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Expert System on Coconut Disease Management and Variety Selection

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Abstract: Knowledge and information on all aspects of coconut disease management and variety selection are the foundations on which integrated disease management and variety selection decisions are made. To improve productivity and overall profitability, the expert system on Coconut disease management was developed to provide the management practices to be followed for getting maximum returns by detecting the disease at an early stage.The practical identification of the suitable varieties for getting high yield of copra or the varieties which are suitable for tender nut purpose, commercial cultivation and to further enhance the productivity and adaptability are the important basis for selection of varieties for getting higher yield. Most of the varieties are documented for their distinct characteristics. An extensive variety selection module is available in the system with a scientific knowledge base in the background. It is concluded that the expert system on variety selection can be used to select the suitable varieties based on the characteristics required by the end user for getting the maximum returns.

I. INTRODUCTION

The cultivation of coconut is distributed in 93 countries in seven continents in the world covering an extent of 12.16 million ha with an annual production of 61.08 billion nuts. Indonesia, Philippines, India and Sri Lanka are the major suppliers of coconut in the world. These countries together account for 79 percent of world production. India accounts for 16.44 per cent in area and 27.04 per cent in the production of coconut in the world. In India, this crop is cultivated in 18 states and 3 Union Territories. Coconut contributes significantly to the GDPs of the states of Tamil Nadu, Karnataka, Andhra Pradesh, Goa and UTs of Lakshadweep, Andaman and Nicobar Islands and Pondicherry. Thus, coconut is eulogized as "Kalpav riksha", which provides food and livelihood-security to more than 10 million people in the country besides guaranteeing employment opportunities to rural poor [1].

The total geographical area of Andaman and Nicobar Islands is 8249 sq. km. of which about 86 per cent of land is under forest and 14 per cent has been cleared for the habitation and agriculture. The Islands have tropical, humid climate with mean rainfall of about 3180 mm per annum. The average mean temperature varies from 23 to 30^0C with over 90 per cent humidity during the rainy season. The Islands receive Southwest monsoon from May to September and Northeast monsoon during October to January. The moderate temperature, high humidity and abundant rainfall provides niche for perpetuation of pest and diseases in these Islands. As the agriculture in these Islands are new most of the pests and diseases are introduced. Due to change in the cultivation practice many of the minor pest and diseases became major[2].The erratic rainfall pattern and excessive humidity create problems for efficient utilization of immense potential of horticultural crops in Islands. In era of commercial and high value agriculture, horticultural crops are front runners for betterment of small and marginal farmers in the Islands. Therefore, utilization of new scientific innovation and intervention in horticultural sector is become imperative for sustainable agricultural development of these fragile Islands. Planting of high yielding varieties and adopting modern production technologies can increase the productivity[3].

II. MATERIALS AND METHODS

One of the most important areas of Artificial Intelligence (AI) is an Expert system. An expert system (ES) known as knowledge based system, is a computer program that uses knowledge and inference procedures to solve problems that are ordinarily solved through human expertise. The main components of an ES are: a) knowledge base, b) inference engine and c) userinterface as shown in (Fig.1). Rules for treatment of disease is present in the IF part and the treatment is present in the THEN part.The inference engine (forward reasoning) is the mechanism through which rules are selected to be fired. It is based on a pattern matching algorithm whose main purpose is to associate the facts (input data) with applicable rules form the rule base [4].

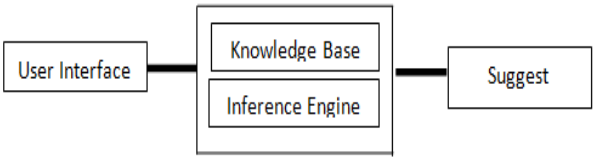

Fig.1 Basic Components Of An Expert System

The main conceptual source of an expert system is knowledge based which can expand to include a knowledge acquisition component that processes data and information into rules. Expert systems has number of application areas like decision making, prediction, planning, monitoring, process control, forecasting and diagnosis etc [5].

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An Expert System makes extensive use of specialized knowledge to solve problems at the level of a human expert. A human expert is a person who has experience in a certain area. That is, the expert has knowledge or special skills that are not known or available to most people. An expert can solve problems that most people cannot solve at all or solve them much more efficiently. The knowledge in Expert System may be either expertise or knowledge that is generally available from books, magazines and knowledgeable persons [6].

