depends on agriculture. Therefore, the need to move from conventional ways of farming to easy, effective and efficient smart solutions are required to minimize yield losses in crop plants. An integrated application to facilitate farmers to communicate their crop related issues directly to agriculture scientists is proposed. This 'AXPERT Platform' consists of web application that provides user centered interface to farmers and a desktop application that facilitates agricultural scientists to identify crop diseases. A case study was developed from Faisalabad region where information about crops, their soil conditions and associated diseases were provided on a web application. An online registration facility was provided along with interface to send image of crop related diseases. The desktop application consisted of an image analyzer that received images from web application and processes them to identify crop disease. The proposed platform was evaluated in collaboration with researchers from Ayub Agricultural Research Institute (AARI), Faisalabad by employing walkthrough and survey with farmers and agriculturists. The study is first attempt in terms of practical usage of ICT tools to bridge research and extension gap and can be used by agricultural policy makers to support agricultural services for farming communities who are otherwise deprived of extension services due to large number of farmers and their huge spread throughout the country.

Key Words: Wheat; Sugarcane; Fungal Diseases; E-Agriculture; Information System; Disease Detection; Pakistan.

INTRODUCTION

E-agriculture has introduced information communication technology (ICT) tools in agriculture and rural development. It integrates software and hardware resources with agricultural activities to facilitate agriculturist. E-agriculture is one of the action lines identified in the declaration and plan of action of the World Summit on the Information Society (WSIS, 2003). The use of ICT in agriculture ranges from advanced modern technologies (such as GPS navigation, satellite communication and wireless connectivity) to older technologies such as radio and television. The application of ICT in agriculture provides opportunities to solve problems of agricultural community and to increase agricultural production by providing scientific information timely and directly to

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agriculturists.

Rust and foliar diseases in wheat crop in particular, are among the oldest crop diseases. The existing information on wheat production can extend yield losses up to 100% and are among the oldest plant diseases (Bux et al., 2012). Diseases like rust, powdery mildew, spot blotch and kernal bunt have prospective threat to world food security (Rattu et al., 2009). Sugarcane is a major sugar crop of Punjab province and its production is affected from many diseases, which cause high yield damages (Agrios, 2002). According to Panday (1997) sugarcane diseases can damage upper leaves, off shoot lose color and wilt slowly. Timely disease identification and its integrated management is the solution to overcome losses and to enhance crop productivity.

In Pakistan, the conventional way of information dissemination between farmers and agricultural experts is largely dependent on extension workers. The job of extension workers is to act as intermediaries between farmers and the agricultural research department. They travel from one village to another to collect crop issues from farmers and communicate them to agriculture experts for solutions. In the next phase, they travel back to these villages to communicate expert recommen-dations. This traditional model is very slow and has not been very efficient due to many reasons. Firstly, the process itself is very tedious (as villages are miles away), and time consuming (have to move back and forth). Secondly, the extension workers are few and they have to cover more villages and solve individual farmer issues. Finally and most importantly, extension workers are not paid much. This results in an inefficient, time consuming and limited link between extension department and research.

To address this issue, an integrated information dissemination platform by making use of web technologies along with a decision support application that include image analyze is proposed. Shen et al. (2008) depicted that this technique of picture analysis for crop foliar diseases is precise and rapid.

MATERIALS AND METHOD

A multi-method approach that combines experiment, walkthrough and survey techniques by taking case study of Faisalabad region was employed. The research process designed for this study (Figure 1). At first, the literature relevant to e-agriculture and its applications were critically analyzed to find out evidences of applications being developed in this area. In next phase, system architecture is developed and Ayub Agricultural Research Institute (AARI), Faisalabad, Pakistan was selected to conduct case study. This choice was made primarily due to access and availability of resources. Since, land conditions and cultivation patterns vary from region to region therefore, at initial stage, it was considered appropriate to focus on one region. In the first phase of research, wheat, sugarcane and some vegetable crops were selected. Crop diseases; ring spot, yellow spot, brown spot, eye spot, tan spot, leaf spot, and narrow spot were selected for plant crops.

