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AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

By

S.HELEN
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THESIS

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DECLARATION

I hereby declare that the thesis entitled **"Agricultural Expert System – A participatory assessment"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associate ship, fellowship, or other similar title, of any other university or society.

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CERTIFICATE

Certified that the thesis entitled **"Agricultural Expert System – A participatory assessment"** is a record of research work done independently by Mrs. S. Helen (2003-21-09) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, associate ship or fellowship to her.

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CHAPTER I

INTRODUCTION

India is a large country with inherent geographic, ecological and cultural diversity, making information dissemination and communication a challenging task. Vastness and diversity of our agriculture is reflected by the fact that it caters to incredibly diverse habits and practices of almost 70 crores of our agrarian population, living in six lakh villages, cultivating 143 million hectare of land broadly demarcated into 20 agro-climatic zones and harnessing 2.02 million km^2 of Exclusive Economic Zone spread around 8,129 km long tropical coastline (Jain, 2003). The new World Economic Order and globalization of markets calls for prompt and efficient infrastructure, better resource management and competitiveness of existing agricultural production systems. Quick access to information at global level through electronic media thus provides the way to tackle future challenges of Indian Agriculture.

Need for sustainable development of agriculture has posed new challenges not only to development of farm technology but also to quick dissemination and extension of agricultural technology to the farmer's fields. To meet new challenges and opportunities, the knowledge and information has become one of the most critical inputs to agriculture in addition to soil, seed, water, fertilizer, pesticides, farm implements etc. Access to knowledge and information about agricultural prices, weather forecast, inputs, right farm practices, reliable research recommendations etc. have become essential for improving agricultural productivity and farm profitability while protecting fragile natural resources. Current system of extension is not able to deliver the desired services either on a regular basis or with the required intensity. Therefore, a Research Dissemination or Technology Transfer and Management System has become absolutely necessary to manage the transferable technology coming out of the research system and value added services.

Background

The overall development of rural areas is taking new prospects. Transformation of traditional societies to knowledge societies has been increasingly felt all over the world. The report of the "Task Force on India as Knowledge Super Power, 2001" emphasized the need for developing the capacity to generate, absorb, disseminate and protect knowledge as a powerful tool to drive societal transformation. The background report of "Working Group on Information Technology for the Masses, 2003", declared that "it is the firm view of the government that if any technology can create new opportunities to bridge the gap between information haves and have-nots in the present times, it is Information Technology". Information and communication technology can play a spectacular role in societal transformation to realize the concept of 'knowledge society'.

The development of concepts like precision farming and system intensification emphasizes the need to provide intensive knowledge to farmers. The information provided should be demand driven and relevant to the day -to –day life of the rural mass. In the era of globalisation and technologies on knowledge intensive precision farming, our farmers must be more competitive in agricultural production (Swaminathan, 2003). Reducing knowledge gaps and increasing knowledge sharing for farmers is an essential step for increasing productivity and boosting growth in rural areas. A holistic view must guide the creation and supply of information (Hussain, 2002). Setting up of 'rural knowledge banks" with a network of computers in various clusters of villages would form the foundation of a meaningful holistic rural extension system (Venkataramani, 2004).

Owing to new challenges and increased global competition in agriculture, the farm holders tend to venture in diversification, value addition, and integrated farm approaches with risk minimization. This increases their demand for acquiring diversified and up-to-date agricultural technical knowledge. But information inadequacy at the grass roots level constrains wider technology uptake and marketability of commodities in globally competitive markets. The use of

Information and Communication Technology (ICT) has emerged as an important option for the farmers and stakeholders in National Agricultural Research System (NARS). ICT offers tremendous potentialities in information delivery and sharing. The World Bank Report entitled "India and the Knowledge Economy: Leveraging Strengths and Opportunities" recommended that the government should promote the application and use of ICTs throughout the economy to raise productivity and growth. National Knowledge Commission of India constituted on August 2, 2005 also has emphasized this view. National Commission on Farmers has suggested establishment of rural knowledge centers. In India, various public and private and non-governmental organizations have initiated ICT-based initiatives but these are isolated efforts. Knowledge - powered rural development is an essential need for transforming India into a knowledge super power (Kalam, 2004).

Cyber Extension

Cyber Extension can be defined as the 'Extension over Cyber Space'. In the applied context of Agriculture, Cyber Extension means 'using the power of online networks, computer communications and digital interactive multimedia to facilitate dissemination of agricultural technology'. Cyber Extension includes effective use of Information and Communication technology, national and international information Networks, Internet, Expert Systems, Multimedia Learning Systems and Computer based training systems to improve information access to the farmers, extension personnel and scientists.

Cyber Extension will add more interactivity, speed of reaching the message and two-way communication. It will add to wider target group broadening the scope of extension. It also improves quality of providing information and minimizing cost and time. A change in the whole method of extension in coming decade was expected by reducing the dependency on so many actors in the chain of extension system (Sharma, 2005). The continuing rapid development of telecommunications and computer-based information technology (IT) is probably the biggest factor for change in extension, which will facilitate and reinforce other changes. There are many possibilities for the potential applications of the technology in agricultural extension (FAO, 1993; Zijp, 1994). Information Technology will bring new information services to rural areas that farmers, as users, have much greater control over current information channels. Even if every farmer did not have a computer terminal, these could become readily available at local information resource centres, with computers carrying expert systems to help farmers to make decisions. However, it would not make extension worker redundant. Rather, they would be able to concentrate on tasks and services where human interaction was essential – in helping farmers individually and in small groups to diagnose problems, to interpret data, and to apply their meaning (Leeuwis, 1993).

Need for agricultural expert systems

There is a need to develop national databases on scientific and technical information related to various agricultural technologies; crops; animal husbandry; fisheries; natural resources; genetic resources; mechanization and agro-processing; agro-climatic conditions; economic and social indicators and results of previous and current researches at both national and international levels. Development of these databases, expert systems and Decision Support Systems (DSS) is a backbone to a successful Management Information System.

Agriculture is the main occupation and way of life for nearly fifty per cent of Indian population. Sustainable agricultural development holds the key for improving the overall human resource development scenario in the country. Indian Agriculture had been on traditional lines till the first waves of Green Revolution in late 60's. The Green Revolution gave a sudden boost to the production and productivity of major cereals in the assured irrigated areas. Speedy dissemination of technological information from the Agricultural Research System to the farmers in the field, reporting of farmers' feedback to the research system and thereby reducing the gap between research and client system are the main functions of any Extension system.

The information and communication support during the last fifty years has mainly been conventional. The extension personnel of the Department of Agriculture disseminated the technological messages to the farmers manually. This approach has not been able to reach majority of the farmers who are spread across the whole country. Shekara (2003) indicated that not more than 25-40 per cent of the technology was transferred, leaving a wide extension gap. This gap remains a challenge for the extension system even today. To reach over 110 million farmers, spread over 500 districts and over 6000 blocks is an up hill task. The diversity of agro-ecological situations adds to this challenge further. The success of Green Revolution was mainly achieved due to concerted homogeneous extension approach for the assured irrigated areas. Now as we move to address the needs of rainfed eco-systems, the extension strategy becomes more complex. Farmers' needs are much more diversified and the knowledge required to address them is beyond the capacity of the grass root level extension functionaries.

Today, it is possible to find a solution to this situation by using the potential of Information and Communication Technologies (ICT) to meet the location specific information needs of the farmers. The information and communication networks are expanding very fast. The number of internet connections in India has crossed the two million mark and the number of telephone connections is over 22 million. The Internet connectivity has touched almost all the districts in the country and is moving down to the block and panchyat levels.

In agriculture itself, there are several areas of specialization. As users of a technology, relevant expertise is needed to solve a particular problem or to take a suitable decision. The major problems in accessing a human expert in a particular subject area are non-availability or scarcity of experts. Even if the human expert is available, there may be problem of access for common people to contact the expert. Consultation may be very expensive and the human expert may feel the repetitive job uninteresting. This in turn may affect expert's efficiency. The other major problems that are being faced by the human expert are the problems of physical mobility and limitation of his memory and processing inability of all the essential knowledge required in the process of decision-making.

As a result of research and developments, new knowledge in enormous amount is being added in every discipline day by day and thus more relevant and accurate advice can be taken from a human expert if his own knowledge is being updated regularly, which is not an easy task. Human experts are bounded by limitations and it is quite difficult for a human expert to consider all the essential factors while taking decision. Thus, some tool or assistance is needed even for an expert to update his knowledge and get help in decision-making process. The advancements made in the discipline of Artificial Intelligence (AI) have tackled the problems related to mental and intellectual processes of the people. Gradual advancements in this discipline have enhanced cognitive capabilities of users. Researchers of AI have been trying to produce systems that can behave like an intelligent human being. In course of such development, researchers and other related resource persons realized the importance of human expertise in a particular field and tried to encode and assimilate the knowledge and experience of human experts in computer that led to the notion of development of expert systems in different domains.

An expert system is a computer-based program that uses knowledge, facts and different reasoning techniques to solve problems that normally require the abilities of human experts. The expert systems are based on the concept of artificial intelligence in which the experience and knowledge of human experts are captured in the form of IF-THEN rules and facts, to solve the field problems (Rao, 2003). The program asks series of questions about the concerned problem and gives appropriate advice based on its store of knowledge. The knowledge, which the expert system use is made up of either rules or experience information about the behavior of elements of a particular subject domain. Such systems can be designed for specific hardware and software configurations, or they can be software systems that are designed to run on a computer. The dissemination of these technologies could be enhanced by using expert systems and other artificial intelligence technologies (Hadi *et al*, 2006).

Expert system started to gain popularity in the early 1980s. Expert systems of today support many problem-solving activities such as decision making, knowledge fusing, designing, and planning, forecasting, regulating, controlling, monitoring, identifying, diagnosing, prescribing, interpreting, explaining, training etc. using different techniques and it was expected that future expert systems would support even more activities (Prasad and Sinha, 2003).

Statement of the problem

It is known that many Agricultural Research Institutes are involved in the development of Agricultural Expert System (AES) to satisfy the information needs of stakeholders, viz; researchers, extension personnel, farmers etc. The researchers who are involved in developing AES (Agricultural Expert System-hereafter Agricultural Expert System is mentioned as AES, as used by Liping, 2003.) conduct validation studies to ensure the precision of knowledge base provided in the system. Whereas the research studies at the users' level in assessing the performance of AES are limited, socio-personal factors responsible for utilization of AES among the users are mostly a forgotten area. Many farmers were ready to adopt computer technology by the way in which farmers assess new technology and make decision about their farming businesses (Hamilton *et al.*, 1991).

Kerala is one of the leading states in the country in the field of literacy. It is also a pioneer in implementing ICT projects. Among the ICT initiatives, Akshya and *Karshaka Information Systems Services And Networking* (KISSAN), Kerala are the important projects related to agriculture and rural development. The institutes under Indian Council of Agriculture Research, State Agricultural Universities and few commodity boards are involved in developing full database of their respective area of interest and AESs. There are chances of introducing these databases and AESs for the use by potential clients. Kerala Agricultural University developed an AES for diagnosing pests and diseases of nine major crops of Kerala called 'DIAGNOS-4' which has drawn tremendous attraction from extension personnel. The modified version of it is likely to be released shortly for the benefit of all the stakeholders involved in agricultural development. It is proposed to install this system in the prospective information kiosks in the Krishi Bhavans and launch a version in KAU web site.

A number of questions can be raised before the launch of the AES. What are the present ways of transferring agricultural technologies to the users? What are the expectations of the researchers involved in developing AES? What are the perceptions of agricultural researchers involved in transfer of technology about the performance of AES in the present situation? What are the experiences of the extension personnel and farmers after using AES? What are the information efficiency and the problem solving capacity of the proposed system? Whether the system will satisfy the information needs of all the stakeholders involved in agricultural development? In the absence of a human expert, how far the AES satisfies the information requirements of prospective users? What are the factors influencing prospective users in AES? Few studies address these issues at the prospective users' level. In the context of Kerala, 'DIAGNOS-4' is going to be the first AES introduced with suitable modifications in wider perspective for the benefit of the stakeholders in agricultural development. This formal study will be the first of its kind in assessing the performance of AES and potential of AES among the users in the state.

Objectives of the study

With this background a fundamental objective was formed to explore the possibilities of functioning of Agricultural Expert System (AES) under the existing extension system in the special context of transfer of technology. To achieve the fundamental objective, following specific objectives were framed:

1. To make an appraisal of the AES available in India.

2.To probe the cognitive and connotative domains of potential users in using AES.

3. To identify the factors influencing the potential users in using AES.

4. To analyze the information efficiency and problem solving capacity of AES.

5. To conduct a case study on the applications of AES.

Scope of the study

Whether an expert system achieves success may be determined by the nature of its user interface. This is the part of the expert system that interacts with the user. Even the most powerful expert system will not be applied if it requires too much effort on the part of the user. For this reason, it is important to make the computer as easy for the user to operate as possible. Almost all modern software programs offer the capacity to interact with the user through text, graphics and animation. AES is developed for offering fingertip solutions to the users, which may enable them to take appropriate decisions in the absence of human experts.

This study would identify whether the intention of developing AES is met at the prospective users' point of view. Before the formal release of the system, it is more appropriate to conduct an assessment by the potential users so that suitable modifications can be made to make it more user friendly. Probably this is a pioneering effort giving much thrust on the perception of all the stakeholders involved in agricultural development as prospective users of AES. In future, AES is going to be an important extension tool in transfer of technology. Assessment of this tool from the different perspectives of all the stakeholders would enable the researchers to strengthen the system with more appropriate package of information, making it more user friendly.

The findings of the study would reveal the efficiency of the AES in terms of providing real time information and solutions to the field problems for making decisions by the prospective users in the absence of human experts. The results of the study would bring out the socio-personal factors of potential users, underlying the possibilities of functioning AES under the existing extension system. The study would make pioneering contribution of users' level assessment of an important tool of cyber extension in the transfer of technology in the coming years.

Limitations of the study

Several institutions are engaged in developing Agricultural Expert Systems in different subject areas with different kinds of programs. As the developments in the field of Information Technology are very faster, the programs used in the development of AES are also changing very fast and hence users are forced to tune themselves to learn the use of newer packages. Since the research at users' level is the neglected area, scarcity of literature related to the study was felt by the researcher.

The present study was undertaken as part of the doctoral degree programme of the student researcher. There was a constraint of time for the research that limited more in depth analyses. Again a part of the research was experimental in nature, the study was restricted to only one district, Palakkad out of fourteen districts in Kerala. Therefore findings have to be viewed in the specific situations prevailing in the area and generalisations are to be made carefully.

Since the investigation was completely based on the expressed responses of the researchers, extension personnel and farmers involved in agriculture sector, it may not be free from their personal biases and prejudices towards the AES. However, careful and systematic procedures have been adopted to carry out the research as objectively and precisely as possible.

Presentation of the thesis

The report of the research programme is presented in six chapters. The first chapter deals with introduction highlighting the importance, objectives, scope and limitations of the study. The second chapter covers the review of literature pertaining to the objectives of the study. The third chapter is the methodology followed in executing the research programme. The fourth chapter deals with the results and discussion of the study. The fifth chapter includes summary, implications and conclusion of the study. References, appendices and abstract are furnished at the end.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

The objective of this chapter is to establish the theoretical framework for the study based on ideas and concepts gathered from review of existing literature of both theoretical and empirical nature. As research studies directly pertaining to the assessment of AES at the users' level were not available, the review of the literature on related aspects of assessment was made. The review of literature is organized and presented under the following subheadings, keeping the objectives of the study in mind:

2.1. Concepts on AES

2.2. History of AES development in other countries

2.3. History of AES development in India

2.4. Cognitive and connotative domains of users

2.5. Factors influencing potential users

2.6. Applications of AES

2.7. Comparison of AES with human experts

2.8. Suggestions for improving AES

2.1. Concepts on Agricultural Expert System

Feigenbaum (1982) explained that AES was an intelligent computer program that used knowledge and inference procedures to solve problems that was difficult enough to acquire significant human expertise for their solutions.