A. Rule-Based Expert Systems

Rule-based expert systems have the ability to emulate the decision making ability of human experts. They are designed to solve problems as humans do, by exploiting encoded human knowledge or expertise. This knowledge can be extracted and acquired directly through interaction with humans, as well as from printed and electronic resources such as books, magazines and websites. The extracted knowledge forms the knowledge base of the rule-based system. The other major component of rule-based systems draws conclusions from this knowledge, and is referred to as the inference engine.

The conclusions and suggestions offered by the rule based system satisfy users' needs for expertise within the chosen domain. Rule-based systems are designed to solve problems in a selected domain. Every domain has its own knowledge and reasoning humans, which can be emulated and even replaced through automated rule-based systems. Many domains contain a large amount of knowledge that can be captured fully only through an information system, since humans may not access or immediately retrieve fully the needed information. There are many advantages of rule-based expert systems: They decrease costs since they reduce the need for human experts; they are permanent; they can be used for different knowledge systems, which increases functionality; they increase reliability since they minimize errors that humans are prone to; and if designed by multiple experts, can increase confidence. Finally, they lack human emotions, which are sources of mistakes in human based systems. The advantages of rule-based expert systems are multifold and they can considerably facilitate human life for the better [7]. ASP technology was found to be simple as a template language to create flexible, easy-to maintain web pages. Expert systems derive the power from the extensive knowledge bases which works as its core[8].

B. Expert System on Coconut Disease Management

C. Knowledge Acquisition

To develop a viable system, adequate information on the working of the particular system being developed must be obtained and represented in a format through which the rules can be applied [5]. During the knowledge acquisition, special care was taken to depict the exact symptoms of the disease. The aim of this study is to find out the diseases prevailing in coconut and suggest the management practices for the same.

D. Knowledge Base

The system has been developed using Active Server Pages (ASP) technology and SQL Server. The knowledge base has been developed by extracting information from the published materials i.e.,e manuals, books, research papers, folders, technical bulletins etc. and rules were created to get the exact disease name and its management by storing the rules in the knowledge base. The chaining mechanism used in this system is forward chaining. The expert system gets all facts from the user and chains forward to reach a conclusion. Programme modules are built by using IF-THEN rules, which is part of the inference engines or inference procedures that manipulate and use knowledge in the knowledge base to form a line of reasoning. Forward reasoning is the process of working from a set of 'facts' towards a conclusion that can be drawn from the data. Thus, in the forward reasoning, the expert system produces the conclusion. In the forward reasoning, each potentially applicable rule is examined to see if the premises contained within the rule are true or not [8]. The knowledge base contains symptoms and diagnosis information, as extracted from the published materials and required by the Expert System's algorithm to produce an outcome.

E. Object Oriented Methodology

Object-oriented methodology combines into one object data together with the specific procedures that operate on this data, where the object combines data and program code[10].

F. Classification of the Symptoms

The data collected from the published materials were classified into different objects namely part affected (Table 1). The symptoms related to the parts were assigned for different diseases affecting the coconut palm.

TABLE 1 CLASSIFICATION OF PART AFFECTED

Leaf	Spindle	Young Palm	Crown	Nut	Leaf let
Stem	Bunch	Root	Fruit	Flower	Frond

Rules were created in the knowledge base in the form of IF THEN ELSE. The symptoms were classified into two groups. First group contains the rules related to a single symptom used.

The same can be confirmed by the image of disease and the symptom. Second group contains the rules with symptoms of different objects.

These classes were used to get the correct disease and management practices to be followed along with the images for confirming the disease and symptom. The symptoms that were assigned for different objects are given in (Table 2).

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TABLE 2 PART AFFECTED AND SYMPTOMS

Affected part	Symptoms							
Leaf	L12	L13	L14	L15	L16	L17	L18	L19
Spindle	SP1							
Young Palm	YP1							
Crown	C2	C3	C4					
Nut	N5	N6	N7	N8				
Leaflet	LF5							
Stem	ST2	ST3	ST4					
Bunch	BN2							
Root	R4							
Fruit	F1	F2						
Flower	FL1							
Frond	FN1							

The representation of knowledge in rule based reasoning is given in Rule 1 and Rule 2.