The application architecture consists of components that include web application architecture, desktop application architecture, and web

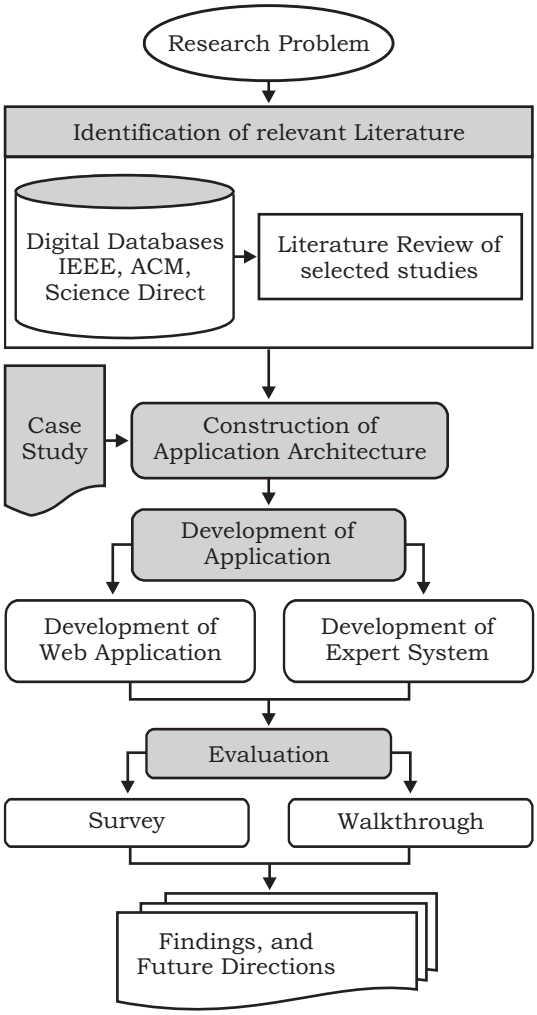


Figure 1: Research process designed to develop and evaluate proposed platform

service to communicate between both applications. The evaluation is carried out by employing walkthrough and conducting survey with farmers, research assistant and agriculture scientists.

Problem Scenario

Scenario was made by constructing an environment where AXPERT (proposed system) addresses the problem (Figure 2). The process starts when farmers interact with web application to send request to agriculture experts. To send request, one needs to register with the website. For this, an online registration form is available on the website. After registration, a form that requires information about area, profession, disease type and image of the leaf having disease symptoms is submitted into the system. After submitting the form, the request goes to desktop application and stores in databases. The decision support application consists of image analyser and contains other functions to facilitate agricul-turist in making decisions about the received request. The image analyser detects the disease and generates reports which are then reviewed. This report is sent back to web application and becomes available in farmer's profile. The farmer can login in to online account and can access report. This method provides an opportunity to farmers to directly communicate with agricul-

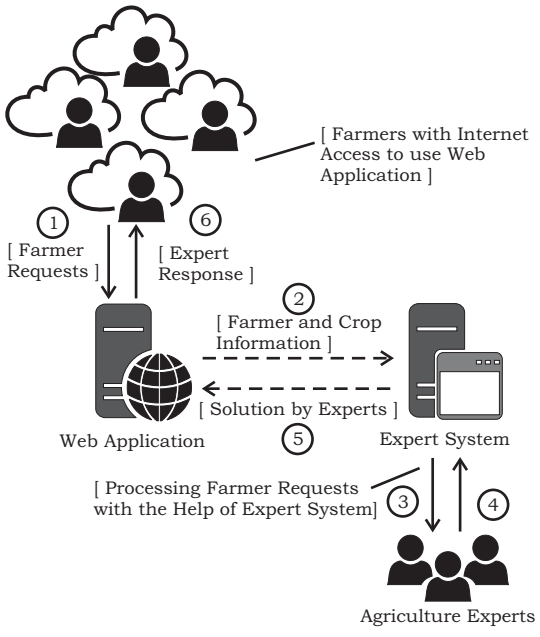


Figure 2: Working of proposed platform in real scenario

ture experts without involving extension workers.

Web Application

This has two purposes. Firstly, it provides information about various crops, soil condition, and spatial information where these crops are harvested. The second is to facilitate agriculturist to get expert-opinion on crop diseases. For this, the web interfaces are designed to facilitate semi-literate users by providing them in two languages i.e., English and Urdu. Through web application, user can register, send request to expert by uploading infected crop leaf image, and view results in their web profile.

