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Application of Expert System in the field of Horticulture

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ABSTRACT

This paper suggests the application of Expert System (ES) in the field of horticulture. Expert Systems are intelligent encoded domain specific expert's computer program solutions. Generalized computerized farm management and Expert System have good scope for managing and coordinating optimal production in agriculture. Horticultural crops, by improving the income in the rural areas, play a unique role in Indian economy. Though these crops hardly occupy 7% of the area and they contribute over 18% to the GDP in the country. Litchi is one of them and is called the Queen of the fruits which play a significant role in our national economy. Horticultural crops are affected by insect-pests and diseases causing destruction if mismanaged .It is therefore essential that the identification of pests, diseases and disorders and application of suitable remedies .For this purpose, application of ES in the management of horticultural crops can helpful for minimizing losses and thereby increase productivity.

Keywords: expert system; horticulture; knowledge base; agro-clinics.

1. INTRODUCTION

This is an era of expert skill, wherein every domain relevant expertise is desired. The major problem is scarcity of real experts in a particular field, if available then there may be a problem of inaccessibility. Consultation may be expensive and the expert may feel the repetitive job uninteresting, which may affect efficiency. The other major problem faced by experts is the memory limitation affecting processing of essential knowledge and information required for decision-making. Researches and developments in every discipline render relevant and accurate advice available from updated experts, which is not an easy task. Experts are subject to limitations and it is impossible to access all the essential factors, while taking decisions. Some factors are always missed and unconsidered. This necessitates computer based tools for assistance, like Decision support system, Decision making system or Expert system to update knowledge and render help in making decisions. In this respect, ES has been a very useful tool. ESs of today support problem solving activities such as decision making, knowledge fusing, designing and planning, forecasting, regulating, controlling, monitoring, identifying, diagnosing, prescribing, interpreting, explaining or training using different techniques, while future expert systems will support many more activities. In the beginning, Expert Systems were developed by the end of 1970s and were operating in the medicine, chemical, education, natural resources and science. ES started to gain popularity in the early 1980s. The announcement of successful

operational systems like PROSPECTOR, a natural resources system that evaluates geographic sites for potential mineral deposits of commercial interest [1], and MYCIN, a medical consulting system [2], were catalytic to technology. The availability of powerful tools has created large number of expert systems in general and particularly for natural resource management (orchard management). ES developed as the first commercial product of artificial intelligence (AI) and is now available in Physics, Chemistry, Geology, Electronics, Agriculture, Medical and Military applications. In the developing countries like India, the farm management practices are traditional and non-scientific. However, in the developed countries the modern agricultural and horticultural practices have evolved into a complex business. Thus, for the application of technology from the researchers to farmers, the roles of computer-based farm management and precision agriculture have evolved. Computer-based farm management in general and Expert System (ES) in particular hold very good scope for managing and coordinating the knowledge for optimal production in every sub-area of agriculture.

2. Brief description of horticultural crop 'Litchi'

Horticultural crops play a major role in Indian economy by improving the income of the rural people. Cultivation of crops requires labor generating employment opportunities for the rural population. Fruits and vegetables are also rich source of vitamins, minerals, proteins, and carbohydrates, referred to as protective foods and assumes importance as a nutritional security. Cultivation of horticultural crops plays a vital role in the prosperity of a nation and is directly linked with the health and happiness of the people. It is estimated that all the horticulture crops put together cover nearly 11-6 million hectares area with an annual production of 91 million tons. Though these crops occupy hardly 7% of the area and they contribute over 18% to the GDP in the country. India with more than 28.2 million tons of fruits and 66 million tons of vegetables is the second largest producer in the world, next only to Brazil and China. With the present population level, the annual requirement of fruits and vegetables will be of the order of 32.58 million tons and 83 million tons respectively. However, per capita consumption of fruits and vegetables in India is only around 46 kg and 130 g [Minimum of about 92 g and 300 g recommended by Indian Council of Medical Research (ICMR) and National Institute of Nutrition (NIN), Hyderabad]. In different agro climatic zones of India, various fruits are grown. Litchi is one of them and is called the Queen of the fruits which play a significant role in our national economy. Litchi (*Litchi chinensis Sonn*.) is one of the most important evergreen subtropical fruit known for its fragrance and quality aril. It is an important commercial fruit crop with tremendous export potential. India is the second largest producer of litchi in the world after China. The total production of litchi in India is 4, 33,000 tons from an area of 60,000 ha and productivity level is 7.4 t/ha [3]. The other important growing countries are China, Taiwan, Thailand, Vietnam, Brazil, Malaysia, Myanmar, Mauritius, South Africa, Australia, New Zealand, Madagascar and USA. The area, production and productivity (2002-03) of litchi at global level have been given in table 1.