Wiig (1991) defined expert system as knowledge based computer program containing expert domain knowledge about objects, events, situations, and courses of action, which emulated the reasoning process of human experts in the particular domain. The components of an expert system were: (*a*) knowledge base; (*b*) inference engine; and (*c*) user interface.

Durkin (1994) defined expert system as a computer program designed to model the problem solving ability of a human expert.

Wai *et al.* (2000) clearly pointed out that expert system as a computer application that solved complicated problems that would otherwise require extensive human expertise. To do so, it stimulated the human reasoning process by applying specific knowledge and interfaces. Expert systems used human knowledge to solve problem that normally would require human intelligence.

Turban and Aronson (2001) conceptualized agricultural expert system as a system that used human knowledge captured in a computer to solve problems that ordinarily require human expertise.

According to Sibon (2002), the expert system was a branch of artificial intelligence (AI), which was widely used as decision-making tools in a wide range of businesses including agriculture. This innovative information technology tool was an intelligent computer programme that made extensive use of specialized knowledge to solve problems at the level of human experts.

Liping (2003) explained that AES was a branch of the artificial intellectual faculty, which was to solve some problems that could be solved by means of special knowledge. It was said that the expert system was one kind of computer system that could solve the problems through imitating the experts' ability in making a strategic decision.

Rao (2003) defined that the expert systems were based on the concept of artificial intelligence in which the experience and knowledge of human experts were captured in the form of IF-THEN rules and facts, to solve the field problems.

Cheng-gang *et al.* (2004) mentioned that expert system was a system by using the knowledge and mathematics model, through the analysis and imitation of computer, to solve the complex problem. It was a system for the dialogue between computer and human being. Expert system was a computer system based on knowledge, and could solve the practical, complex problem in some special field, just like human expert. It was a computer software system that had special knowledge, and could use the knowledge to detect, judge and solve practical problems. An ideal expert system composed of seven parts; they were language treatment program, knowledge bank, data bank, explanation program, dispatching program, coordinative and statement program.

Rajotte *et al.* (2005) commented that agricultural expert systems were tools for agricultural management since they could provide the site-specific, integrated and interpreted advice that farmers and consultants need to more efficiently manage agricultural concerns.

It may be generalized from the above review of literature that Agricultural Expert system (AES) is a computer-aided software designed to solve field problems in agriculture based on the concept of artificial intelligence. The experience and expertise of human experts are captured and stored in computer which can be retrieved and utilized in the problem situation. For the sake of convenience and improve the user friendliness of the software, various developments in the programmes were noticed.

2.2. History of AES development in other countries

Kurata *et al.* (1989) described Expert Systems for farm machinery, troubleshooting and farm work scheduling. The farm machinery program collected information about problems in machinery operation and provided a scheduling system for sending a technician to the farm, depending on the diagnosis. The work scheduling Expert System consisted of long, middle and short term scheduling programs for field operations. The number of working days for each farm, progress of operations, materials to use and requirements for a specific day's operation were some of the questions answered.

Morgan *et al.* (1989) described Expert System for crop variety selection for winter wheat in Scotland. The system considered the soil characteristics, water availability and prevalence of diseases. By using the system, agricultural extension officers were able to recommend varieties with confidence thereby reducing the demand for advice from specialist crop advisors.

Travis (1992) developed an expert system known as the Penn State Apple Orchard Consultant (PSAOC) to help apple growers make better decisions about production and pest management. The system integrated various facets of apple production. It gave the apple grower the information necessary to reduce some purchased inputs by substituting high quality, integrated, information derived from three sources (state-of-the-art apple production and IPM knowledge; site specific, farm level data; and weather records). A primary emphasis of the PSAOC expert system was to decrease the detrimental environmental impacts associated with pesticide and fertilizer use as well as input costs, thereby improving farm profitability and reducing economic risk. After four years of development and testing, this system was made available for sale in 1990 to fruit growers in Pennsylvania through Penn State Cooperative Extension.

Rafea (1996) introduced LIMEX (Lime Expert System) an integrated expert system with multimedia that had been developed to assist lime growers and extension agents in the cultivation of lime for the purpose of improving their yield. The scope of

LIMEX expert system included the assessment of requirement of inputs for irrigation, fertilization, and pest control.

Christov (1997) indicated that Information Technology for Crop Irrigation Scheduling and fertilizing (ITCISF) software was developed and tested on large scale to improve water and fertilizer use efficiency at no current sampling, multi-variant management. It was found to provide new opportunities for both the investigators and farmers.

Murthy and Srinivasacharyulu (1998) reported that the Synapse expert system developed by IRDC, Canada captured the expertise necessary in low technology industries that depended on experience. This was tested in tea factories in SriLanka. The system could be used in industries where maintaining quality control was necessary, for overseeing instruments and monitoring agricultural activities.

Giles *et al.* (1999) designed a Cereal Aphid Pest Management Expert System to help the users to manage cereal aphids in winter wheat. It was developed through the cooperative efforts of the USDA Agricultural Research Service, Site Specific Technology Development Group of Stillwater (SST), and Oklahoma State University. This expert system had a Greenbug Economic Threshold Calculator, which would calculate a treatment threshold for greenbugs based upon data that the user provides. It also allowed the user to print a Glance 'n' Go sampling form that could be used for multiple fields. Treatment thresholds that were calculated by this expert system were precise because it used historical weather data to predict growth rates of greenbug populations as it calculated treatment thresholds. In addition, it had an "Insecticide Selection" helper, an "Aphid Identification" helper, and a "Natural Enemy" information module.

Warren (1999) designed The Virginia Integrated Pest Management Expert for Wheat to combine the best available information regarding wheat pest management of disease pathogens, weeds, and insects into a decision support system that would provide potential outbreak risk and pest control information to the Comprehensive Resource Planning System (CRPS). This system was an educational tool for farmers and extension personnel.

Lukeeram *et al.* (2000) reported that the Potato Extension and Training Information System (PETIS) was developed principally for the small-scale potato growers. The system was equipped with audio files that provided information in English. Illiterate users had an option that read the summary of the content in Creole and Bhojpuri. Icons and pictures were included to enable rural users to navigate easily at the basic levels of the site.

Pun *et al.* (2000) stated that the Cooperative Research Centre for Viticulture (CRCV) in Australia carried out basic and applied science research on grape vines and their management. As part of its technology transfer program, the CRCV developed an expert system, AusVit. The system provided advice to vineyard managers and grape growers about pest and disease risk in their vineyards and what appropriate action might be taken. The system also advised on irrigation, chemical use, and the like. The advice was based on vineyard profile, data from weather stations and user input from vineyard monitoring, all of which was interpreted by a series of disease simulators and a rule-based expert system. A chemical database provided details of the active components in agricultural chemical products, their application and registration information.

Rafea *et al.* (2000) reported that the Egyptian Regional Wheat Management System, an integrated expert system with a crop simulation model aimed at addressing all aspects of irrigated wheat management in Egypt. In order to achieve this goal, the system was designed to perform the functions such as select the appropriate variety for a specific field, advise the farmer on field preparation, design schedules for irrigation and fertilization, control pests and weeds, manage harvests, prevent malnutrition, diagnose disorders and suggest treatments. Main subsystems of the Neper Wheat were: Wheat Planning System, Pest Identification System and Weeds Identification System.

Bell *et al.* (2001) reported that 'TropRice' was a knowledge driven support system that delivers expert information to help technology transfer agents make more informed practical decision related to rice production in the tropics. It was developed in response to the recognition that many researchers, extension agents, and farmers did not have access to the most up-to-date information on how to improve their rice growing practices.

Wilkins *et al.* (2001) PRICE (Pesticide Residues in Irrigated Cereal Ecosystem) was a Decision Support System, developed to determine environmentally acceptable and relevant herbicide for use and irrigate rice in the high potential Indo- Gangetic plains of Northern India and Bangladesh. The DSS was available on a CD- ROM.

Witt *et al.* (2001) gave an account of the Nutrient Decision Support System (NUDSS) for irrigated rice. It was part of IRRI's initiative to provide decision support for site specific nutrient management in the irrigated lowlands. The NUDSS was a user friendly software package to help users develop improved fertilizer strategies that aim at efficient fertilizer use and increased farmers' profit. It was programmed using visual Basic 6.0 and M S Access.

Edrees *et al.* (2002) presented an expert system for paddy production. management, gave advice to paddy growers in Egypt to improve paddy productivity. The system contained two main parts namely: strategic part and tactic part. The strategic part gave a strategic advice (i.e. list of agricultural operations) before cultivating paddy crop. The strategic part contained four sub-systems namely: variety selection, land preparation, planting, irrigation and fertilization. The tactic part diagnosed the problems that occurred during paddy growing season and gave advice about how to control these problems. The tactic part contained two subsystems namely: disorders diagnosis and treatment.

Sibon (2002) reported that the Sarawak Department of Agriculture had developed a special system for diagnosing nutritional disorders of black pepper. The tool was developed as an aid for agriculture extension workers to provide advisory services on crop health measures to pepper growers in Sarawak. Named 'XCRO-pepper', the system could assist users in diagnosing symptoms caused by 16 diseases, 13 pests and 10 nutritional disorders of black pepper.

Liping (2003) gave an account of AES that had been studied in China since 1970's and there were more than ten kinds of AES developed and applied into the management of agricultural production machinery, irrigation, variety breeding and selection, control of diseases and pests, feed prescription of livestock and poultry and so on. A software developed by Beijing Youluo Science and Technology Development Company guided the farmers richening themselves with the scientific method; realize agricultural production with good quality, high yield efficiency and sustaining development. This resulted in obvious economic and social benefit.

Norton (2003) reported that the on-line 'Rice Doctor' key was available for users to access across the Internet – it could be accessed at the following site - http://www.knowledgebank.irri.org/ricedoctor_mx/ricedoctor.htm. Diagnostic keys allowed users to systematically diagnose specific field problems by selecting those features and symptoms they observed in the crop. As features were selected, a short list of likely causes of the problem was filtered out from over 80 possible causes. The LucID key included numerous images to help users diagnosing their problems and access relevant information about the problem. The features and symptoms that might be observed were defined and illustrated by notes and images. Both keys provided access to summary information sheets and full information sheets that contain images, text descriptions of symptoms and other information about particular pests, plant diseases, nutrient disorders and other causes of rice crop problems.

Shen (2003) mentioned the following expert systems: **PestDiag** was a multimedia expert system to identify common vegetable insects of more than 80 species in north China. Designed with the technology of SASD (Structural Analysis and Structural Design) and OOP (Object Oriented Programming), the system had been encoded by Microsoft Visual BASIC. PESTDIAG proved useful in assisting vegetable insect pest management for agricultural administrative agencies, plant protectionists and farmers. It helped users to identify vegetable insect pests in the field and then provided them with knowledge of integrated management of the pests. In addition, the system actualized a new way to professional education and training either at agricultural university level or peasant level. Multimedia technique made this system user-friendly, more vivid and vigorous.

PQ-InforMIS was a system for managing information with text and illustrations of 58 species of plant quarantine insects that were as a whole listed in documents by the Chinese governmental authority. The information stored included name and classification status of the species, their morphological description with texts and images, host plants, geographical distribution in the world, spread approach, record of capture, etc. In addition, the system could work as a consultant to guide quarantine staff to identify a species of quarantine risk, with a knowledge base and in terms of dialogue.

PQ-PickBugs was another multimedia expert system with almost same architecture as PestDiag. However, it had been developed as a plant quarantine oriented product, based partially on the knowledge that was transplanted from PQ-InforMIS and added with new information on more species that were similar morphologically with the quarantine species.

CN-VegePest, a multimedia database, consisted of about 200 species as vegetable pest insects distributing in China and runs on Windows platform. This system included information of the insects on Chinese name, English name, scientific name, vernacular name, synonym, classification status, geographical distribution, host plants, morphological characters, harmful behaviour, habits, outbreak condition and control strategy. The information was expressed, as well as shown textually, with images of morphology of eggs, larvae, pupa and adults, images of damaged characters of crop plants caused by the pests, audio voice to introduce the pests and video records to show life cycle in field. The software had a friendly graphic interface, easy to operate.

Cheng-gang *et al.* (2004) stated that the agricultural expert system contained fertilizer inquiry system, cultivating inquiry system, plant protection system and climate inquiry system. By those systems agriculture production was instructed. With the development of Internet, Intelligence expert system was developed from single version to net version. Such as 'grape cultivating management expert system' were issued by Academy of Chinese Agricultural Sciences. 'Intelligence Rice Cultivating Management Expert System' and 'Intelligence Corn Cultivating Management Expert System' were issued by Changchun Academy of Agricultural Sciences. In Jilin province, the peasants could use the expert system to solve the entire problem they met during the agricultural production.

Singh *et al.* (2004) and Prasad and Babu (2006) reported many expert systems developed for various crops in other countries. They were as follows:

Sl.No	Name of AES	Subject	Name of the institution	Details of developed AES
1	COMAX	Cotton		Integrated Crop Management
2	The MAIZE	Field Corn	PENN State University	Pre season and production season Insect, disease and weed control, hybrid selection.
3	The Penn State Apple Orchard Consultant	Apple	PENN State University	Pest management and Chemical management
4	GOSSYM	Farm	PENN State University	Daily management decision recommendations
5	POMME	Apple	PENN State University	Pest and orchard management.
6	PLANT/dss	Soyabean	PENN State University	Diagnosis of diseases.
7	Expert system	Cotton	PENN State University	Management recommendations
8	CALEX	Agricultur-e	University of California	Black board based integrated expert decision support system for agricultural management.
9	Weiping Jin Expert System	Crop growth	PR.China	Provide support for crop growth control system.
10	WHEATWIZ	Winter wheat	GIS Expert System by Naidan Zhang	To assist in variety selection.
11	CLIPS	Soil manageme-nt	Purdue University	Soil drainage, Soil Ph, Soil P test, Soil K test, Use of alfalfa crop, chemical weed control, variety recommendation, rate of seeding and pure live seed.

Abeyrathne *et al.* (2005) designed an expert system using wxCLIPS shell, which worked under windows environment. The SSSDPS (Simple Sprinkler System Designing Expert Systems) Expert was designed with an interactive GUI where the non-experts and non-technical users could browse through the expert system with much ease through interaction with the computer. Almost all the technical data needed for a preliminary designing of a simple system was embedded to the expert system, so that the user only needed to provide field specific information. The developed SSSDPS Expert gave very accurate outputs for given conditions. The system output was useful in proper designing of a simple irrigation system. This system could help non-technical users and sprinkler irrigation system installers in Sri Lanka to come up with better system layouts for productivity maximization with the available resources.

Hogan *et al.* (2005) reported that late-season insecticide sprays could be reduced by using the Bollman program. Cotman was a computer-based expert system developed by the University of Arkansas Division of Agriculture and contained Bollman as one of its components.

University of Illinois (2005) brought out that the "SOYSEED" program, an "expert" at the farmer's elbow. The knowledge automation system gave the same recommendations an expert would based on answers to questions, which were specifically tailored to each farmer's situation. The program combined 'expert intuition' with hard data. Farmers, farm managers and farm advisors used SOYSEED, and it served as an experimental and demonstration program in agronomy. SOYSEED screened 29 varieties of soybeans for suitability to a farmer's location, field conditions, farm plans, and need for pest and disease resistance. It listed varieties that were reasonable choices and their yield chances under certain conditions. The farmer could see the agronomic reasoning behind each recommendation and run 'what if' scenarios to see how his preferred management affected choices. Questions were simple and limited. For example, instead of asking the farmer his 'maturity group region' which determined the type of bean that could develop adequately, the program let him show his location on a screen map of Illinois, Indiana, or the entire Midwest.

Rubber Research Institute in Malaysia (2005) reported that knowledge automation system was developed by the Rubber Research Institute in Malaysia to recommend specific rubber tree clones for plantations based upon the specific conditions of that plantation. The complete system included the knowledge automation system, presentation graphics of environmental condition maps and information on the various types of clones. A critical aspect of system design was for the system to be run by end users with no training. It was designed to be used by the plantation growers themselves and was made available to plantations without electricity on battery powered laptops.