Desktop Application

The decision support application has two functions (Figure 2). Firstly, it provides analysis of crop leaf images to identify disease. For this purpose, image analyzer that makes use of various algorithms to identify ring spot disease in the image was developed (Figure 2). The processed image help experts to analyze how much severe the effect is. The algorithm can identify diseases such as ring spot, yellow spot, brown spot, eye spot, tan spot, leaf spot and narrow spot. The second purpose of this application was to generate report to provide solutions. The generated report is sent back to user account.

Image Analyzer

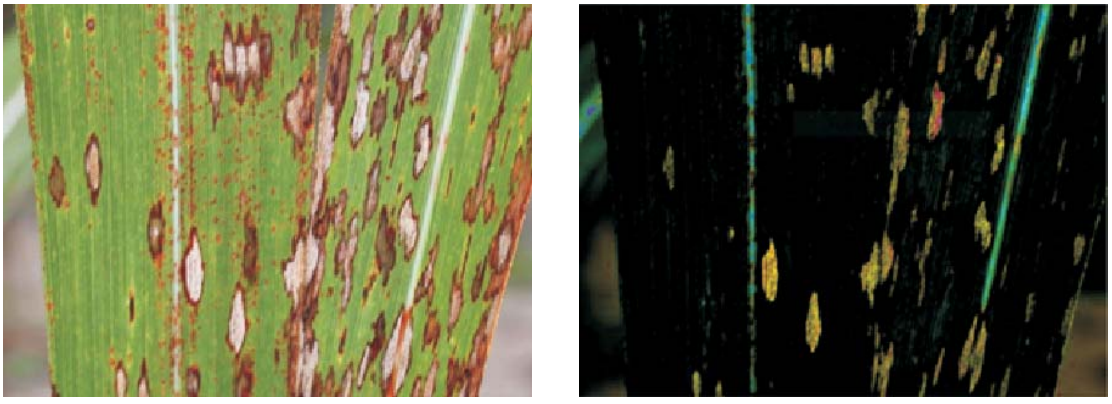
It provides two types of facilities to identify disease in the given leaf image namely, Visit Analysis and Full Analysis.

Visit Analysis Technique

The algorithm consists of the following steps to correctly measure the disease i.e., to acquire the image, use of HIS (Hue Saturation Intensity) algorithm on the image before its finalization and the final step is to report image generation (Figure 3).

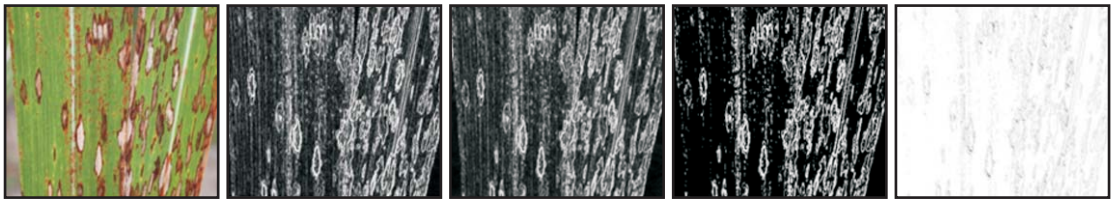
Full Analysis Technique

There are six steps to correctly apply full analysis. This technique makes use of various algorithms to process image. In this technique, agriculturist or any person using image analyzer can see how step by step disease is identified through developed system. The process steps and algorithms applied includes acquiring image, apply Sobel Edge



(a) Actual Image (b) After Applying HIS Algorithm

Figure 3. Results of image analyzer after applying HIS algorithm for ring spot disease in sugarcane leaf



(a) Actual Image | (b) After Applying Edge Detection Algorithm | (c) After Applying Grey Scale Algorithm | (d) After Applying Banalization | (d) After Applying Emboss-filter

Figure 4. Results of Image Analyzer for ring spot disease in sugarcane leaf

Detection Algorithm, Grey-scale algorithm, Banalization on image, Emboss-filter and finally generate the results (Figure 4).

RESULTS AND DISCUSSION

The evaluation of AXPERT is carried out by employing walk through and survey with farmers and agriculturists in AARI, Faisalabad. The walkthrough was conducted by following the review protocol and guidelines taken from (Weinberg and Freedman, 1984; Ackerman et al., 1989; IEEESTD, 2008).