Table 1: Global production of litchi

Country	Area (ha)	Production (tonnes)	Productivity (t/ha)
China	5,88,000	1,280,000	2.18
Taiwan	12,000	108,000	9.00
Vietnam	30,000	50,000	1.70
Thailand	23,000	81,000	3.50
India	56,200	4,29,000	7.70
Bangladesh	4,800	12,800	2.70
Nepal	2,300	14,000	6.10
South Africa	1,500	8,000	5.30
Madagascar	3,000	20,000	6.67
Israel	300	2,000	6.67
Australia	1,500	5,000	3.33
USA	240	1,000	4.20
Mauritius	1,000	12,000	12.00
Brazil	350	2,120	

In India, commercial cultivation of litchi is restricted in northern part, particularly in foothills of the Himalayas from Tripura to Jammu & Kashmir and Gangetic plains. The major litchi growing states are Bihar, West

Bengal, Uttrakhand, Jharkhand, Assam, Tripura, Orissa and Punjab. Bihar produces 75% of total litchi production of the country and occupies nearly 54% of the area under litchi plantation. State-wise area, production and productivity of litchi (2004-05) in India have been given in table 2.

Table 2: State-wise production of litchi in India

State	Area ('000 ha)	Production ('000tonnes)	Productivity (t/ha)
Bihar	28.4	284.9	10.0
West Bengal	7.2	69.9	9.8
Assam	4.5	22.5	5.0
Jharkhand	1.4	16.5	12.0
Tripura	2.2	12.4	5.6
Punjab	1.3	12.6	10.0
Orissa	3.9	11.9	3.0
Uttrakhand	6.7	8.9	1.3
Himachal Pradesh	3.4	3.6	1.1
Chhattishgarh	0.5	3.4	7.0
Haryana	0.2	1.0	6.2
Others	0.5	1.0	2.0
Total	**60.2**	**448.6**	**7.4**

In India, there are large numbers of varieties (approximately 52 cultivars) grown in different parts under different climates and soil conditions. Approximately 90% of the produce utilized as fresh at various stages and post harvest losses exceed 30% sometimes followed by market glut. Litchi plants and fruits are also affected by insect-pests and diseases, which cause considerable losses, if not properly managed.

In general, litchi plants are least affected by diseases but fruits are prone to certain diseases and disorder if not managed properly. So, proper management of litchi orchard can be helpful to increase total production as well as minimizing losses.

3. Expert System

Expert Systems (ES) are intelligent computer program encoded, domain specific knowledge and reasoning of experts to produce solution. ES derived its knowledge from experts, supported by literature on application. ES differs from conventional computer program in many ways: uses knowledge rather than data for controlling solutions. Knowledge is encoded as an entity separate from the control of the program, it is capable of explaining how and why a particular solution is obtained, it uses symbolic representation for knowledge (rules, semantic nets or frames), it often reasons with meta knowledge i.e., knowledge about itself and has self learning capabilities.

The rule-based expert system has five components: (i) the knowledge base, (ii) the database, (iii) the inference engine, (iv) the explanation facilities, and (v) the user interface. The basic components of rule-based expert system are shown in fig.1.

