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Online Expert System on Indian Tobacco Varieties

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A B S T R A C T

In India, around 93 tobacco varieties were released and three cultivars identified for commercial cultivation in 10 types of tobacco grown under various agro climatic regions. In order to make this information available to researchers, farmers and students, an online expert system on tobacco varieties was developed using Agridaksh tool designed for creation of knowledge base of all crops at a single platform for global accessing. The information on tobacco varieties provided by the domain experts of tobacco crop was used in constructing the knowledge model. The developed system stores the knowledge base of tobacco varieties with various parameters and can be updated by the experts as and when required. This can be accessed at any location and point of time by the users through user friendly menus and ontology based inference system using Internet. The module allows the user to enter into question-answer session in text mode leading to identification of tobacco varieties suitable to different areas with their images and yield potentials.

Introduction

Tobacco is one of the important commercial crops grown in India. Around 10 types of tobacco with various end uses are grown under different agro-climatic conditions. The tobacco types grown are broadly classified as Flue-cured Virginia (FCV) and non-FCV types. Non-FCV types include burley, *natu*, cigar filler, cigar wrapper, Cheroot/Natu/Pikka, hookah, bidi, snuff, chewing etc. Around 93 tobacco varieties are released and three cultivars identified for cultivation under different tobacco types. Most of the released tobacco varieties have been documented for their characteristics and suitability to various tobacco growing areas. Organization of this information in an expert system will be helpful for its effective utilization by farmers, researchers and students.

Expert systems combine experimental knowledge and experience with intuitive reasoning skills of specialist's to aid farmers in making best decision for their crops (Durkin, 1994; Hart, 1986; Rani *et al.*, 2011). A number of expert systems were developed

in agriculture for various crops (Yadav *et al.,* 2012; Islam *et al.,* 2012; Singh *et al.,* 2013; Ani Dath and Balakrishnan, 2016; Prasad Babu *et al.,* 2010; Wang and Lu, 2008; Wharton *et al.,* 2008). At ICAR-Central Tobacco Research Institute, standalone expert systems were developed on various aspects of tobacco cultivation (expert systems on tobacco germ plasm (Ravisankar *et al.,* 2012), insect pests (Ravisankar *et al.,* 2014a; 2014b) and weather parameters (Ravisankar and Sarala, 2014).

"Agridaksh" tool was used to develop a web based expert system for tobacco varieties for global accessing of the required information. AGRI daksh is a tool developed by IASRI, New Delhi for building online expert system for various crops (Marwaha, 2012). It is Semantic Web compliant and built on robust, platform independent java technology using n-tier web architecture. It consists of modules on Knowledge Model Creation, Knowledge Acquisition, Problem Identification, Knowledge Retrieval, Ask Questions to Experts and administration. This tool enables to build online expert system for each and every crop in significantly less time with minimal intervention of knowledge engineers and resources.

Online expert systems have the capability to transfer location specific technology & advice to the farmers efficiently and effectively. The ontology based variety selection module was used to build tobacco varietal expert system for improving the productivity with proper variety selection and increase in income of the farmer. Ontology is the recent knowledge representation technique that allows the domain experts to code their knowledge in a specific domain. They have the potential to be used in a distributed environment like Internet and provide the dynamic and reusable capability to the knowledgebase.

Materials and Methods

As a first step for building the expert system, domain experts of the tobacco breeding are consulted for the list of attributes for building the knowledge model on tobacco varieties. After preparing the attribute list, the required knowledge was captured as per the activity chart developed by the domain experts. Using this knowledge base, a web based tobacco varieties expert system was developed using a tool "Agridaksh" in an N-tier architecture in the form of static web pages and ontology based system (Figure 1).

The N-tier architecture composed of two components viz., Client side Architecture consists of web browser and Internet connectivity and Server side architecture with application logic level JSP, JESS inference engine, Semantic Web framework JENA and database. The last layer in this structure is the database layer consisting of tobacco varietal information. Java Server Pages (JSPs) with HTML documents interleaved with Java are used as a technology to create dynamic content on the Web. The application logic spread over a Web Server and an Application Server. If the request is for an application, it will forward the request onto the Application Server. The Web Server handles request from Web Clients and generate response through static HTML document. To retrieve the list of varieties from the system, whenever the user click that option using web browser, that request will be received by JSP in web server through internet and generate a response to the client in the form a table as a simple HTML document.