EXNUT (Expert System for Peanuts), a knowledge automation system to help manage irrigated peanut production, compiled data from individual peanut fields throughout the growing season and made recommendations for irrigation, the application of fungicides, and if favorable pest conditions might exist. Many other knowledge automation systems had been developed at the NPRL (National Peanut Research Laboratory) that made decisions on variety selection, land preparation and harvest scheduling, as well a whole farm-planning modules, which used a linear programming interface for optimization. Each of these knowledge automation systems function as stand-alone systems or as modules in farm operations management. (USDA, 2005)

Hadi (2006) reported that a new ICT-KM project developed a series of expert systems that would provide farmers with the latest information on the pest management of chickpeas, barley and wheat. The Utilization of Intelligent Systems in Plant Protection (UISPP) project included knowledge acquisition tools and pest management knowledge database. UISPP team members represented the Central Laboratory for Agricultural Expert Systems (CLAES), International Center for Research in the Dry Areas (ICARDA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and International Rice Research Institute (IRRI). They were working directly with farmers and through extension agents. The team expected to offer the human and technical resources to address safe pest control and related concerns by project's end.

2.3. History of AES development in India

Raman *et al.* (1992) described an expert system used for drought management. The system used linear programming model to generate optimal cropping patterns based on data from past drought experiences as also from synthetic drought occurrences. Using this, one can identify the degree of drought in the current situations and its similarity to the identified drought events and be able to get the corresponding management strategy.

Mahabharat (1993) claimed that Indian Institute of Horticultural Research (IIHR), Bangalore launched, world's first comprehensive databank on integrated management of pests of cabbage. Compiled on floppy disks, the 'Cabbage-pest expert system 1.0' program described the international pest scenario, the biology of insects that damage cabbage, the application of alternative hosts, predators, and biocontrol measures. A special feature on utilization of Indian mustard as the trap crop had been incorporated in the system which proved a treasure-house of information for farmers, as well as the scientists working on pests across the globe.

Mohan and Arumugam (1994) developed a personal computer (PC) based expert system (CROPES) for selecting crops in a region in Tamilnadu. This system acted as an intelligent consultant by asking a set of questions and then suggested appropriate crop. It recommended crops to farmers based on location, climate, soils and available resources.

Chaudhary *et al.* (2003) reported that 'Krushimantra': a decision support system for Indian farmers were developed to make correct and timely decisions regarding farm activities, to incorporate context based knowledge and information regarding farm production system. Such knowledge–based system would support retrieval of required information pertaining to a relevant farm situation.

Ghosh and Samanta (2003) presented a rule–based, object–oriented expert system for insect pest management in tea code named 'TEAPEST.' The system identified major insect pests of tea and suggested appropriate control measures. 'TEAPEST' showed good performance.

Rao (2003) and Prasad and Babu (2006) reported that the National Institute of Agriculture Extension Management (MANAGE) developed, an expert system-Rice Crop Doctor in collaboration with National Institute of Information Technology, to diagnose rice pests and diseases and to suggest curative and preventive measures. The rice crop doctor diagnosed the pest or diseases depending on the symptoms identified by the user with the help of photographs and textual information.

Balasubramani (2004) developed computer based Expert System on plant protection aspects of rubber, based on the judges opinion, collected from scientists and Extension Officers of Rubber Board and rubber growers. He named the system as RUBEXS-04 using Visual Basic 6.0 software.

A computer- aided software named "Diagnos-4" incorporating all the modern features with multimedia and graphics had been developed. This package would help in identifying the pest and diseases of major crops. The package was user- friendly and easy to operate, more attractive and aesthetic. It was hoped that this package would support the agricultural extension workers for decision-making and help them in suggesting suitable control measures of the major pest and disease of major crops of Kerala. (Ganesan, 2004 and Ganesan *et al*, 2005).

The ICAR Institutes had developed various software systems, viz. (i) *Database Management Systems*: for (*a*) Genebank Management, (*b*) Identification and

Management of Nematodes in India, (*c*) Poultry Disease Diagnostics and Remedy; (*d*) AGRI-IS on Animal Genetic Resources of India, (*e*) Agricultural Pest Information System, (*f*) Pulse Information System for UP, and (*g*) Potato Pests CD; (ii) *Application Software Systems*: for (*a*) Implementing the HACCP by Seafood Processing Plants, and (*b*) Identification of Eggs and Larvae of Parasites, (iii) *Expert Systems*: (*a*) Expert Systems for Grape, Cabbage, Mushroom Cultivation Expert Systems, (*b*) Cotton Insect Pest Management System, (*c*) Statistical Quality Control for Dairy plants. A Decision Support System (DSS) had been developed for integrating and utilizing the knowledge base of a large number of agricultural disciplines for agricultural planning and development. (ICAR, 2006).

Pratheepa *et al.* (2004) developed a suitable user-friendly software package on bio-control of *Helicoverpa armigera*, which could be used by all the stakeholders. This package was developed by using MS-ACCESS. It contained valuable information on the pest with emphasis on the association of the pest with its natural enemies and their role in the management of pest on different crops. This database would be of extreme help for students, research workers and policy makers who had been striving to find an answer to the *Helicoverpa /Heliothis* problem. Command buttons were provided to go back to the previous screen or to the main menu, and pictures were given for all stages of *Helicoverpa armigera*, which aided the beginners to identify the pest. So they reported that this computer database was a simple and effective tool to get quick access to available information about *Helicoverpa armigera* and its natural enemies. This would also serve as a valuable extension tool in the transfer of technology. Educated farmers would also find this useful. The authors concluded by stating that since information technology was evolving as modern tool in taking essential information to every nook and corner of the country, the 'Helico-info' database might help in the safe and better management of a very serious pest, *Helicoverpa armigera*.

Singh *et al.* (2004) gave a brief report on the expert systems developed for IPM of various crops in India. They were as follows:

Sl. No	Name of the expert system	Crop	Institute which developed the system	Purpose
1	SOYPEST	Soyabean	National Research Centre for Soyabean,	To solve the farmers queries related to Soybean pest diagnosis and management
2	Rice crop doctor	Rice	National Institute of Agricultural Extension Management (MANAGE), Hyderabad	To diagnose pests and diseases for rice crop management.
3	AES on mushroom South Indian Horticultural crops	Mushroom and comprehensive package of practices of about 148 horticulture crops for cultivation.	Indian Institute of Horticultural Research, Bangalore	To provide guidance to cultivators of 4 Southern states of Kerala, Tamilnadu, Karnataka and Andhra Pradesh.
4	AGREX	Paddy, fruits and vegetables	Centre for Informatics Research and Advancement, Kerala	To give timely and correct advice to the farmers about fertilizer application, crop protection, irrigation scheduling, diagnosis of diseases and post harvest technology.

Bahal *et al.* (2006) worked on developing a web enabled expert system of extension (ExSyEx). The knowledge and expertise of an agricultural expert could be easily adopted and utilized by the farmers and extension workers and at different locations without the presence of an expert. This was the first attempt in the field of extension to work on web site of extension in India. This would be really helpful to the farmers, extension workers students, and professionals and even to the general public. ExSyEx was built on Java Technology. The user interaction layer was built using HTML, CSS and java script while knowledge base was in SQL Server 2000.

Batra *et al.* (2006) reported that AgProtect was a web-based information Dissemination System that used internet to bridge the gap between the end- users and the experts. AgProtect helped farmers directly by providing the crucial expert information at right time. It provided broader platform for end – to- end information in pest management through cost- effective remedial steps provided by the experts and knowledge bank.

Farooqi e*t al.* (2006) designed Expert System on Wheat Crop Management (EXOWHEM) to assist farmers in scientific ways to address all problems related to wheat, including pest management. The entomological aspect of the expert system helped the farmer in identifying the insect with which the crop was infected. The package operated in an interactive manner based on the responses provided by the user. It identified the insect and suggested the treatment and preventive measures.

Ganesan (2006c) developed Nutrient Recommendation System for Rice, 'NRSR' would aid as a decision support system for calibrating the required dose of fertilizers and organic sources for a particular area of land and also the total expenditure to be incurred. Information on organic farming, biofertilizers, fertilizer guide, guidelines for maximizing fertilizer use efficiency, Malayalam terminology and abbreviations were also incorporated in the software to make it more user friendly. This package would act as an efficient extension tool for the agricultural officers, scientists in the field of agriculture and extension workers and help them in decision making and suggesting suitable recommendations.

Islam *et al.* (2006) presented 'Expert System on Wheat Crop Management', an integrated system that addressed all aspects of wheat management in India. This system designed to cover the agriculture operations, variety selection, fertilizer application, and insecticide/pesticide application on one hand and economic benefits on the other. This system would help in diagnosing a pathological disorder in the plant and would suggest its control measurers. It would also help in identifying insect/pest/weed and would suggest defense mechanism measure.

Prasad *et al.* (2006) described the development of a rule-based expert system, using expert system shell ESTA (Expert System Shell for Text Animation), for the diagnosis of the most common diseases occurring in the Indian mango. The objective was to provide computer-based support for the agricultural specialists or farmers. The proposed expert system would make diagnosis on the basis of response/responses of the user made against queries related to particular disease symptoms. The knowledge base of the system would contain knowledge about symptoms and remedies of 14 diseases of Indian mango tree appearing during fruiting and non-fruiting season. The picture base of the system contained pictures related to disease symptoms and was displayed along with the query of the system. The result given by the system had been found to be sound and consistent.

Raju and Rao (2006) developed Poultry Expert System PES using Visual Basic 6.0 and MS Access on selected dimensions of poultry farming. Its efficacy was tested among the Veterinarians and Veterinary students. PES had greater utility, less complexity and moderate compatibility. It possessed good technicality, feasibility, designed in a user friendly and aesthetic manner and brought improvement in the user attributes. Both the groups were significantly differing on few items of applicability. The study concluded that PES was an IT enabled tool for faster dissemination of expert advice in multiple locations at the same time.

Rao *et al.* (2006) reported that Groundnut expert system was developed by ICRISAT, provided information on groundnut pests and diseases and remedies.

Rao and Kumar (2006) stated that Fertilizers Information and Recommendations Manager (FIRM) was basically a software and nutrient management decision support system, designed and developed, considering the modern needs of farming. FIRM had three main modules viz. Information Manager, Recommendations Manager and Application Manager. Firm had a facility at the end to generate reports either for taking printouts or for storing as files. FIRM was a menu based, user friendly software applicable to farm advisory and nutrient management decision. This was a proven handy tool for extension workers, advisory personnel, agronomists, soil scientists and progressive farmers. Utility of FIRM was high when it was embedded in the networks.

Sunil (2006) developed information and decision support system in banana called banana technology manager. The software for the system was developed in HTML, Flash and Java. The results of the study revealed the existence of information and decision support need in the areas such as cultivation, plant protection, marketing and management.

Mathew (2007) stated that E-krishi web site integrated with the Karshaka Information Systems Services and Networking (KISSAN) developed by the Indian Institute of Information Technology and Management - Kerala and the Virtual University for Agricultural Trade (VUAT) attached to the Kerala Agricultural University. The web site and call centre were intended to provide the farmer with information on market demand, prices, good agriculture practices, quality agriculture inputs and expert advice. KISSAN worked as an expert system and provided recommendations for use of fertilizers if soil-testing results were fed to it.

Developments in the field of AES in India as well as other countries are in the process of making a big head way in reducing the information gap among the farmers and various stakeholders related to agriculture in providing better means of accessing and utilizing wide range of information for sustainable and profitable farm management. The above observations suggest the need to study the performance and potentials of the plant protection module of AES in major three crops of Kerala such as paddy, coconut and banana.

2.4. Cognitive and connotative domains of users

Hiranand and Singh (1981) reported that none of the dryland farmers knew the integrated control measures recommended by the scientists.

Ganesan (1982) observed that no paddy growers knew about biological control of pests.

Legenstein (1988) conducted a study to find out the effects of varied instructional strategies in facilitating a student recall from visually complemented text in computer-based instruction. It was found that the presence of elaborated text increased recall performance at both low and high cognitive levels.

Broner *et al.* (1990) opined that a knowledge-based crop management Expert System incorporated heuristic knowledge from various sources such as field experts and growers with more structured knowledge acquired from research results. Knowledge was commonly acquired from different regions, which may differ in climate, soils, and cultural practices, as well as from several field experts, resulting in a cognitive model, which represents an average crop expert in an average area.

Bonny (1991) observed that majority (67 per cent) of commercial vegetable growers had medium level of knowledge of improved vegetable cultivation practices.

Hochman *et al.* (1994) found out that not a single respondent rated decision support systems as 'not useful'. However, advisers wanted systems to be more 'user friendly', more reliable/ accurate, and required less time to master. The growth of the system and the time spent on user consultation plotted against calendar time showed that development activity was driven by consultation with users. It also increased the users' acceptance and knowledge of the new technology.

Meera (1995) found that the farmers of Thiruvananthapuram and Alapuzha districts were ignorant about biological, physical and integrated methods of plant protection.

Fabry (1998) concluded that interactive educational multimedia materials had the potential to mindfully engage learners. The strength of interactive educational software was the variety of cognitive opportunities available to students through colourful, action oriented graphics and photo, relevant stories that engage students in discussion and reflection and activities that require interaction.

Balasubramani (2004) reported that a majority of the subjects were most satisfied and expressed that the diagnostic path leads to correct conclusion (81.67 per cent), diagnostic path is sequential and logic (72.00 per cent), questions were based on field reality (61.67 per cent) etc. But, a considerable per centage (23.33 per cent) of them was not satisfied with the adequacy of the message. Most of the subjects were satisfied with regard to background colour (40.00 per cent), size of letter (30.00 per cent), colour of the letter (26.67 per cent) etc. A majority of the respondents were most satisfied with voice clarity modulation (70.00 per cent) and voice pace (66.67 per cent). Majority of the subjects expressed satisfaction that CD with Expert System could be easily portable (80.00 per cent) and satisfied with ease in use and functionality of Expert System (51.67 per cent).

Thomas (2004) identified that majority of the respondents (96.60 per cent) had low to medium level of knowledge on the scientific practices in homegarden.

Sunil (2006) reported that the final testing of content and design of the information and decision support system revealed a "very good" rating by the respondents. The respondents liked both the content and design part of the system. And among the different components of the system, the appealing graphical design was liked by most of the respondents. This was followed by the clarity of content information presented through the system. Among the different uses perceived by the researchers, the most important one was as a tool to enhance the learner participation. This was followed by such uses like a tool for the single window extension counters, material for reference purpose, distance education and academic teaching tool in the order. The important utility of the system as perceived by the farmers was a tool to diagnose various plant protection problems, a calculator to estimate chemicals and also a management tool in identifying various concerns.

Ahire and Kiran (2007) indicated that the respondents had medium level of knowledge about various integrated management practices.

The literature reviewed under their section clearly indicates that the cognitive domains of technology users ranged from low to medium and different kinds of computer based instructional devices were used as an efficient extension tool in the various fields of farm activities. The researchers observed that there was an improvement in the cognitive levels of users after using the soft wares, connotative domains of users suggest the need to develop a user friendly computer based AES considering user resources, nature of problem and the users' ability to use the soft wares.

2. 5. Factors influencing potential users

Nuthall and Bishop-Hurley (1996) made clear that farmers' personality, age and education level were the major factors in explaining the views held related to the performance of expert systems.

Anandaraja (2002) reported that educational status, mass media participation and progressiveness were found to be positively associated with knowledge gain whereas, age and farm status were found to have a negative association with knowledge gain.

Liping (2003) stated that the users operated an expert system only depending on their understanding and guess if they had not well knowledge of speciality and computer of fully mastering all functions of the expert system. The application of figure, voice, video frequency could make normal users without rich computer knowledge master rapidly and skillfully the system. In the application of, "Expert System of Poultry Diseases", normal users lacking in the special knowledge were difficulty to get a corrective diagnose about the poultry disease if there would not be relevant figures and words that described the internal pathological changes of poultry birds. In the system added the figures and words, the users made corrective result by those descriptions so that the factors resulting in the reduction of identifying accuracy could become lower.