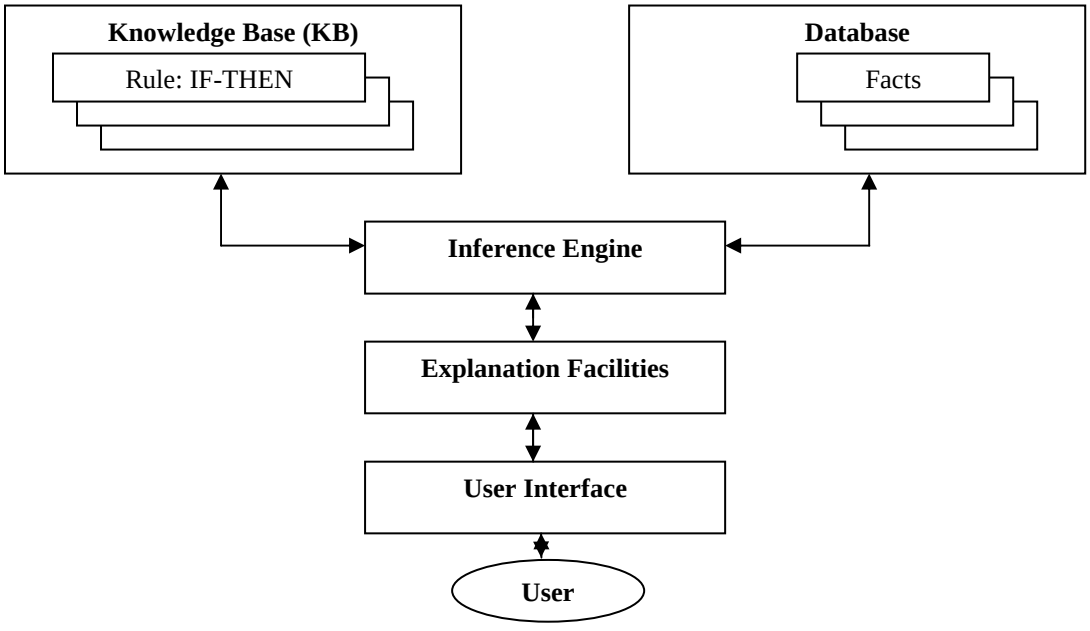

Fig.1 Components of Expert System and User interface

The expert system developed in the Prolog programming language functions as an inference engine [4] in the backward chaining.

(i) Knowledge Base: It is a declarative representation of the expertise, often in IF-THEN rules including such things as simple facts about the domain, rules or constraints that describe relation or phenomena in the domain, and possibly also methods, heuristics and ideas for solving problems in this domain.

(ii) Database: It is the data or a set of facts which is specific to a problem being solved used to match against the IF (condition) parts of the rules stored in the knowledge base.

(iii) Inference Engine: It carries out the reasoning by interplaying the information or facts obtained from the user with the knowledge stored in the knowledge base whereby the expert system reaches a solution.

(iv) Explanation Facilities: It explains about how a particular conclusion is reached and why a specific fact is needed and also explains its reasoning and justifies its advice, analysis or conclusion.

(v) User Interface: It provides communication between the user and expert system.

4. Application of the Expert System in horticulture

The agricultural practices as performed by farmers are traditionally based and non-scientific. Computer based general farm management and Expert System can be helpful in providing solutions to the problems in horticulture. ES can provide a comprehensive management of orchards. It can help in disease, pest and disorder management of plants. Since, plants and fruits are affected by insect-pests and diseases, which cause considerable loss, if not properly managed. So, proper management of orchard for diagnostic purposes can be helpful to increase total production and minimizing losses. Computer based general support and ES can be helpful in creating awareness and giving timely preventive suggestions. It can also help in insect identification, monitoring, insecticide selection, and disease management. It can be cost effective; as users need not wait for experts. By repeated consultations, farmers can develop self-skill and awareness for care-taking and ES can become advisory-cum-training tools. The transfer of knowledge from consultants, scientists, researchers and experts to extension workers in any area is very important for the development of agriculture and horticulture. The ES technology provides a good platform to facilitate the transfer of knowledge from expert to extension workers or farmers. The ES technology in the area of horticulture has been developed especially related with decision-making, pests, diseases, or disorders diagnosis. Some of the Expert Systems developed for the horticulture applications are: CUPTEX- for cucumber crop production [5], TOMATEX- for tomatoes [6], CITEX- for orange production [7], LIMEX- for lime production [8], PLANT/ds- for the disease diagnosis among Soyabean [9], AMRAPALIKA- for the diagnosis of pests, diseases, and disorders in Indian mango [10], POMME for apple orchard management [11], CITPATH- a rule based system for the citrus plant and it provides hypertext-linked descriptions and graphic displays of symptoms [12], NERISK- for the evaluation of effects of pesticide applications [13], HAZLPEST- for insect and disease pest management on hazelnuts (*Corylus avellana L.*) [14], PCEST for pest control in Tomato [15], PROPA- to solve disease, nutrition, insect and other problems related to papaya management [16], DIANA- for the diagnosis of disease, disorders, pest and environmental stresses in the pineapple [17], GRAPEX- for grapes management [18], CIT Xpert- for disease diagnosis of citrus [19], CALEX/Peaches- It is a rule (containing 600 rules) based diagnostic expert system for the diagnosis of peach and nectarine disorders (120) in California [20] /Other ES for peach and nectar cultivar is described in [21], and POMI- An ES for integrated pest management of apple orchard [22].