The expert system developed was in the form of static web pages using hypertext mark-up language (HTML) and ontology based system using a Web Ontology Language (OWL). For ontology based retrieval of the information on tobacco varieties from database, JESS

inference engine and Semantic Web framework JENA were employed in the system. JESS is an expert system shell and scripting language and it supports the development of rule-based expert systems which can be tightly coupled to code written in the powerful, portable Java language. JENA is a Java framework for building Semantic Web applications. It provides a programmatic environment for Resource Description Framework (RDF), RDFS and Web Ontology Language (OWL), including a rule-based inference engine. Protégé (Noy *et al.,* 2001) a language belong to OWL (Smith *et al.,* 2004) a family of knowledge representation languages for authoring ontologies was used to write ontology based selection module. At its core, Protégé implements a rich set of knowledge-modelling structures and actions that support the creation, visualization, and manipulation of ontologies in various presentation formats. Protégé was customized to provide domain-friendly support for creating knowledge model on tobacco varieties and entering data. After developing knowledge model, values of attributes for each variety of tobacco has been entered in the system through the knowledge acquisition module and stored in text format as well as in decision tree format. The entered knowledge was validated and the expert system was tested for any possible errors or shortcomings. JESS was used to make inter relations with one query to the other with the stored database until a particular variety is selected. The system thus developed has the capability to store and manage extensive information on tobacco varieties. The system assists the client to use ontology based inference for varietal identification based on the stored knowledge.

Results and Discussion

Developing an expert system in a specific knowledge domain is quite a difficult task as it requires team of experienced knowledge engineers, programmers as well as domain experts. Knowledge engineers gather knowledge from domain experts and put it in such a form that system can use for inferring and reasoning using a knowledge representation technique. Programmers then build an online interface so that the end users can use the system over the Internet. Using AGRI daksh tool an online expert system was built for tobacco varieties. The knowledge model in the expert system was created using the information provided by the domain experts (Crop Improvement) of tobacco crop. Values of attributes for each variety of tobacco has been entered in the knowledge model and stored in text format as well as in decision tree format. The system was developed in a way to store and manage extensive information on tobacco varieties. The module thus developed allows the user to enter into question-answer session in text mode leading to identification of tobacco varieties suitable to different areas with their images and yield potentials.

To identify a particular variety through ontology based inference system, the user has to select the ‘Problem Identification’ option from the tobacco agridaksh home page (http://agridaksh.iasri.res.in/tobacco.jsp) followed by ‘Language (English)’ and select module options viz., ‘Pest identification, Disease Diagnosis and Variety selection’(Fig. 2). Proceeding further with ‘Variety selection’, the system will prompt ‘select the crop’ with Maize, Tobacco and Indian mustard options as expert question. After selecting the tobacco crop, the system will display Question-answer history and expert question, “Select the area of adaptation” viz., Andhra Pradesh, Bihar, Karnataka, Gujarat, Orissa, Tamil Nadu and West Bengal. After selecting the area of adaptation, again the system prompts, “Select the type of tobacco” in terms of ‘Flue Cured Virginia’ or Non-Flue cured Virginia’ in case of Andhra Pradesh and

Karnataka and Non-flue cured Virginia in other regions along with Question-answer history. If the user selects 'Flue Cured Virginia (FCV)' in Andhra Pradesh, the system asks the expert question as to select the region for FCV i.e., Northern Light Soil (or) Southern Light Soil (or) Traditional Black Soil and in Karnataka, the system asks the expert question as Karnataka light soils. After selection, the system displays the list of varieties with their name, Average Yield and its photo (Fig. 3). If the user select the type of tobacco as "Non-Flue cured Virginia" then the system asks to choose the type of Non-FCV tobacco viz., Bidi, Burley, Cheroot, Natu, Oriental, chewing, cigar cheroot, cigar wrapper, hookah grown in various states. After selecting the type of non-FCV tobacco grown in a region, the system will identify and display the list of varieties recommended to that region with name and average yield with picture (Fig. 4). Restart button available at each step after select the crop option allows the user to backtrack to select the module option. To retrieve the list of all varieties, the user has to select 'Tobacco Varieties' option in the home page of tobacco agridaksh which displays Variety name, Year of release, State, Productivity and Salient traits (Fig. 5).