Senthilkumar (2003) exposed that the variables namely family status and annual income were found to have positive and highly significant relationship with the effectiveness of cyber extension tools.

Balasubramani (2004) revealed that after doing correlation analysis, the variables namely area under rubber cultivation, experience in rubber cultivation and information seeking behaviour exhibited a positive and highly significant relationship with knowledge gain at 1.00 per cent level of probability whereas age, possession of modern electronic gadgets and familiarity in using computer had shown a positive and significant relationship at 5 per cent level of probability.

Babu (2005) observed that income, number of years of schooling, media exposure, innovation proneness, attitude towards ICTs, achievement motivation, level of aspiration were having positive relationship with the perception and e-readiness of the farmers in the study area of Central Kerala.

User friendliness of the system needs special attention, which is mostly a forgotten area in any of the technology development process. In order to enhance the user friendliness of the system, it is essential to understand the factors influencing users in using AES. The studies reviewed under this section clearly indicate that socio- personal characters were the most influencing variables among users. Hence in this study, socio- personal characters were selected to study their influence on prospective users.

2. 6. Applications of AES

Evans *et al.* (1989) revealed that expert system technology was suitable for solving problems in farm management, for example, the fertilizer problem, because of several important features. First the incremental development process was exploratory by nature, and hence it aided in the formalization of ill structure and poorly understood problems. Second, explicit representation schemes make it easy to understand and modify knowledge; thus, it was much easier to make changes to a developing system. Third, through the use of extensive domain knowledge, an expert system considered only relevant information and was able to reduce difficult problems down to a manageable size. Finally the ability of an Expert System to provide explanation and justification for its recommendation decreased user skepticism and made it possible to ensure that a system's results were accurate.

Vecino (1989) concluded that creation of an expert system on any theme had the indirect positive effect of forcing the decision making centre to clarify its reasoning processes. In this way a large amount of knowledge about the real processes of decision making by experts was obtained.

Gilmore (1993) commented that expert systems were becoming widely used in all areas of the community and provided a way of accessing knowledge bases especially the distilled knowledge of experts in a wide variety of disciplines. Expert systems would feature and should feature as means of providing simple access to complex information.

Knight and Mumford (1994) identified that decision support systems were able to help farmers make difficult decisions by providing information in an easily understandable and quickly accessible form. The scarcity of expert advice, increasingly complex decisions and reduced economic margins increased the importance of making the right pest management decision at the right time. It was against this background that decision support systems had an important role to play in the fight against losses caused by pests and diseases.

Arumugam (1995) supported that all the three classes of the developed expert systems were found to be effective when compared to the actual field practice. It was concluded that the expert system technique was a viable and efficient tool for intelligent decision – making for these irrigation management domains.

Nuthall and Bishop-Hurley (1996) stated that feed management in grazing situations involved many complex decisions. Most New Zealand farmers relied on mental figuring, initiation and experience to make decisions. A project was designed to explore whether Expert Systems might provide useful assistance to farmers in making feed management decisions, as it was clear from production figures that efficiency improvements were possible. The trial farmers believed that three Expert Systems developed for components of the overall feed management problems were useful and had positive economic value. The farmers in general agreed with the advice and explanations provided. They did not find themselves in disagreement and presumably were prepared to take action based on the result of their Expert System experience.

Rafea (1996) reported that in all the application modules, LIMEX was ranked the highest or second highest in accepted performance and ranked lowest in number of non-accepted or wrong case results. LIMEX was able to correctly assess 16 out of 20 cases and to provide excellent assessment of the lime cultivation feasibility in 12 out of 20 cases. These results suggested LIMEX as a significant and useful tool for lime cultivation.

Hoogenboom (1998) developed the Decision Support System for Agro technology Transfer (DSSAT) provided easy access to data bases and crop models so that the user may 'test' on screen the performance of new cultivars, sites, or management practices. This system allowed user to screen new technology packages, such as a new cultivar or fertilizer management strategy, without spending excess time on expensive, time-consuming field trials. By simulating outcomes of strategies on the computer screen, user could ask 'what if' questions and explore the options on screen. Sustainable agriculture required tools that enable decision makers to explore the future.

Sadagopan (1998) mentioned that expert systems could capture the human expertise and multiply it, provide affordable expertise to all, use the 'distilled' expertise of human expert to train others and could document the expertise for prosperity.

Wai *et al.* (2000) reported that the agriculture expert system were to help the farmers to do single point decisions, to have a well planning before start to do anything on their land. Secondly, it was to design an irrigation system for their plantation. Third was to select the most suitable crop variety or market outlet. Fourth was Diagnosis or identification of the livestock disorder. Fifth was to interpret the set of financial accounts. Sixth was to predict the extreme events such as thunderstorms and frost. And lastly was to suggest a sequence of tactical decisions throughout a production cycle such as plant protection and nutrition decisions, livestock feeding and the like.

Rafea and Mostafa (2001) showed that NEPER performance in the laboratory was comparable with human experts. Field evaluation revealed that NEPER had good economic and environmental impacts. The field-testing results had also shown that NEPER was usable, applicable and needed.

Edrees *et al.* (2002) developed, verified and tested paddy expert system. The system was tested in the field to be mature enough and capable to be used by extension officers and paddy researchers. It gave strategic advice, which enable paddy growers to apply the right operation at the specific time. This enabled users to avoid the problems that occured during growing season. It diagnosed the problems and advised users how to control these problems either by agricultural operations or chemical operations.

Marwaha *et al.* (2002) predicted the scope of Expert system of Extension (ExSyEx) as it would be possible to create a virtual platform wherein both top-down and bottom-up information flow could be possible, resulting in timely and effective solution to the farmers' problems. They cautioned that the scope of the same would be limited to few crops in a selected region because of the vast domain of agriculture and varying geographical and socio-economic conditions.

Rafea (2002) conducted experiments to measure the economic and environmental impact of using expert system in the field. The experiments showed that the net production had increased by approximately 25 per cent. The impact on environment conservation was assessed using two measures: water saving and chemicals usage reduction. It was found that fields managed by expert systems used less water by approximately 35 per cent and less fertilizers by approximately 16 per cent. The impact on enhancing the performance of the extension workers when using the expert system was also measured. A tangible enhancement was observed which ranged from 80 to 157 per cent in different expert systems.

Sharma (2002) explained that the expert systems were based on the concept of artificial intelligence, where the expert system could be made to learn and develop its own set of pairs of (rule, action) set. Once the knowledge base was large enough, the advice obtained from expert system could save lot of hassles and drudgery for the experts. Even to some extent, the experts could be substituted by the computer- based expert systems.

Balasubramani *et al.* (2003) pointed out that the expert system was intended to help farmers to make better decisions and provide useful advice, filling the knowledge gap between the expert and the user.

Liping (2003) commented that AES had rich agricultural knowledge and deductive procedure of imitating mankind that could provide the users with all kinds of consultation services and the measures of making a strategic decision to solve the different agricultural problems. AES possessed the superiority of wide adaptability, rapid response, low cost and less dangerous.

Sarma (2003) mentioned that inputs distribution, marketing information systems, land-water management, cropping pattern, management of natural resources and extension services etc. could be solved through various techniques of modeling and Expert Systems.

Reddy *et al.* (2004) reported that using Web-based Agricultural Expert Advice Dissemination System, the farmers in Kothapet had reduced the consumption of fertilizers and pesticides.

According to Senthilkumar (2004), expert systems were important development in information technology. These advised the farmers which alternative to choose from a wide range of possible alternatives by processing data from a large number of variables according to certain decision rules. These systems applied the decision rules more consistently and processed the relevant data more effectively than the farmer could himself.

Yuan *et al.* (2006) tested an expert system in the demonstration farm of Miyun- suburb farm of Beijing, it was concluded that irrigating the winter-wheat properly not only saved water but also got higher yield. This system worked like an expert on winter-wheat real irrigation. The total water used for this demonstration farm was 30 per cent less than the regular farm and the wheat yield for this demonstration farm was 20 per cent higher than regular farm based on the same other agricultural treatments. The system helped users to make appropriate decisions on winter wheat irrigation so that the goal of water- saving in irrigation could be achieved. It also helped farmer to make correct decisions on agricultural practices. But it was only applicable to China-Beijing region right now because it was developed based on Beijing's climate, field experiment and other agricultural practices.

Balasubramani *et al.* (2005) designed RUBEXS-04 an expert system on rubber crop for decision support on rubber protection technologies. In order to test the effectiveness of the RUBEXS-04 as a tool in the process of technology transfer, an experimental study was conducted with suitable comparisons. Multiple group-randomized design was adopted for different treatment such as human experts without discussion (T1), human experts with discussion (T2), RUBEXS-04 without discussion (T3), and RUBEXS-04 with discussion (T4). These treatments were tested for their relative effectiveness of the 4 treatments in terms of knowledge gain, knowledge gain related to skill, symbolic adoption and the knowledge retention of the subjects. The result indicated that RUBEXS-04 with discussion (T4) resulted to maximum mean knowledge gain. It was also found to be the most effective and superior method as compared to other treatments in terms of imparting knowledge related to skill aspects, knowledge retention and influencing the symbolic adoption behavior of the subjects.

Reddy *et al.* (2005) stated that agricultural experts successfully delivered the expert advice based on the photographs and related information. Further, the results showed that the expert advice was helping farmers to improve input efficiency by guiding them in Integrated Pest Management (IPM) and Integrated Nutrient Management (INM). The results indicated that e-Sagu enabled continuous monitoring of each farm by agricultural scientists in a cost-effective manner and helped the farmers in judicious use of pesticides and fertilizers. Specifically, the benchmark study showed that, with the help of e-Sagu, each farmer saved about Rs 3,800/- per acre due to reduced input.

USDA (2005) stated that EXNUT (Expert System for Peanuts) optimized irrigation management based upon peanut plant, soil, weather, insects and plant diseases. The system had been evaluated on over 50 farms and thousands of acres of peanuts. The fields managed by EXNUT had consistently produced higher yields and quality using less water and fungicides, than those managed by even the most productive farms without the technology.

Anandaraja *et al.* (2006) explained expert systems that would bring new information services to rural areas, which farmers as users had much greater control than over current information channels. Even if every farmer did not have computer terminal, these could become readily available at local information resource centers, with computers carrying expert systems to help farmers to make decisions.

Adhiguru and Birthal (2006) stated that expert system had the merits in terms of more subject matter coverage, decision support, direct access to information, minimize time and distance barriers, empower rural intermediary organizations. It had the potential to facilitate cost-effective production, vertical integration, value added marketing, minimize transaction costs, improved communication efficiency, encourage competitiveness and accelerate growth.

Ganesan (2006a) stated that an Agricultural Expert System was a Decision Support System for Agricultural Extension Agents who had to decide what advise to be offered to farmers who had to decide what action to be based on it. It was one of the most efficient extension tools to take the technology from scientists to the farmers directly without any dilution of content which normally happened in because of the number of agencies involved in normal technology transfer systems. The expert system was designed to answer questions typed at a keyboard attached to a computer on such diversified topics.

Ganesan (2006b) opined that expert system would play a major role in the dissemination and application of useful knowledge leading to economic growth and higher standards of living. They were not only the vehicles to apply expert's knowledge to particular problems, but were potentially powerful learning resources to help users to develop their own expertise. For both developed and developing countries this could bring more productivity and employment in agriculture through wider and more diverse applications of new scientific results. More over this provided wider scope for individual managerial initiative of farmers, reinforcing local abilities to solve local problems.

Kaur *et al.* (2006) mentioned that at present most of the farmers generally depended upon agricultural experts from the State Department of Agriculture and Agricultural universities to get information for decision-making. Unfortunately, this assistance was not always available to them when they needed it most. To solve this problem, expert system could be used as a powerful tool with extensive potential in agriculture. An expert system or knowledge-based system was a computer programme designed to stimulate the problem solving behaviour of an expert in a narrow domain or discipline. In agriculture, expert system combined the accumulated expertise of individual disciplines like Agronomy, Entomology, Plant Pathology, Horticulture etc. into a frame work that best addressed the specific, on-site needs of farmers. Expert system combined the experiential and experimental knowledge with the intuitive reasoning and skills of specialties to help farmers in crop production decisions. Expert systems could also be used by the extension workers to up-date their knowledge and expertise from time to time.

Sunil (2006) found that the most important utility of the system as perceived by the farmers was as a tool to diagnose various plants protection problems. The next important utility of the system was as a calculator to estimate chemicals and also as a management tool in identifying various concerns. The most important use of the information and decision support system for the extension personnel was as a tool in estimating quantity of chemicals and fertilizers. This was followed by such uses like reference materials and diagnostic tool assumed top priority.

Vijayalakshmi *et al* (2006) commented that the expert system would be useful in designing extension programmes, which would save the time of both the extension worker and farmers. This expert system could be installed in agricultural extension centers. The farmers could get easy accessibility whenever they need. The farmers' problems were solved by providing recommendations in response to a user's request thus acting as a decision support tool. This kind of expert systems were introduced not to substitute the experts but to assist them in solving the farmers' problems.

The literature related to the application of AES vividly brings out the significance of AES as a tool for effective decision making against complex problems and technology transfer in the various fields of agriculture. But there was no defined methodology to assess the performance of AES among users. Hence, in the present study an attempt was made to find out the perception of prospective users towards the performance and potentials of AES.

2. 7. Comparison of AES with human experts

Batchelor *et al.* (1991) established that pest management recommendations from extension bulletins and the expert system were compared with an expert's recommendations. Results indicated the potential improvement in decision-making processes with the adoption of expert systems.

Rafea (1998) measured the difference in advice given by extension workers using the expert system and those who were not using it. It was found that the per centage of matching between advice produced by AES and extension workers' advice was only 44.3 per cent. The extension workers' performance could be enhanced by 125 per cent if they used the system.

Anandaraja (2002) found that the mean knowledge gain with regard to IMCD (Interactive Multimedia Compact Disc) through computer monitor was maximum with a score of 12.39, which indicated 61.96 per cent of knowledge gain. This was followed by IMCD through LCD projector + with interaction (10.92) and IMCD through LCD projector + without interaction (7.96) which accounted for 53.63 per cent and 39.84 per cent knowledge gain respectively. The results also indicated that among the three treatments, IMCD through self learning resulted in substantial knowledge gain and was most effective and superior one for the transfer of knowledge aspects of a technology.

CLAES (2004) showed that the expert system was the best performer in four subsystems. It was the second best performer in two subsystems: irrigation and fertilization. Generally, the expert system had the best overall system performance.

Reddy *et al.* (2005) reported that the system provided opportunity to provide e-sagu agricultural expert advice to the farmers in a cost effective manner. Almost all the participants convinced that delivering expert advice by getting the crop status through photographs and other data was viable. It was also very effective and more useful to the farmers. Discussions with farmers made it clear that input savings and yield increments among the project area made the farmers confidant about the new technology.

CLAES (2006) reported that the experts system stood in comparison to the other human experts. The expert system's disease diagnosis results were equivalent to those of the best human expert while its treatment outperformed all those of the human experts. In the Insect's as well as in the nutrition deficiency subsystem, the expert system's diagnosis results surpassed those of the other human experts. However, its treatment results ranked third among the human experts.

Results of research perused in this section showed that the expert system had the best overall performance among all the treatments, since it was built with the combined effect of several human experts. Therefore, it prompted the researcher to compare the performance of AES with human experts among the prospective stakeholders.

2. 8. Suggestions for improving AES

Hochman *et al.* (1994) found out that not a single respondent rated decision support systems as 'not useful'. However, advisers wanted systems to be more 'user friendly', more reliable/ accurate, and required less time to master. The growth of the system and the time spent on user consultation plotted against calendar time showed that development activity was driven by consultation with users. It also increased the users' acceptance and knowledge of the new technology.