The application of the ES in the area of horticulture is well justified and many developed

countries have developed the expert system for their use. Although adoption of this technology in Indian agricultural practices is rather slow in comparison to developed countries, Indian farmers felt the need for such technology to increase agricultural productivity. Since, signs and symptoms of the pests, diseases and disorders have due geographical variations, expert system developed for a particular climatic and geographical region does not apply to different geographical region. Therefore, it is necessary to develop a new one or modify the existing system for that particular geographical region. Since, the concept of ES technology in agriculture has enough potential to revolutionize the agricultural practices, its use in India is urgently needed to enhance the productivity. ES can also help in finding nutrient status using visual symptoms in the plant and use of proper fertilizers in order to control the nutrient disorders and preventing damage to that tree. The information provided by farmers during consultation can be used to develop database of specific orchard for region-specific agricultural practices and problems. Such database will become valuable research resources in the future. In the modern days the concept of agro-clinic has come into practice as shown in fig 2. Such clinics are being established near the agricultural land in the rural areas. Obviously farmers will seek these clinics to get solutions for problems encountered. For this purpose, ES can also be installed for consultation in local agro-clinics or like ATM machines where farmers can have direct access. The person managing this clinic will need expert knowledge to help farmers. Under such conditions, ES will be highly useful and will attract farmers to these clinics. The ES available at agro clinics in remote area can be linked with central remote sensing center to make predictions about disease spread and weather conditions, enabling advance planning in care-taking of orchards. Such scheme will be highly helpful in alerting farmers in rural area for taking preventive steps to save crops in adverse weather conditions.

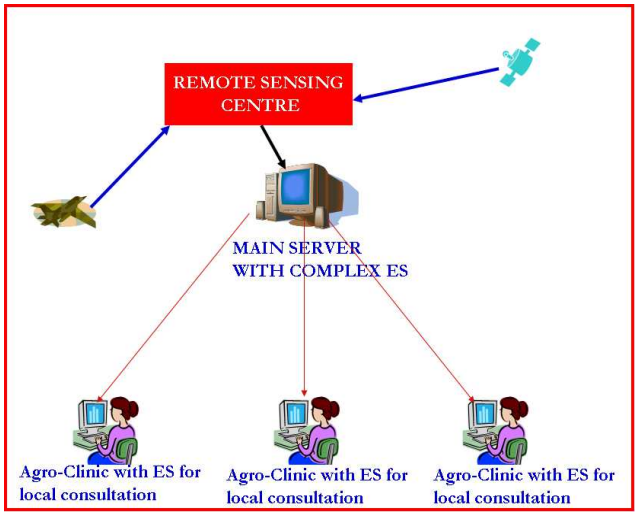

Fig 2. Role of ES in agro-clinics

5. CONCLUSION

In this paper, the application of expert system in the field of horticulture has been emphasized and justified. The production scenario of horticultural crop 'litchi' has been discussed in brief. ES and their structure have been presented along with different expert systems developed for the care taking of different fruits. The application of ES technology in horticulture has enough potential to revolutionize agricultural practices, and its use in India is urgently needed to enhance productivity. ES can also help in judging nutrient status, using visual symptoms in the plant and selection of proper fertilizers to control the nutrient disorders, preventing damage to that tree. In this way application of ES through agro-clinics, akin to ATM machines can be very useful for the grass-root worker.

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