Rule1 shown in (Fig.5)
IF part affected = 'Leaf' AND
Symptom 1 L17 = 'In the mature leaves of the outer whorl, yellow specks encircled by a greying band appear which later turn to greyish white. The spots coalesce into irregular necrotic patches causing extensive leaf blight. When the infection is severe the leaf blade completely dries and shrivels off'

THEN Disease Image1, Symptom Image1
Disease = Leaf blight or Grey Leaf spot disease

Management = 'Cut and remove older affected leaves and spray the foliage with 1% Bordeaux mixture. Leaf blight disease intensity increased with increase in temperature. Disease intensity was high during March-April and found at the low during October -December. A range of 42 to 66 percentage of similarity was observed among the L. theobromae isolates collected from various locations of Tamil Nadu. Remove and destroy the severely affected fronds to avoid further spread. Spraying of 1% Bordeaux mixture or 0.25% copper oxychloride for 2 to 3 times during summer months was effective against leaf blight incidence. Root feeding of Tridemorph 2 ml or Hexaconazole 2 ml or Carbendazim 2g + 100 ml of water/palm thrice at quarterly intervals was effective in reducing the leaf blight disease.

Application of Pseudomonas fluorescens talc formulation @ 200g/ palm/year was effective against leaf blight disease. Application of 1.5kg MOP in addition to the recommended dose is suggested to improve the palm health as well as disease tolerance/resistance against leaf blight disease. Root feeding of P. fluorescens culture suspension @ 25ml/palm at quarterly interval along with soil application of P. fluorescens talc formulation (50g/palm/yr) + Neem cake (5 Kg/palm/yr) was found to be the best against leaf blight disease. A microbial consortia containing the antagonists viz., P. fluorescens Pf1, B. subtilis (kambalapatti) and T. viride (TV1) was developed for the management of leaf blight disease of coconut. 100 ml of water/palm thrice at quarterly intervals was effective in reducing the leaf blight disease. Application of Pseudomonas fluorescens talc formulation @ 200g/ palm/year was effective against leaf blight disease. Application of 1.5kg MOP in addition to the recommended dose is suggested to improve the palm health as well as disease tolerance/resistance against leaf blight disease. Root feeding of P. fluorescens culture suspension @ 25ml/palm at quarterly interval along with soil application of P. fluorescens talc formulation (50g/palm/yr) + Neem cake (5 Kg/palm/yr) was found to be the best against leaf blight disease. A microbial consortia containing the antagonists viz., P. fluorescens Pf1, B. subtilis (kambalapatti) and T. viride (TV1) was developed for the management of leaf blight disease of coconut.'

Rule2 shown in (Fig.6 and Fig.7)
IF part affected = 'Leaf' AND Part affected = 'Leaflet' AND
Symptom1 L13 = 'Flaccidity, the characteristic bending or ribbing of the leaves'
AND
Symptom2 LF5 = 'General yellowing and marginal necrosis of the leaflets are the important visual diagnostic symptoms.'

THEN Disease Image1, Symptom Image1,
Disease = Root (wilt) disease

Management = 'Root (wilt)disease is not lethal, but debilitating in nature. No curative measure has so far been identified against it. The strategy is to contain the disease in its present geographical limits and managing the disease by improving the condition of affected palms and increasing the yield – through proper manuring and other agronomic practices. Eradication of the disease in mildly affected areas by cutting and removal of affected palms. In the heavily disease affected tracts remove all the severely affected uneconomic adult palms (those yielding less than 10 nuts per palm per year) and all diseased palms in the prebearing age. Adopt improved management practices in the affected gardens to enhance the yield of palms. Apply the recommended dose of NPK, 3kg magnesium sulphate and 50 kg organic manure per palm. Organic recycling by following mixed farming system – Raising fodder crops in the interspace and maintaining milch cows and application of farm yard manure to palms. Growing suitable inter and mixed crops. Basin management with green manure crops. Irrigation during summer months. Control of leaf rot disease which is usually noticed in root (wilt) affected palm. Replanting with progenies of disease free palms located in hot spot areas.'