Fig.1 N-tier architecture of the system

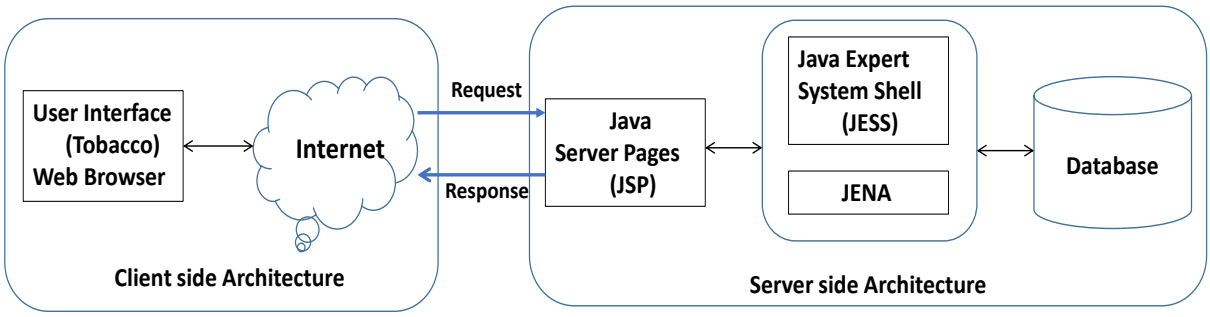


Fig.2 Flow chart for ontology based online expert system for tobacco varieties

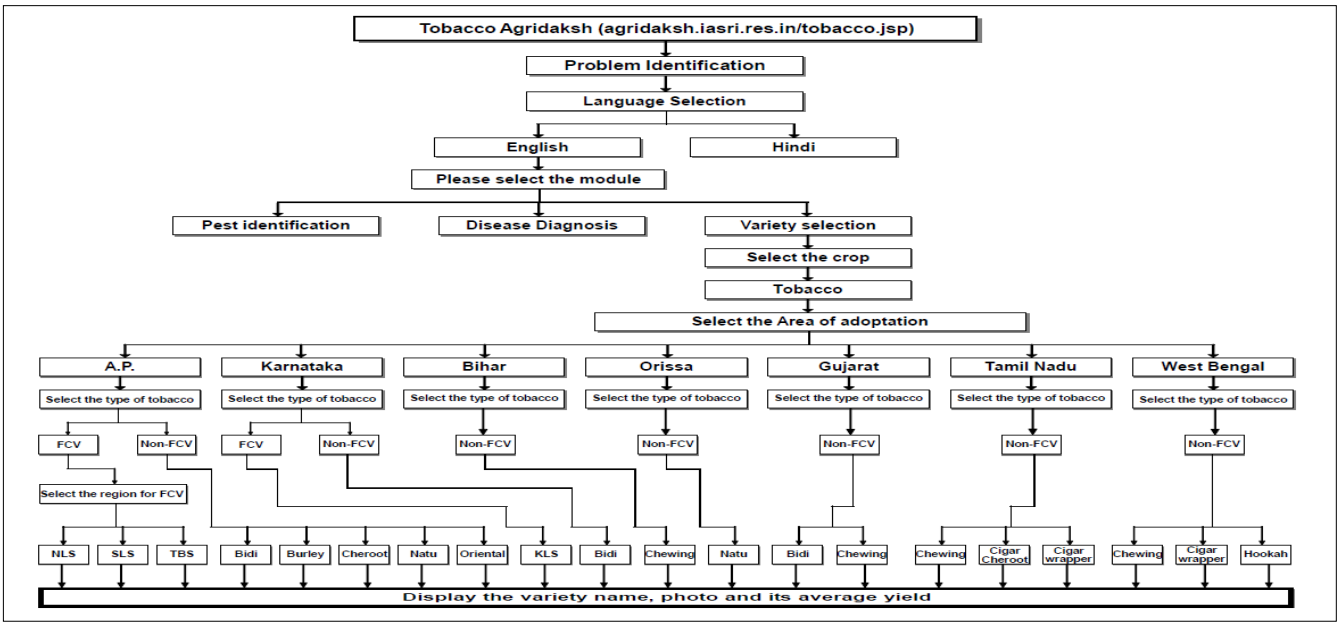


Fig.3 Flow chart for ontology based online expert system for tobacco Varieties through expert system