Rao *et al.* (1999) reported that majority of the farmers and agricultural officials were willing to undergo training for using expert system in TOT as it directly concerned them. The potential for designing short training session for using expert system for TOT and related activities needed to be exploited on a priority basis. The recommendation without graphics was preferred by farmers whereas Extension officials preferred it with graphics for interpretation analysis in TOT. Interactive video type expert system had been preferred by all for effective training. Expert systems which were highly crop specific or technology specific were preferred over the general packages. Increased accessibility to computer would certainly increase the effectiveness of expert system.

Balasubramani (2004) reported that cent per cent of the subjects requested to conduct training on the operation of the Expert System. A majority (88.33 per cent) of the subjects felt one day training was enough to familiarise with operation of Expert System. Cent per cent of the subjects suggested keeping the CD with Expert System packages in Rubber Producers Societies (RPS). A great majority of them suggested to keep with field officers of Rubber Board (86.67 per cent), Krishi Club

(68.33 per cent) etc., in that order. A great majority (96.67 per cent) of farmers stated that they could afford to buy the Expert System packages and computer through groups. Cent per cent of the subjects felt that they needed assistance to purchase computer and CD loaded with Expert System.

Chatterjee and Prabhakar (2005) found out that that the presence of a number of desired features in any ICT system design for rural India lead to higher user satisfaction. Such features were broadly aimed at satisfying one or the other of the following immediate user objectives: ease of access, up-to-date content, layout, design, consistent themes, easy navigation, higher interactivity, access through multiple media (particularly voice), higher use of non-textual information, language options and lower cost of transaction.

Reddy *et al.* (2005) suggested that the system should be more interactive. It should be an integrated project for weather information, soil strengths, crop patterns, inputs, pest control, pre and post harvest technologies and if possible to see and plan the needs of a farmer. e-Sagu advises should be extended to all the crops and agricultural allied aspects viz., animal husbandry, poultry etc for effective farming. Advices should be given in local language for easy understanding and adoption.

Sunil (2006) suggested developing more location and language specific software to enhance the use of the information and decision support system. He suggested a strategy for popularizing the system as a tool for transfer of technology.

It can thus be noted that the suggestions to improve the user friendliness of AES included development of location and language specific soft wares, improvement in the layout and higher interactivity. The suggestions from users' level would be of great help to the researchers to enhance the user friendliness of AES. Therefore an attempt was made in this study to invite the suggestions of the prospective users of AES developed by Kerala Agricultural University. From the above review it could be derived that AES had served as an efficient extension tool in the dissemination of information in the absence of human experts. Kerala Agricultural University has been engaged in developing AESs, which are to be released shortly. Hence a study on the performance of AES as assessed by prospective stakeholders was considered contemporary and relevance.

The review of literature has provided sufficient insight to identify the independent and dependent variables for the present study. Some variables were also identified through pilot study as well as discussion with judges. Based on this, a conceptual model has been developed and presented in Fig.1. Having gained sufficient idea and insights through this conceptual framework, the research methodology for the study was developed and presented in the next chapter.

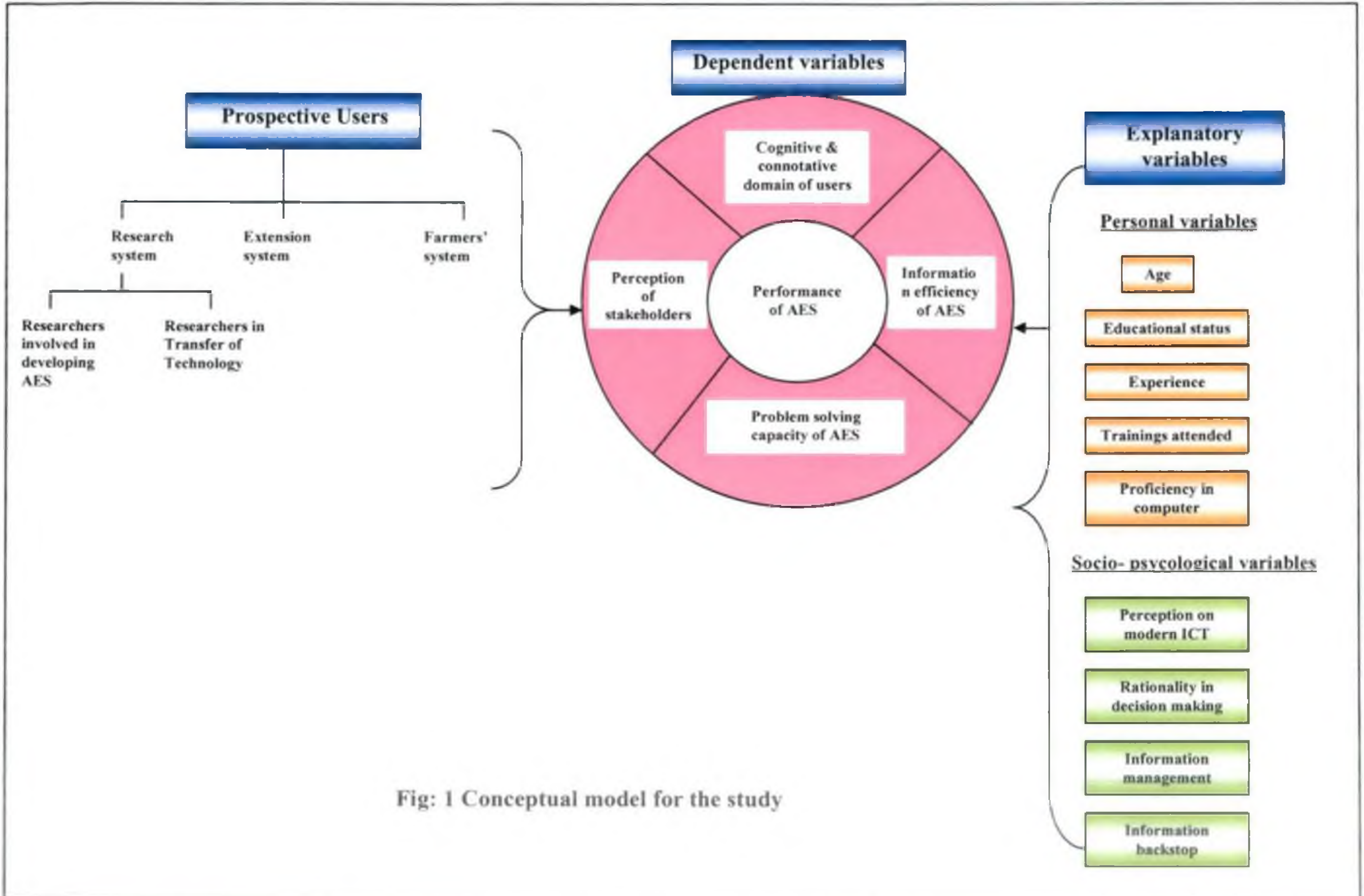

Fig: 1 Conceptual model for the study

Methodology

CHAPTER III

RESEARCH METHODOLOGY

A systematic way of presentation of research design is indispensable for a research that requires tangible results. This study was conducted to assess the performance of AES among the prospective users. The study being one of the pioneering attempts, careful endeavour has been made to outline the procedure followed. According to the specific objectives, the methodology adopted in the study is presented in the following sub headings:

3.1 Research design
3.2 Appraisal of AES available in India
3.3 Selection of AES
3.4 Locale of the study
3.5 Selection of respondents
3.6 Operationalisation of concepts used in the study
3.7 Hypotheses set for the study
3.8 Selection and measurement of variables
3.9 Procedure used for data collection
3.10 Statistical tools used for the study

3.1 Research design

Research design is the plan, structure and strategy to carry out research. According to Kerlinger (1964), it gave direction to the research and showed how things should be planned and carried out the research. Keeping in view of the objectives of the study, the research was conducted among the prospective users in two phases viz., exploratory design among researchers and experimental design among extension personnel and farmers.

Exploratory design was an initial research which analyzed the data and explored the possibility of obtaining as many relationships as possible between different variables without knowing their end application. Researchers could explore the possibility of using general findings in future (Paneerselvam, 2004). It helped the researchers to gain more insights in identifying areas of further study. Exploratory research design was adopted to identify the expectations of researchers in AES development and to assess the perception of researchers in TOT about the performance of AES.

Between group-randomised design was considered in the second phase of the study among extension personnel and farmers. This design could enable the researcher to select the groups randomly and separately for each treatment (Singh, 1986). Moreover, this was the classical experimental design to assess the performance of AES at the users' level subjected to different treatments and facilitate the researcher for comparative analysis.

3.2 Appraisal of AES available in India

An attempt to collect information on the details of Agricultural Expert System related to crops in India were made by contacting the researchers involved in developing Agricultural Expert System by post and through e-mail. The researchers were identified in discussion with experts, organizations, referring literature and through internet. Thus, the identified researchers were requested to mention the name of the AES developed or assisted by them, subject covered, name of the program used, year of development and the status on release. Collection of their responses gave details about the developments happening in the field of AES development in India.

3.3 Selection of AES

The application of expert system technology to agriculture seems natural, considering the widespread use of it among extension agents in the field. Aid from experts, who have encoded their knowledge in computer programs, may help alleviate some of the problems in agriculture. These software programs typically fit into the category of decision support tools. Although there is no general standard for expert systems, most include a knowledge base of domain facts, an inference procedure or control structure for utilizing the knowledge base and a natural language user interface. The expert system is designed to answer questions typed at a keyboard attached to a computer on such diversified topics, such as, pest and disease management, the need to spray, selection of a chemical to spray, mixing and application, optimal machinery management practices etc. Artificial intelligence (AI) is already very much a part of everyday life in industrialized nations. AI is helping people in every field make better use of information to work smarter, not harder. Some expert systems are designed to take the place of human experts, while others are designed to aid them. Expert systems are also increasingly being used in the management of agricultural operations for competitive production of crops. Several agricultural research institutions are engaged in developing AES to transfer their technologies to the users, keeping in pace of the developments in the field of Information Technology.

Kerala Agricultural University, Vellanikkara, Thrissur initiated a project on 'Development and field testing of expert system as an aid to agricultural extension work' during 1997 with the assistance of the Indian Council of Agricultural Research (ICAR), New Delhi. The software was named 'Diagnos-4'. It is a computer-assisted software for the identification of major and minor pests and diseases of nine identified crops such as rice, coconut, banana, pepper, cashew and vegetables like amaranthus, bhindi, cucurbits and brinjal. It also suggests management measures for combating pest and diseases. This package is aimed to support the agricultural extension workers and literate farmers for decision-making and aid them in suggesting suitable control measures of the major pests and diseases of important nine crops of Kerala (Ganesan *et al*, 2002). As part of the project implementation, the knowledge base of the system has been validated in consultation with the scientists of different research stations of Kerala

Agricultural University and the officials of the Department of Agriculture. No systematic users' level study has been conducted so far to assess the user friendliness of the system. This study tries to fill the gap and facilitates to improve the user friendliness of the system by giving more thrust on the sociological point of view.

It is true that India possesses valuable agricultural knowledge and expertise. However, a wide information gap exists between research and practice. Timely expert advice regarding crop protection is the most needed information among the farming community. Hiranand and Singh (1981), Ganesan (1982), Meera (1995), Thomas (2004) and Ahire and Kiran (2007) reported that farmers had low and medium level of knowledge in the integrated pest and disease management practices. Jabbar (1996) stated that plant protection was the most preferred area where training was required. Sunil (2006) reported that the most important need of farmers was on management of various plant protection problems. Anantharaman (1991) found that farmers remained backward in information management. Plant protection aspects were highly knowledge intensive and due to lack of knowledge, farmers depended on pesticide dealers for advice. The information about plant protection measures during critical stage in right time was a crucial factor. The timely availability of information in terms of plant protection helped the farmers to take right decision that boost yield and economic benefit (Batra *et al.*, 2006).

From these studies, it could be derived that farmers need to be educated on integrated pest management. Integrated pest and disease management measures was the most demanding information among the technology users 'Diagnos-4' is a concise capsule form of recommended measures offering finger tip solutions to the users. As already stated, it is a computer-aided software, incorporating all the modern features with multimedia and graphics. This formed a pioneering and ambitious programme of Kerala Agricultural University in this field and hence was selected purposively for the study.

3.3.1 Description of 'Diagnos-4'

'Diagnos-4' is the Agricultural Expert System, specially designed software for tackling the problems in transfer of technologies related to plant protection aspects of important crops of Kerala. A 'Tutorial page' has been provided to familiarize the users about this package, before using 'Diagnos-4'. The home page designed for this tutorial is developed in such away that it leads the users to all the features of the package. Navigating from the home page, the user will know about the expert system, operation of expert system and cultivation practices of selected crops. While navigating on the graphical button 'Crop Protection System', a well-animated page appears with a list of all possible complaints of the selected crops. The user when selects a complaint, a list of symptoms will appear on the screen. While answering questions with 'YES' or 'NO' appearing in each new window will finally lead to an advice page with list of management measures including cultural practices, chemical and biological control methods. Video clippings, photographs and graphics are provided in the software to help the user to confirm the symptoms. A copy of the first page and home page of the software is given in Fig: 2 and 3.

3.4 Locale of the study

The first phase of the research was conducted among the researchers from the Agricultural Research Institutes all over India, who are involved in developing AES and TOT. Researchers are considered as one of the stakeholders in the development and use of AES. At the national level, Institutes under Indian Council of Agricultural Research (ICAR) and State Agricultural Universities (SAUs) are engaged in technology development specific to the agro ecological region and its dissemination. As part of dissemination of technologies, majority of the institutes are currently developing AES utilizing the advances in Information and Communication Technologies (ICTs). Apart from these institutes, few other institutes related to Information and Communication Technologies (ICTs) are also involved in the development of AES. Hence, the researchers both involved in

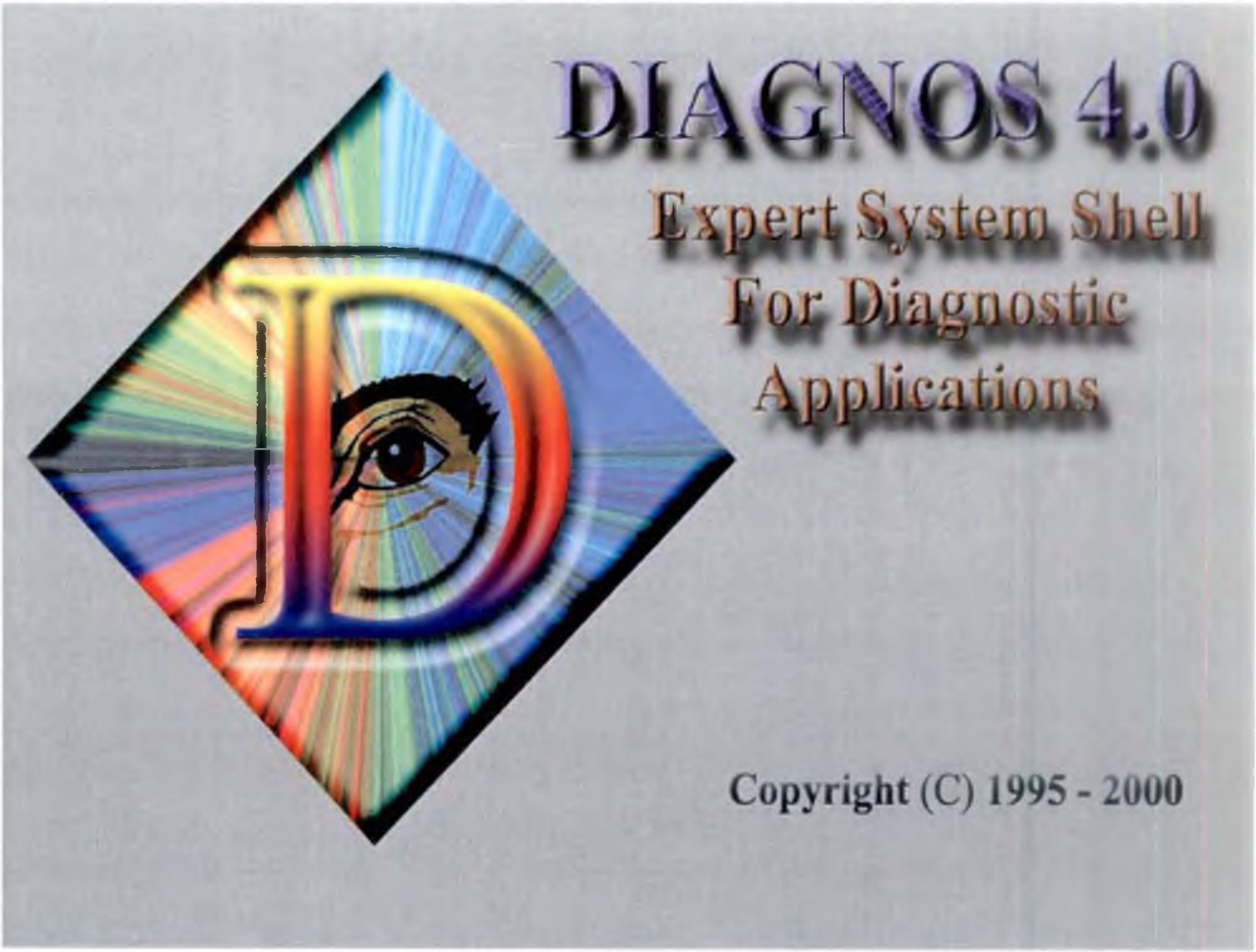

Fig: 2 First page of the 'Diagnos- 4'