Expert Validation of the Platform

The walkthrough session lasted for two hours as it is recommended that walkthrough session should not exceed two hours otherwise, the review will be less effective. Required participants having background in agriculture includes agriculturist, practitioners and farmers and therefore, contacted AARI, Faisalabad which is the largest governmental set-up to provide agricultural research services in Punjab province. Therefore, the participants involved in the session were researchers from AARI Faisalabad, Pakistan Agricultural Research Council, Nuclear Institute for Agriculture and Biology and farmers from Faisalabad district. The session was structured in three parts. In the first part, a presentation was delivered about e-agriculture and its implications on agriculture community and economy. In the second part, problem scenario was explained. In the third part, AXPERT platform was introduced.

The interest was in collecting data about issues raised by participants about application and domain problem being addressed. The main concern was to get right population which was addressed by involving a combination of agriculture experts and farmers. Another concern was related to biasness in selection of participants. This was addressed by taking participants from different organization who were not involved in problem domain (scenario) construction and also in application development. The third and last concern was related to data consistency which was addressed by collecting session data in audio and video along with hand written notes.

A survey was conducted for usability analysis of application and data was collected through a semi-structured questionnaire (Table 1 and 2). The survey was designed to give demonstration of the developed software to respondents and get their response on their perception about usability parameters including effectiveness, efficiency and learning ability. Five point Likert-type scale was used to collect responses from 25 farmers. The participant farmers

Table 1. Participants' responses, mean value

Group A Participants	Responses	Group B Participants	Responses
1	5	1	6
2	6	2	6
3	5	3	5
4	5	4	6
5	5	5	4

were mainly divided into land owners, owner cum tenant and tenants. Out of selected farmers, 17 were land owners, 3 were owner cum tenant and 2 were tenants. The participants were largely involved in subsistence farming. Only four farmers were doing commercial farming.

To measure participants' responses, mean value of each evaluation variable was calculated. The responses were divided into two groups i.e. strongly agree and disagree (Table 1). In this study, AXPERT platform was discussed which is an integrated application to facilitate agriculturist especially farmers and agriculturist (Steddom et al., 2005; Bock et al., 2001) for leaf diseases identification. The platform is developed to provide an alternative way of communication between farmer community and agriculture organizations. The initial response on this platform is very encouraging. Plant diseases are identifiable through developed algorithm (Camargo and Smith, 2009). This method of identification based on hue and saturation used in citrus diseases identification by Pydipati et al. (2006) and the method is found very applicable. Further, improve-ments are required at web interface level to deal with the challenge of lack of technological literacy.

Disease evaluation by using latest technologies is proficient and it needs improvements to realize the potential of photograph analysis (Bock et al., 2010). Currently, the

Table 2. The mean value for questions under three usability parameters i.e. effectiveness, efficiency and learnability was calculated and results are presented.

Effectiveness		Mean
Q1	Using the system would improve my task performance	3.6
Q2	Using the system, it would be easy to find the required information	3.5
Q3	The system gives error messages that clearly tell me how to fix problems	2.6
Efficiency		
Q1	Using the system would enable me to accomplish tasks in less time as compared to conventional way of doing.	3.9
Q2	It would make my job easy by minimizing the dependency on extension department/experts. For example, I would be able to get required information directly from experts using internet without involvement of human mediators.	4
Learnability		
Q1	The system was easy to understand for me	3.9
Q2	I think that I would need the support of a technical person to use this system.	2.1

system provides information in two languages i.e., English and Urdu with an audio facility in Punjabi language. However, in future more languages could be added to facilitate wider community. The decision support application requires agriculture scientist to apply various algorithms to analyze the received image. In future, an enhanced version of this could be developed to automatically process images and find patterns of crop diseases.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S.No	Author Name	Contribution to the paper
1.	Ms. Arshia Naeem	Concived the idea, Overall management of the article Data collection, Evaluation
2.	Dr. Maria Anjum	Technical input at every step, Data Analysis, Evaluation
3.	Dr. Mariam Rehman	Data entry in SPSS and analysis, Research Design, Evaluation
4.	Mr. Zahid Maahmood	Data Analysis, Evaluation
5.	Mr. Muhammad Asif Kamran	Data collection

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