G. Expert System on Coconut Variety Selection

Expert System on coconut variety selection has been developed using Active Server Pages (ASP) technology and SQL Server. One of the major problems of coconut cultivation in Andaman and Nicobar Islands is because of overcrowding of senile and very old palm. Such coconut gardens should be regenerated by replanting with quality seedlings [11]. The selection of proper variety is an important module for the end user for selecting the suitable variety on their choice based on the characteristics selected. The different characteristics for the selection of suitable variety are type of palm, state, suitable for

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commercial cultivation, copra content, early flowering, suitable for tender nut etc. The scripting language is used to develop the inference engine, applying production rules and binding it with the knowledge base. For developing this system the chosen knowledge representation is with simple IF and THEN rules. These rules are normally in the form given as IF <antecedent> THEN <consequent>. Knowledge on varieties and their related characteristics like type, suitable for, bearing, yield, copra, oil, tender nut water and recommended states were acquired from published materials. The knowledge base can be updated by experts. Forward chaining mechanism is used in the system. The two interfaces of the system are the user interface for getting variety details and expert interface for updating information and adding new attributes.

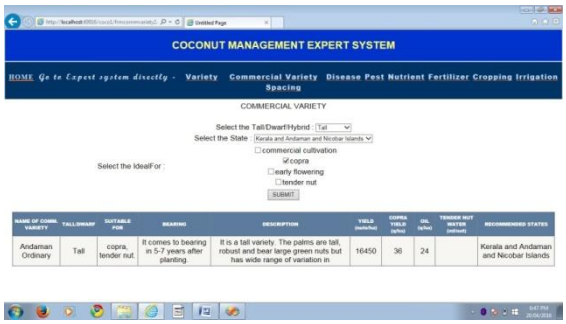

Fig.2 Variety Selection Module

Fig.3 Login for Experts

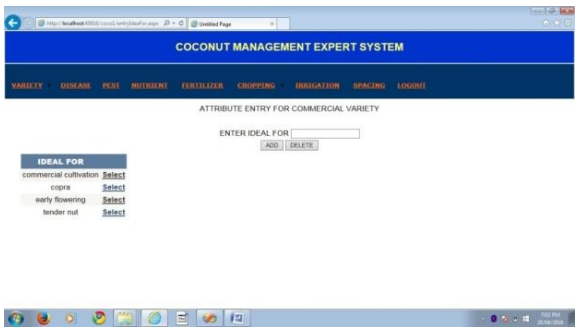

Fig.4Attribute Entry Module for Experts

III. RESULTS AND DISCUSSION

The expert system on coconut disease management provides the management practices to be followed for the different diseases affecting coconut palm such as Bud rot disease, Root (wilt) disease, Leaf rot disease, Stem bleeding disease, Thanjavur wilt/ Ganoderma disease/ Basal Stem Rot / Root rot, Mahali (Fruit rot and nut fall) disease, Leaf blight or Grey Leaf spot disease, Tatipaka disease, Crown Choke disease by selecting the part affected and the symptoms. The system is implemented using Bayesian Networks of uncertainty. It was initially developed by Pearl (1988) [9].

The variety module is characterized into two categories, one for the end user (Fig.2) and the other for the experts. Experts can add new variety details through the login id and password (Fig.3). They can add new attributes for selecting the suitability like commercial cultivation, copra, early flowering and tender nut (Fig.4). The system is developed using ASP.NET and SQL Server. The details of 45 varieties are present in the system.

Fig.5 Input and Output of Rule 1

Fig.6 Input of Rule 2

Fig.7 Input and Output of Rule 2

IV. CONCLUSION

Disease diagnosis and variety selection are the two important modules in the agriculture sector due to its impact on the agriculture production. An Expert System is a system that employs human knowledge captured in a computer to solve problems that ordinarily require human expertise. The expert system on coconut disease management can be used to increase the production by timely detection of disease and by following the integrated disease management practices. The different characteristics for the selection of suitable variety are type

of palm, state, suitable for commercial cultivation, copra content, early flowering, suitable for tender nut etc. Expert system on variety selection provides the end user the ease of identification of suitable varieties based on their input.

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