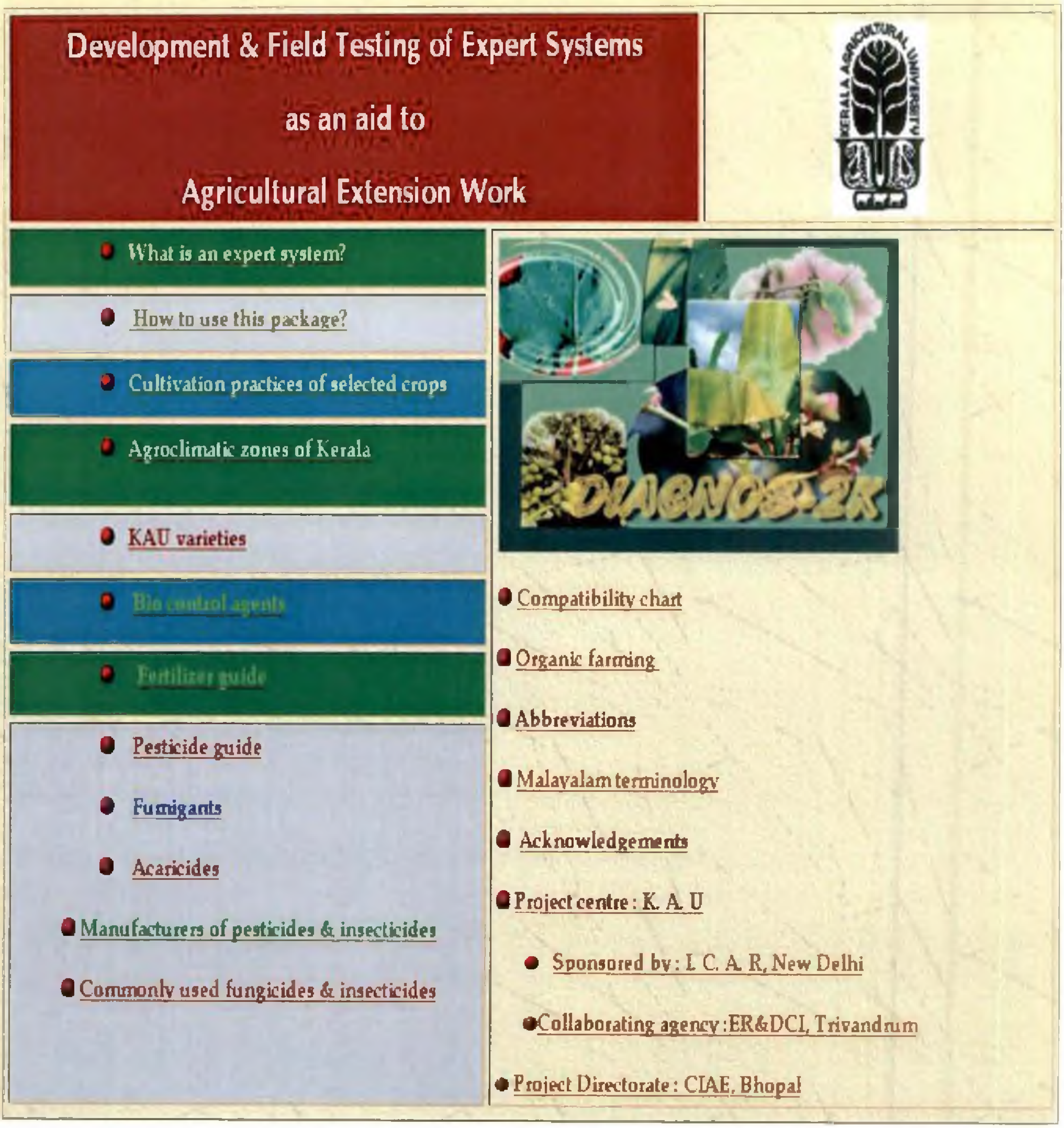

Fig: 3 Copy of the Home page of 'Diagnos- 4'

developing AES and TOT from these research institutes were selected at a national perspective.

Second phase of the research was conducted among the extension personnel and farmers in the Palakkad district of Kerala. Palakkad district is situated in the South West Coast of India. The district is bounded on the North by Malappuram District, in the East by Coimbatore district of Tamilnadu, in the south by Trichur district and in the west by Trichur and Malappuram districts. Topographically the district can be divided into two regions, the low land comprising the midland and the high land formed by the hilly area. The soil is laterite in the hill and mid land regions. The main crops cultivated are paddy, coconut, banana, rubber, pulses, vegetables, areca nut, tapioca, ginger, groundnut, sugarcane, cotton etc. Paddy, coconut and banana occupy the predominant place among the major crops of Palakkad District. (Government of Kerala, 2007)

Palakkad district accounts for about 11.5 per cent of the total land area of the state of Kerala, with the share of population is 8.20 per cent. Agriculture is the main occupation of the people of the district. Eighty per cent of the rural population of the district is agriculturists or agricultural laborers. Area of the district is 4480 sq.k.m. The district has achieved cent per cent literacy in 1991. Palakkad is one of the major paddy growing areas in the state. It is often called as the "Gateway of Kerala". The Sahya Ranges bordering the region and the 32Km long gap in the mountains exert a dominant influence on the climate of the region. This Gap is known as "Palakkad Gap".

Kerala state has initiated many Information and Communication Technology (ICT) projects to increase the application of Information Technology (IT) in all walks of life. Palakkad district is one of the leading districts in Kerala where ICT initiatives of Kerala Government through Information Kerala Mission are implemented in the form of FRIENDS (Fast Reliable Instant Efficient Network for Disbursement of Services), SEVANA (Internet facility in rural libraries), AKSHAYA and KISSAN Kerala *(Karshaka Information Systems*

Services and Networking), etc. Krishi Bhavans in Palakkad district are being computerized as part of ICT initiatives of Kerala Government. There are greater chances of installing AES after its release in Krishi Bhavans to provide fingertip solutions to farmers. Introduction of AES as part of cyber-based extension will form a milestone in Kerala's agricultural development that provides all required information about all possible questions of extension personnel and farmers. Hence, Palakkad district was selected purposively for conducting the study among extension personnel and farmers (Fig: 4).

3.5 Selection of respondents

Three groups of respondents, viz., researchers, extension personnel and farmers were considered as the stakeholders of developing and using AES and hence they were found necessary as respondents for the study.

3.5.1 Researchers

The category of researchers was further grouped into researchers involved in developing AES and the researchers in TOT. Based on purposive sampling, these two categories of researchers were selected as respondents to find out the expectations of researchers on the potentials of AES in the near future. Collection of relevant literature from research journals and Internet and discussion with the experts in the university helped in identifying the researchers involved in developing AES and researchers in TOT. Researchers in TOT were the scientists, who lead the technology transfer from the research system to the extension system.

After an exhaustive search through literature forty-two researchers involved in developing AES and seventy-five researchers in TOT were selected and the standardized questionnaire were mailed to them. They were contacted regularly through personal letters, e-mail, telephone and personal visits and collected their responses. Responses from 28 responses from researchers involved

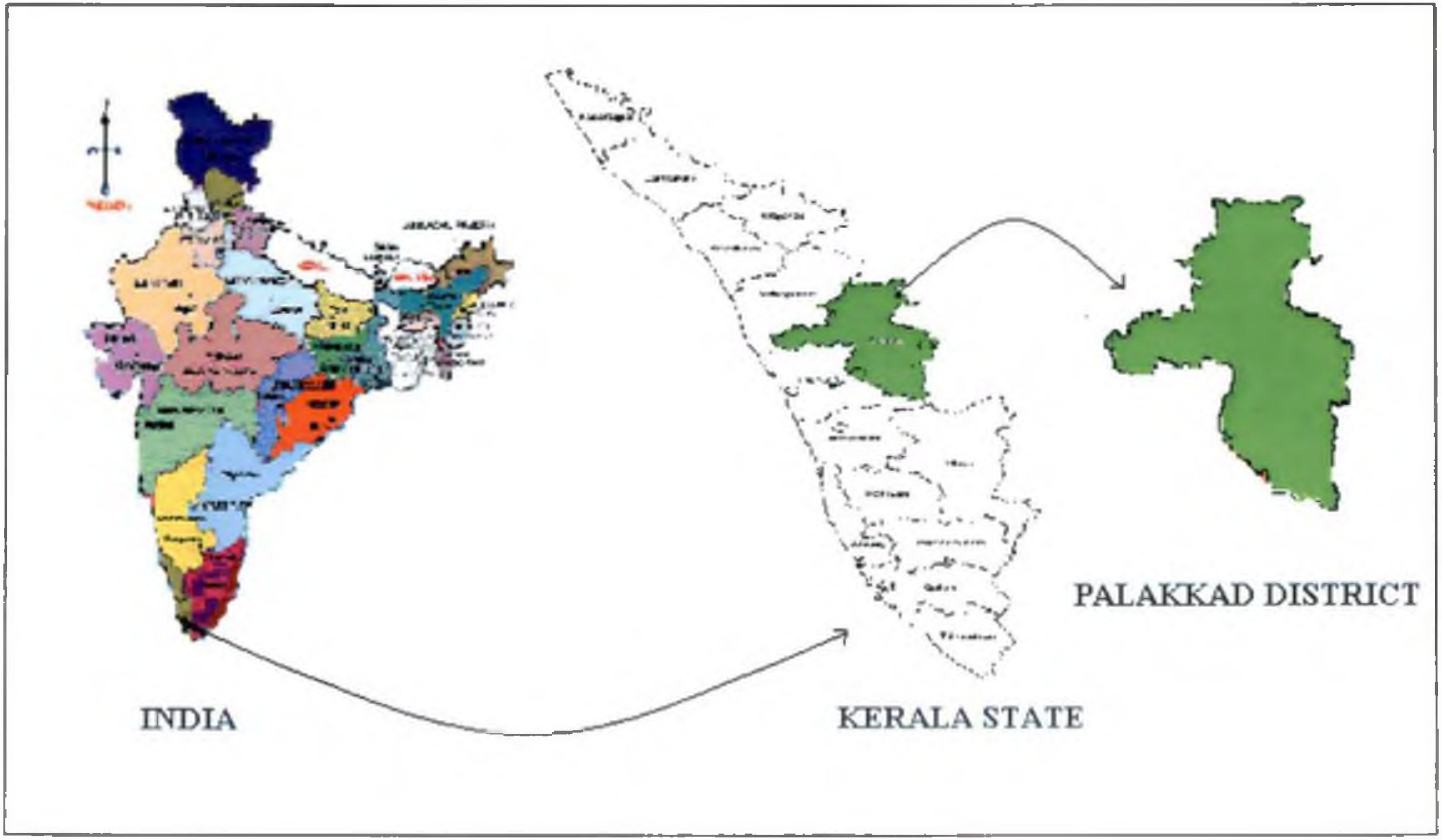

Fig: 4 Map showing the study area

in AES development and 43 responses from researchers in TOT were received ultimately. Based on the completeness of responses, 25 researchers in AES development and 40 researchers in TOT were finally included in the study.

3.5.2 Extension personnel

Extension personnel working in the jurisdiction of Palakkad District constituted the second group of respondents. Using the random sampling technique, they were categorized into four treatment groups viz; T_1, T_2, T_3 and T_4. Thirty extension personnel formed each treatment group.

T_1 - In this treatment group, socio-personal profile and the existing cognitive domain related to plant protection aspects of rice, coconut and banana of the respondents were assessed by administering them a standardized questionnaire before providing exposure on either of the system.

T_2 - Second treatment group was exposed with human expertise by way of exposing them to a lecture class on plant protection aspects of rice, coconut and banana by experts in Plant Pathology and Entomology, who clarified their doubts on field problems by way of discussion. At the end of the session, they were administered with standardized questionnaire for obtaining their responses related to socio-personal profile, information gain related to plant protection aspects of rice, coconut and banana, sufficiency of solutions received for their field problems.

T_3 - Third treatment group was given an exposure on the use of 'Diagnos-4' by the researcher. The software was demonstrated before the group about the general setup in the software and how to retrieve information from it. The respondents were allowed to practice themselves to retrieve needed information. At the end of the session, they were provided with the standardized questionnaire for collecting their responses related to socio-personal profile, information gained related to plant protection aspects of rice, coconut and banana, sufficiency of solutions received for their field problems and their perception towards the performance and potentials of AES.

T_4 - Fourth treatment group was exposed with the combined effect of T_2 and T_3 and their responses were collected.

3.5.3 Farmers

Representative farmers formed the fourth group of respondents from the selected panchayaths of Palakkad District. By following purposive sampling technique, farmers who had a minimum educational attainment of secondary education were selected since the system demanded basic literacy for its use. They were also categorized similar to the groups of extension personnel. Farmers from Kottayi, Polpully and Thathamangalam panchayats formed the treatment groups.

3.6 Operationalisation of concepts used in the study

3.6.1 Prospective users

Prospective users are the immediate potential users of 'Diagnos-4'. They are likely to use 'Diagnos-4' in their profession, expecting immediate fingertip solutions to the field problems faced by them. 'Diagnos-4' will be released by Kerala Agricultural University after necessary modifications. Researchers in TOT, extension personnel and farmers are expected to use it to satisfy their information need. These three groups of stakeholders are therefore considered to be the prospective users of 'Diagnos-4'.

3.6.2 Cognitive domain

Bloom *et al.* (1956) in their taxonomy of the cognitive domain arranged educational objectives in a hierarchy from less to more complex level such as knowledge, comprehension, application, analysis, synthesis and evaluation. They further clarified that cognitive domain involved knowledge and the development of intellectual skills. That included the recall or recognition of specific facts, procedural patterns and concepts that serve in the development of intellectual abilities and skills.

Cognition is a generic term referring to such higher mental processes as representational learning, concept acquisition, comprehension of sentences, meaningful problem solving, thinking, meaningful retention, judgment and to such simpler forms of learning as conditioning sensorimotor and discrimination learning. (Ausubel *et al.*, 1978, Jerry *et al.*, 1978) stated that values, attitudes, beliefs, and needs were the key components in a receiver's cognitive system. They served to influence the quality of audience responsiveness. They acted like gatekeepers by maintaining constant vigil and monitoring every bit of new information that comes by.

Wiig (1991) defined cognitive domain as the personal mental approach and reasoning style of an individual. Cognitive styles included preferences for graphic or verbal representations of concepts, hemispheric dominance and many other factors. The cognitive dimension of a capability involves gaining of an understanding, knowledge and information in order to perform the task (Rao, 1991). Knowledge was truth, approaches, judgments and methodologies that were available to handle specific situations. Knowledge was used to interpret "information" about a particular circumstance or case (Wiig, 1991). Rajkamal (2001) stated that knowledge assessment required an appropriate measurement tool such as cognitive scale. Therefore, a cognitive scale to measure the level of knowledge of backyard poultry keepers about scientific management of backyard poultry was developed.