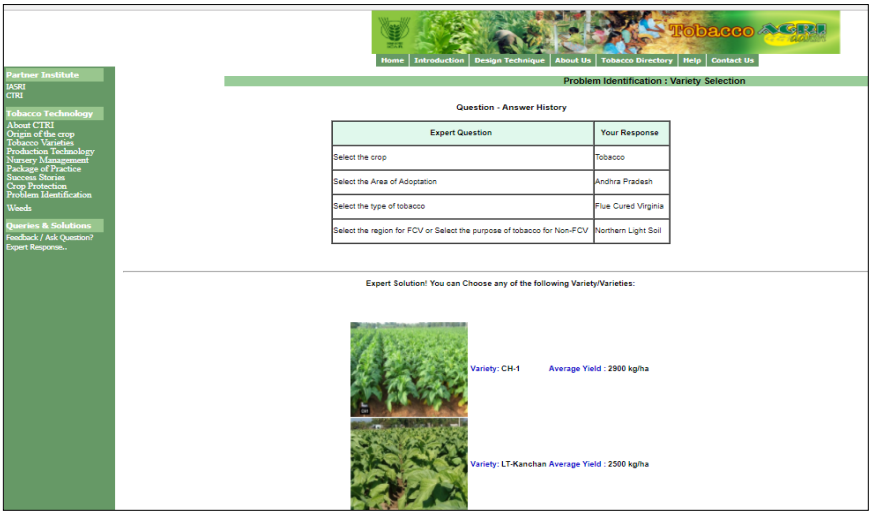
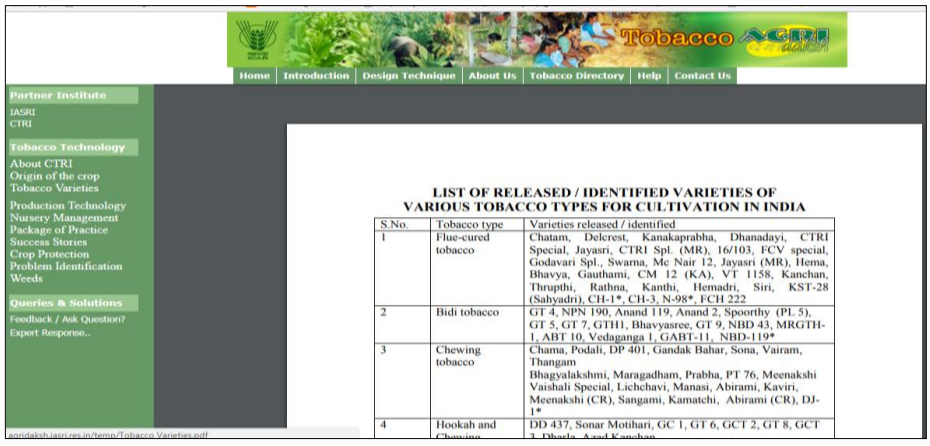


Fig.4 Identification of Natu (Non-FCV) tobacco variety suitable to Orissa through expert system

Fig.5 Tobacco varieties retrieval information through expert system



As part of the AGRI daksh, the tobacco varieties knowledge model assists in providing information to the user at a single point along with all other crops. It is very useful system for speedy dissemination of information, technology, etc to the farmers at global level. The Web technologies allow the knowledge engineers and domain experts to build the expert systems having dynamic knowledgebase capabilities (Marwaha *et al.*, 2002). Ontology is the recent knowledge representation technique that allows the domain experts to code their knowledge in a specific domain. They have the potential to be used in a distributed environment like Internet and provide the dynamic and reusable capability to the knowledgebase. The domain experts can update the knowledge at the central server and the users can access to the recent knowledgebase through a Web interface. A number of expert systems were developed for various crops viz., Maize, Tomato, and Mustard in AGRI daksh.

On-line expert systems are developed on various aspects of Coconut (Ani Dath and Balakrishnan, 2016), MAIZE (Yadav *et al.*, 2012), Tomato (Prasad Babu *et al.*, 2010), Cotton (Wang and Lu, 2008), Wheat (Islam, 2012), Potato (Wharton, 2008) etc. for storing and disseminating location specific information. Stand-alone expert systems developed at ICAR-Central Tobacco Research Institute are helping in the storing, retrieval and dissemination of the information on various aspects of tobacco cultivation (expert systems on tobacco germ plasm (Ravisankar *et al.*, 2012), pests and diseases (Ravisankar *et al.*, 2014a; 2014b) and nutrient deficiencies (Ravisankar *et al.*, 2009).

It is concluded that the web based tobacco varieties expert system developed is an integration of image and textual data. The system can be used by extension personnel, researchers and farmers to identify the tobacco varieties. User can easily identify the variety suitable to any specific region on the bases of question-answer form. This expert system developed for tobacco. This system can be accessed from any location and easily be executed with user-friendly interface for obtaining the required information.

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