Cognitive domain in the study refers to the existing knowledge among the respondents on selected technologies related to plant protection aspects of rice, coconut and banana.

3.6.3 Connotative domain

Morgan *et al.* (1956) explained connotative meaning as the emotional and evaluative meaning of words and concepts. Connotative meaning was a relationship between a sign, an object and a person. Connotative meaning is person oriented. It was most closely related to personal experience. Judgements were sentences that emphasize connotative meaning (Berlo, 1964). Connotative meaning was the idiosyncratic attitudinal or affective reactions elicited by a concept name (Ausubel *et al.*, 1978). Connotation indicated the sentiment and feeling of persons about an object. It thus indicated the general implications that the object has for the person (Singh, 1986).

Theodorson and Theodorson (1970) explained perception as the selection, organization and interpretation by an individual of specific stimuli in situation according to prior learning activities, interest and experience. Harrison (1972) referred perception as the inferred psychological process that organized, structured and interpreted the incoming information. Sartain *et al.* (1973) defined perception as the interpretation of sensory inputs. It involved finding meaningful interpretations of our experiences. Ausubel *et al.* (1978) stated that perception as which involved the generation of an immediate content of awareness from stimulus input. Nehru (1993) defined perception as the awareness and consciousness derived from a stimulus by an individual. Alex (1994) referred perception as the thinking and feeling function of respondents. Krishnankutty (1995) operationalized perception as how far a respondent viewed, analysed and interpreted by himself/herself about the intended object. Perception was the process through which selection, organization and interpretation of information gathered by our senses in order to understand the world around us (Greenberg, 1999).

For the purpose of this study, connotative domain is considered as the perception of different categories of respondents about the performance of AES. Only the perception level of the respondents was measured since AES was not popular and not used by many of the respondents at the time of the conduct of the study. Perception was operationalized as the views, opinion and understanding of the respondents about the performance of AES.

3.6.4 Performance

Performance was referred to as a function of an individual's ability, knowledge and motivation by Devar (1969). Sobhana (1982) operationally defined performance as the role being actually performed by virtue of occupying a particular position. Alex (1994) defined role performance as the action function performed by the agricultural laborers in relation to decision making by the farmers employing them in paddy production process.

In this study, performance of AES was operationalized as the ability of the 'Diagnos-4' to provide information and technical solutions for taking decisions in farming or to confirm the recommendations when the users face problems in the field.

3.7 Hypotheses set for the study

Keeping in view of the objectives, review of literature and discussion with experts, the following null hypotheses were framed for the present study:

1. There would be no significant relationship on the expectations of the researchers in the development of AES and the agricultural researchers in TOT on the performance of the AES.

2. There would be no significant agreement among the perception of farmers, extension personnel and researchers about the performance of the AES.

3. There would be no significant difference of AES in terms of the information efficiency of the system among the extension personnel and farmers after getting its exposure.

4. There would be no significant difference in the problem solving capacity of AES among the extension personnel and farmers after getting its exposure.

3.8 Selection and measurement of variables

3.8.1 Selection of independent variables

Based on the objectives of the study, review of literature and discussion with experts, a list of 30 variables related to the assessment of the performance of AES were identified. They were operationally defined and subjected before 30 judges comprising of scientists of Kerala Agricultural University, Thrissur; Tamil Nadu Agricultural University, Coimbatore; National Academy of Agricultural Research and Management (NAARAM), Hyderabad and National Institute of Agricultural Extension Management (MANAGE), Hyderabad. Personal discussions were held with the judges for eliciting their relevancy rating by the researcher in a five-point continuum ranging from 'most relevant' to 'least relevant'. (Appendix: I) The scores were assigned as follows:

Response	Score
Most relevant	5
More relevant	4
Undecided	3
Less relevant	2
Least relevant	1

The variables were selected based on the Relevancy Index. Relevancy Index was worked out as follows:

$$\text{Relevancy Index (RI)} = \frac{\text{Total actual score obtained by the variable}}{\text{Total maximum possible score that variable could secure}} \times 100$$

In this study, the Relevancy Index of the variables ranged from minimum of 58.00 to a maximum of 93.3. The average of minimum and maximum was taken as the cutting point (75.65) for the selection of variables for inclusion in the study. Thus, 14 variables that secured a Relevancy Index of above the cutting point and common among different respondent groups were selected for inclusion in the study. The lists of finally selected variables with Relevancy Index (RI) are shown in the Appendix-II.

3.8.2 Independent variables

3.8.2.1 Age

Age was operationalised as the number of completed years of respondents at the time of investigation and the chronological age was taken as a measure. All the categories of respondents were classified into three categories, viz; young, middle and senior based on Census Classification method with slight modifications. The intervals were followed as given below:

Sl. No.	Category	Years
1	Young	Up to 35 years
2	Middle	36 to 45 years
3	Senior	Above 45 years

3.8.2.2 Educational status

The educational status was operationally defined as the extent of literacy attained by the respondents. It was measured by adopting the scoring system followed in the socio-economic scale of Trivedi (1963) with modifications. In this study, educational status refers to the completion of important stages of formal education system undergone by the different categories of respondents at the time of enquiry. The scoring procedure adopted was as follows:

Sl. No.	Researchers		Extension personnel		Farmers	
	Category	Score	Category	Score	Category	Score
1	Post graduation	1	Graduation	1	Up to secondary school	1
2	Doctorate	2	Post graduation	2	Secondary school completed	2
3	Post doctorate	3	Doctorate	3	Graduation	3

3.8.2.3 Experience

Baby (2001) operationalised experience among researchers as the number of completed years of service by the respondents in the field of agricultural research at the time of enquiry. Kamalakkannan (2003) defined experience as the number of years a farmer had been involved in vegetable cultivation on commercial basis, and was measured in number of completed years. In this study, the respondents were categorised base on the method followed by Padmaiah and Ramanjanayulu (2005). Experience was operationalised based on the number of completed years of experience by the respondents in their own profession at the time of investigation. One score was given to every additional class of experience in their own profession. The respondents were categorised into three classes as low, medium and high experience.

Sl. No.	Class	Category	Scores
1	Low	Upto 10 years	1
2	Medium	11-20 years	2
3	High	Above 21 years	3

3.8.2.4 Awareness about AES

Murthy and Singh (1974) measured awareness and followed by Nehru (1980). They measured awareness by asking the respondents to state what sources of information were generally known to them. Salunkhe (1978) measured awareness of farmers by asking questions on different aspects of Small Farmers Development Agency's activities and giving scores for each correct answer. Cherian (1984) adopted the method followed by Naik (1981) to measure the awareness of respondents about T&V system. Singh (1989) measured the level of awareness of development programmes of illiterate workers by administrating an oral test with some items of 'yes/no' type and some others of 'open end' type. Babu (2005) measured the level of awareness of respondents regarding various Information and Communication Technologies (ICTs). Respondents were asked to choose their level of awareness about eight ICTs corresponding to three levels of awareness namely aware, partly aware and not aware. The total score obtained by the respondents was taken as their awareness about ICTs.

For the purpose of this study, awareness about AES was operationalised as the level of awareness of respondents about the functions of AES. To assess the awareness about AES, respondents were asked to define AES and list out the AESs that were known to them. Based on their responses they were assigned scores from five to one and classified into low, medium and high categories based on cumulative frequency method.

3.8.2.5 Trainings undergone related to ICT

Mathew (1989) referred training as the total number of trainings attended by the scientist in service within and outside the organization. It was calculated in weeks. Baby (2001) followed the procedure adopted by Mathew (1989).

The scoring procedure followed by Balasubramani (2004) was adopted in this study with suitable modifications. It was operationally defined as the number of trainings undergone by the respondents so far in the subject matter related to Information and Communication Technology (ICT). The scoring procedure was adopted based on the number of trainings undergone by the respondents. If he/she had attended a training, then he/she was awarded with the score of two. For each additional training, score of two was given. If he/she had not attended any training, then he/she was left with the score of one. Based on the total scores the respondents were classified into low, medium and high using cumulative frequency method.

3.8.2.6 Proficiency in computers

It refers to the expertise and the frequency of use of computers by the respondents. A separate schedule was developed for the study. Seven items were identified to assess the proficiency in a five-point continuum scale- five indicates that the respondents always use computers and one indicates that the respondents never use computers. The scores in between in the decreasing order show the degree of decrease in the level of their usage. The respondents were categorised into low, medium and high using cumulative frequency method.

3.8.2.7 Experience in computer use

It refers to the number of years the respondents used computers for information retrieval at the time of conducting the study. The respondents were categorized based on the number of years they used computers.

Sl. No.	Researchers		Extension personnel		Farmers	
	Category	Score	Category	Score	Category	Score
1	< 5 years	1	< 5 years	1	Not using	1
2	5-10 years	2	5-10 years	2	< 5 years	2
3	11-15 years	3	11-15 years	3	5-10 years	3
4	16-20 years	4	-	-	-	-
5	> 20 years	5	-	-	-	-

3.8.2.8 Perception about ICT

Babu (2005) operationally defined perception towards ICT as the meaningful understanding of people about various aspects of ICTs. It was assessed using 20 statements and the respondents were asked to choose from a five-point continuum. For positive statements, a score of 5,4,3,2 and 1 respectively was given. Negative statements were scored in the reverse order. Hence the scores ranged from 20-100. Mean perception score was calculated for each category of respondents.

In this study, the scoring procedure followed by Balasubramani (2004) was adopted with necessary modifications. It was operationalised as the level of agreement of respondents towards the performance of modern Information and Communication Technologies. The perceived opinion of the respondents about modern information communication technologies with respect to information access, decision-making, self learning etc. were collected. A score of two was given for their positive response and one was given for their negative response against each statement. The scores obtained for each statement by an individual respondent were summed up and the total was the perceived opinion score for an individual respondent. The respondents were categorized into high, medium and low based on the following criteria:

High :	Above (mean + 1 S.D)
Medium:	Between (mean ± 1S.D)
Low :	Below (mean – 1 S.D)

3.8.2.9 Rationality in decision-making

Supe and Singh (1969) inferred that the act of an individual was considered rational to the extent to which he justified his selection of most efficient means, from among the available alternatives on the basis of scientific criteria for achieving maximum ends. Geethakutty (1993) defined rationality in decision making as the ability of an individual to select those 'means' which were justified of bearing rationality from various 'means' available at his disposal to reach an end. Deepa (1999) defined rationality in the decision making as the quality or the status of the respondent of being logical and high acceptability of reasonableness as perceived by the respondent. This covered the discriminating ability of a farmer to say, what, when, where, to whom and to what extent. The scale developed by Vipinkumar (1994) was used by Deepa (1999).

Rationality in decision-making behaviour was assessed by following the procedure developed by Mathew (1989) with modifications appropriate to the present study. Six items were adopted with a five point continuum ranging from '5' indicates 'always' to '1' indicates 'never'. The scores in between in the decreasing order show the degree of decrease in the level of time taken by the respondents in decision making. The responses of the respondents were categorized into high, medium and low based on the following criteria:

High :	Above (mean + 1 S.D)
Medium:	Between (mean $\pm$ 1S.D)
Low :	Below (mean – 1 S.D)

3.8.2.10 Behaviour of information source utilization

Behaviour of an individual is a function of the sources of information. An individual gaining knowledge from different sources will have a direct bearing on his performance. Prakash (1989) measured the behaviour of information source utilization. Each respondent was asked to indicate as how often he got information regarding agricultural technologies from the listed sources. The scoring pattern was most often to never with a corresponding score 3 and 0.

The scale developed by Boniface (1996) was adopted with modifications to measure information source utilization pattern. The relevance of sources was identified through judges' opinion and assigned scores based on the frequency of consultation for information by the respondents. The scoring pattern ranged from 'Always-5' to 'Never –1'. The scores thus obtained by each respondent were added together and categorized as low, medium and high.

3.8.2.11 Information utilization behaviour

Rajendran (1992) and Jabbar (1996) operationalzed similarly the concept of utilization, as the acceptance of the practice by the farmers, which was synonymous to the concept of adoption that was widely used in the transfer of technology process. The proper utilization of the practice based on the package of practices recommendation of KAU was created with two scores; improper adoption with one score and non- adoption with zero score. The total utilization score was divided by the number of selected crops raised by the farmer to arrive utilization index. Gullisken *et al.* (2006) defined analysis of information utilization as a method for specifying how information entities encountered in information analysis in the work situation.

In this context, information utilization behaviour was operationalised as the frequency of authentic use of technical subject matter related to the cultivation of rice, coconut and banana in the form of storage, retrieval and educate the technologies in the case of researchers and extension personnel and deployment of technologies in their own field in the case of farmers. The schedule was developed based on the purpose of the study. The subject matter was classified into six items and the respondents were asked to indicate in a five-point continuum ranging from 'always' as 5 to 'never' as 1. The scores in between in the decreasing order showed the degree of decrease in the level of utilization of information. The score for information utilization behaviour was worked out by adding the scores given for each items by individual respondents. They were classified as low, medium and high using the earlier procedure.

3.8.2.12 Information output behaviour

Ambastha and Singh (1976) measured information output pattern as all the activities performed by a researcher for dissemination of scientific information related to summer paddy and dwarf wheat technology. Sanoria and Singh (1976) defined information output pattern as the activities performed by an individual for disseminating scientific and technical information to the clients and it was measured by developing information output index. Pandyaraj (1978) defined information output as the 'ofteness' of utilization of different extension methods by the Agricultural Officers for dissemination of technical information related with HYVs of rice to different category of personnel including farmers. Kareem (1984) operationalized information output as the 'ofteness' of utilization of different interpersonal communication methods by the contact farmers for dissemination of technical information related to fellow farmers. To measure the information output, each respondent was asked to indicate how frequently he/she communicated the technical information the fellow farmers and also asked to indicate how frequently they used different methods for communicating technical information.

In this study, information output behaviour was operationalised as the frequency of the respondents to transfer technical information to the personnel at receiving end. Researchers transfer technical information to extension personnel and occasionally straightaway to farmers, extension personnel transfer technical information to farmers and farmers in turn exchange information among themselves. The possible receivers for the selected respondents were identified and selected based on judges' opinion. The respondents were asked to indicate in a five-point continuum ranging from 'always' as 5 to 'never' as 1 against the selected receivers. The scores in between in the decreasing order showed the degree of decrease in the level of frequency by the respondents to transfer technical information to the clients at the receiving end. Based on the responses, the respondents were categorized as low, medium and high using the earlier procedure.

3.8.2.13 Information feedback behaviour

According to Berlo (1964) the term 'feedback' meant a special aspect of receiver reaction and the reaction was useful to the source for determining its own success. Pandyaraj (1978) operationalized information feedback as the ofteness of receipt of feedback information by Agricultural Officers on technical, administration and supply of inputs aspects of HYVs of rice from farmers and subordinates through different methods. Kareem (1984) defined information feedback as the 'ofteness' of receipt of opinion, feeling, doubts, ideas and thoughts as a result of information given by the contact farmers through different inter personnel communication methods. The respondents were asked to indicate how frequently they receive information feedback from fellow farmers through the different inter personnel communicational methods. They were also asked to indicate how frequently they receive different types of information feedback from fellow farmers.

Information feedback behaviour was operationalized in the study as the frequency of providing opinion, feeling, doubts, ideas and thoughts as a result of information received from the source in relation to rice, coconut and banana cultivation. The procedure followed for measurement of information feedback is given below:

The respondents were asked to indicate how frequently they provide feedback information to the sources. Methods of information feedback were listed out. The level of information feedback regarding technical aspects of subject area were assessed on a five point continuum ranging from 'always' to 'never'. The information feedback score for each respondent was obtained by adding the scores corresponding to the response pattern of the respondents.

3.8.2.14 Information backstop

Information backstop refers to the availability of facilities and opportunities to the users for updating or confirming or gaining new information on technical matter related to farming. The schedule developed by Surendran (2000) and followed by Nath (2004) was modified suitably for the study. The schedule consisted of 5 statements. The respondents were asked to respond to the statements in a five-point continuum ranging from 'always' to 'never' that carried a score of 5 to1 respectively.

3.8.3 Dependent variables

The following dependent variables are selected for the study:

1. Expectations of researchers on the potential of AES.
2. Perception of stakeholders about the performance and potential of AES.
3. Information efficiency of AES.
4. Problem solving capacity of AES.

3.8.3.1 Expectations of researchers on the performance of AES

Every researcher will be expecting a certain degree of success or achievement out of the technology developed by him or her. In this study, the researcher intended to assess the expectations of researchers involved in developing AES with a series of items in a five-point continuum. Initially, 45 items under three dimensions were framed by the researcher after referring literature, results of related studies, own experience and observations of the researcher. The framed items were subjected to judges' opinion to conduct relevancy test. After relevancy test, 25 items under five dimensions were included in the questionnaire. Many items were modified and refined. The identified researchers were asked the degree of potential of AES as expected by them in the five-point continuum, '5' indicated 'Highest potential' and '1' indicated 'Lowest potential' to the corresponding statement. The scores in between in the decreasing order show the degree of decrease in the level of their expectations on the potentials of agricultural expert system.

3.8.3.2 Perception about Agricultural Expert System

Perception is the process of understanding sensation or attaching meaning based on experience to signs. Ashaletha (1993) defined perception as the perceived degree of importance attached to the items to be performed by the respondents. In this study, the perception of the respondents was studied about the performance of 'Diagnos-4', a module of Agricultural Expert System among the prospective users.

3.8.3.2.1 Measurement of perception

Morgan *et al.* (1956) defined perception as whatever was experienced by a person. Balasubramani (2004) measured perception of respondents about the Expert System, from a list of items seeking different contents viz., technical aspects, message components, appearance and layout, voice and utility of Expert System were prepared. These items were administered to the subjects in a three-point continuum namely, most satisfied, satisfied and not satisfied. Based on the scores the perception index was worked out.

Sunil (2006) assessed the perceived utility of the decision support system developed by him among farmers, extension personnel and researchers. They were asked to answer the most important five utilities they perceived. The responses were categorized, analysed and ranked in their order of importance.

In the present study, the perception level of the respondents about the performance of Agricultural Expert System, sixteen dimensions were identified based on available literature and discussion with experts working in the relevant field. They were screened to ten dimensions based on judges' opinion. (Appendix-III). Relevant items were prepared under each dimension and standardized after judges' rating. These items were administered to the subjects in a five point continuum ranging from 'I am most satisfied' with 5 scores to 'I am not at all satisfied' with 1 score. The scores in between in the decreasing order show the degree of decrease in the level of their perception towards the performance and potentials of agricultural expert system. Based on the received scores the mean rank on the perception was calculated using Kendall's Coefficient of Concordance.

3.8.3.3 Information efficiency of AES

3.8.3.3.1 The concept of Information

Information efficiency consists of two terms viz., information and efficiency. To develop the concept of information and efficiency it becomes necessary to analyse these component terms.

According to the Oxford English Dictionary, the earliest historical meaning of the word *information* was the act of *informing*, or giving form or shape to the mind, as in education, instruction, or training. The word was apparently derived by adding the common "noun of action" ending "*-ation*" (descended through French from Latin "*-tio*") to the earlier verb *to inform*, in the sense of to give form to the mind, to discipline, instruct and teach.

Logical decisions in farming require an understanding of the technology, inputs, price trends and marketing alternatives which become possible only with proper information gathering and processing. Hicks and Gullett (1981) stated that the more pertinent and timely the information, better would be the resulting decision. Gathering information on technologies, price of inputs and marketing trends help the farmers to make a comparison which would lead to rational decision on cost effective inputs and profitable marketing.

Harsh *et al.* (1981) pointed out that farmers required varied types of information to make decision according to type of farm, location and resources available to them. Singh and Kumar (1983) found that a majority of farmers required information on components like inputs, markets, credit and subsidies. Information described a particular circumstance or case. Information consisted of facts or data and may take on any one of several forms, levels of abstraction and degrees of certainty. Information was used as "knowledge" to reason about a particular circumstance or case (Wiig, 1991).

Computer Encyclopedia (2004) enlisted information as the summarization of data. Technically, data were raw facts and figures that were processed into information, such as summaries and totals. But since information could also be the raw data for the next job or person, the two terms could not be precisely defined, and both were used interchangeably.

Wikipedia (2006) explained that information was a term with many meanings depending on context. But as a rule, it was closely related to such concepts as meaning, knowledge, instruction, communication, representation, and mental stimulus. Simply stated, information was a message received and understood. In terms of data, it could be defined as a collection of facts from which conclusions might be drawn. There were many other aspects of information since it was the knowledge acquired through study or experience or instruction. But overall, information was the result of processing, manipulating and organizing data in a way that added to the knowledge of the person receiving it.

Information was interpreted in different ways in various contexts as follows:

1. Knowledge derived from study, experience or instruction.
2. Knowledge of specific events or situations that has been gathered or received by communication; intelligence or news.

3. Statistical information: collection of facts or data.
4. The act of informing or the condition of being informed; communication of knowledge.
5. Computer science: processed, stored, or transmitted data.
6. A numerical measure of the uncertainty of an experimental outcome.

Information was defined according to the subject it was being used. Information as a concept had a diversity of meanings, from everyday usage to technical settings. Generally, the concept of information was closely related to notions of communication, data, instruction, knowledge, meaning, mental stimulus, perception, and representation. In this study, information referred to the subject matter related to agricultural technologies provided in the AES.

3.8.3.3.2 The concept of efficiency

The word efficiency come from the Latin prefix 'ef' meaning 'out' and fic-meaning 'to do'; make, plus the Latin suffix-ent which is the same as the English-ing. Thus efficient means making or turning out results with little waste of efforts. Drucker (1974) stated that efficiency was concerned with doing things right and concerns itself with the input of effort into all areas of activity. Effectiveness is related to goals which are externally focused. Efficiency is used in engineering way and it refers to the relationship between input and output. This denotes how much inputs have been used to produce certain amount of outputs. It is not necessary that both go together always (Prasad, 2004).

Rosenberg (1978) defined efficiency as the measure of production relative to input of human and other resources. Agarwal (1979) described efficiency as the amount of work performed within a given time. Hicks and Gullett (1981) described efficiency as doing things accurately and with minimum use of time and resources. Padmanaban (1981) defined efficiency as the capacity to do productive work on the farm per man per unit time. Suresh (1983) stated that efficiency was a relative concept. It could not be defined accurately and precisely became efficiency of any economic activity would vary according to working units and motivation of decision making units. Different meanings were attributed to the term like capacity or ability to do things well. It was commonly accepted as an index ratio or per centage. In this sense, the term was a measuring rod to gauge the ratio of performance in terms of numerator and denominator. In general, efficiency has been recognized as an index of performance of the degree of achievement to economic course of action.

Koontz *et al* (1986) viewed efficiency as achievement of the ends with least amount of resources and effectiveness as the achievement of objectives. Verma (1990) stated that efficiency referred to the manners in which goal oriented operation were carried out, generally measured as the ratio of inputs to outputs. Anantharaman (1991) derived efficiency as performing right things (input) to achieve the determined goal (output). Shanthy (1996) defined efficiency as the ability of an individual to do productive work in the right and just manner to achieve the desired result. Literature revealed that there does not seem to have consensus as to the precise definition of the efficiency.

Sanoria (1977) measured communicational efficiency of extension personnel by developing a communicational efficiency index based on the following equation:

$$CEi = \frac{EFi}{(Ci+Fi)\,Jc}$$

Where, CEi – Communicational efficiency index

EFi - Communicational effectiveness index

C i - Cost index

Fi - Facility index and Jc - Job communicational index

Reddy and Singh (1979) developed a communicational behaviour index to measure the communicational behaviour of village level extension workers. The index represented different components of extension behaviour, viz., awareness of the selected agricultural messages through technologically competed sources, knowledge, communicational translation behaviour in respect of selected messages, communicational abilities, communicational skill qualities and channel use effectiveness. Bhaskaran (1979) developed an inter personnel communicational behaviour efficiency index. This referred to the cumulative index obtained by a respondent and indicated the effectiveness of his inter personnel communicational behaviour as measured with reference to the selected sub divisions of inter personnel extension behaviour operationally it indicated a person's extent of effective interaction in inter personnel information exchange situation.

Labour efficiency was explained as the capacity to do productive work on the farm per man per unit time (Padmanabhan, 1981). Labour efficiency referred to the manner in which the different agricultural operations were done by the laborers (Prakash, 1989). Shanthy (1996) defined labour efficiency as the physical and mental ability of an individual to do productive work in the right and just manner to achieve the desired result.

Job efficiency of an agricultural officer was conceived as his ability in achieving his tasks, duties, responsibilities and assignments in the right and just manner to produce the desired results. The right and just manner implies that the activities performed would produce within the framework of organizational objectives and ethics (Nehru, 1993).

Managerial efficiency was defined by Anantharaman (1991) as the consistency with which the farmers undertake mental as well as operational managerial activities with regard to a crop enterprise, which contribute to profit maximisation of that crop enterprise.

In the light of the above views, information efficiency of AES was operationalised as the capacity of the system (Diagnos-4) to provide maximum information at ease to the users. Information efficiency of AES depends on the nature of provided information, how it was presented, ability of the system to provide information at ease to the user, knowledge gain from the system, relevancy and practicability of information to the user.

3.8.3.3.3 Development of scale to measure the information efficiency of AES

The main aim behind the scale development was to construct a scale of general nature so as to enlarge the scope of application of the scale to measure information efficiency of computer aided instruction tools. It was measured with the help of a scale developed for the study. In this direction, a review on various aspects of measurement of communication efficiency, inter personal communication behavioural efficiency, labour efficiency and managerial efficiency was attempted so as to provide a justifiable footing to the measurement procedure of information efficiency adopted for this study. The information efficiency index was composite, reflecting the ability of the system to provide maximum information to the users at ease.

A critical analysis of the literature revealed that no one had attempted to measure the information efficiency of any instructional tool or decision support system. Most of the scales were developed to measure labour efficiency belonged to functional approach. The present study tried to assess the efficiency of the AES by the users in terms of its information efficiency. As this was a pioneering study on this aspect, no standardized procedures were available to measure information efficiency. The items for the scale were prepared after an elaborate review of pertinent literature available, consultation with experts and based on researcher's own conviction.

3.8.3.3.3.1 Item generation

The first step in the development of the scale was to identify all possible items related to information efficiency of AES. The primary source for item collection was literature, discussion with experts in related fields and through critical incident technique. The collected items were screened by verifying its applicability in relation to the performance of AES. Seventy five items were generated and theoretically classified under ten major dimensions. (Appendix-IV). The appropriateness of the items was pre tested with a group of judges.

3.8.3.3.3.2 Preliminary screening of items

The relevancy of the 75 items generated was established by sending these items to 50 judges with proper guidelines. The judges were asked to indicate the relevancy of items on a five-point continuum of 'MOR-Most relevant, 'MR-More relevant', R- Relevant, 'LR- Least Relevant' and 'NR- Not Relevant'. The responses of thirty-five judges were taken into account. The relevancy index for all the items were worked out and presented in Appendix-V. The item having relevancy index of 70 and above were selected for the study.

3.7.3.3.3.4 Item analysis

Item analysis was referred to a set of procedures that was applied to know the indices of truthfulness of items (Singh, 1986). Item difficulty, discrimination index and correlation of items score with total score were the most common indices used in item analysis (Anastasi, 1961 and Guilford, 1971).

While developing managerial leadership scale by Mathew (1989), managerial efficiency scale by Anantharaman (1991) and labour efficiency scale by Shanthy (1996) followed the relevancy test and calculated item discrimination of the items. In this study also, the selected items were administered to 30 extension personnel selected randomly from the non-sample area. The responses were quantified by allotting scores of 5,4,3,2 and 1 for the responses such as 'MOR-Most relevant', 'MR-More relevant', R- Relevant, 'LR- Least Relevant' and 'NR- Not Relevant' respectively. Item discrimination of each item was calculated.

3.8.3.3.3.5 Item discrimination

It refers to the power of an item to discriminate the low efficiency from the high efficiency as assessed by the respondents. The total score for each respondent was found. Following the suggestion of Kelley (1939) high and low level groups were formed by grouping the respondents whose total score fell within top and bottom 27 per cent respectively. The values of critical ratio were used as discrimination index as suggested by Singh (1986) and followed by Shanthy (1996). Item discrimination was worked out by adopting the same procedure.

3.8.3.3.3.6 Selection of items for final scale

The results of the item analysis of the items performed on the basis of discrimination index are presented in Appendix-VI. Fifty items under ten dimensions for researchers, forty six items under nine dimensions for extension personnel and forty items under nine dimensions for farmers, which had significant discrimination were selected for inclusion in the study. Based on the stages of application, the dimensions such as Retrievability, Relevancy, Practicability, Information content, Knowledge gain by the respondents were selected arbitrarily for developing the information efficiency scale.

Retrievability: Retrievability was operationised as finding out the required information without much effort. It was the extent to which the information was easily drawn from the system. It also indicated that the information provided in the system could be easily located by any user with in less time. The received information should be easily understood by the user and could be printed as handout for future reference.

Relevancy: Relevancy of the information was meant as the relation of something to the matter at hand. In this study it was operationalised as the opinion of the respondents about the suitability of the information provided in AES to the users' situation. It was assessed whether the system was able to provide information suitable to the users' resources and appropriate to the users' needs.

Practicability: Practicability of the information was referred as the opinion of the respondent about the feasibility of the information given in AES in the actual field situation. The information given in AES should have direct application in the fields. Practicability was analysed as the viability and possibility of application of the information provided in AES to the users' circumstances. The dimension of practicability was measured whether the information provided in the system was adoptable in the real situation and feasible to the users.

Information content: Information content was measured as the extent to which the information on the subject matter was covered in the system. It was assessed whether the provided information was complete and understandable to the users.

Knowledge gain: Knowledge gain was the quantity of information gained by the respondent before and after exposure of each treatment. Knowledge was the treasure of truth and facts and was a pre- requisite for performing any activity with perfection. It was an inevitable pre-requisite input for efficient management would be a favourable niche to take right decision as well as extension of action in various functional areas of farming.

The scores obtained by each dimension were worked out to form total score. Thus Information Efficiency Index was calculated as follows:

$$\text{Information Efficiency Index} = \frac{\text{Obtained total score}}{\text{Maximum possible score}} \times 100$$

Information. Efficiency Index calculated for each respondent was used to categorize the respondents separately who assessed the system as high, medium and low as follows:

High:	Above mean + 1 S.D
Medium:	Between mean $\pm$ 1S.D
Low:	Below the mean – 1 S.D

3.8.3.3.3.7 Standardization of the scale

The standardisation of the scale was done by establishing the reliability and validity of the scale.

3.8.3.3.3.7.1 Reliability of the scale

The reliability of a test refers to the consistency of scores obtained by some individuals on different occasions or with different sets of equivalent forms (Anastasi, 1961). According to Kerlinger (1964), reliability was the accuracy or precision of measuring instrument. Among the various methods of estimating test reliability, the split half technique was employed in the present study. A single form of a test is administrated once among the respondents to arrive a measure of test reliability by odd- even method. In this method, two scores were obtained for each individual respondent on the odd and even items of the test.

Accordingly the scale was administrated to 30 respondents in a non sample area. Two half scores obtained for each respondent were then correlated using Pearson's product moment correlation formula. The r value was 0.85 which was found to be highly significant indicating excellent reliability for the scale.

3.8.3.3.3.7.2 Validity of the scale

A scale is said to be valid when it actually measures what it claims to measure (Goode and Hatt, 1952). The validity of the IEI scale was ascertained using the following procedures:

Content validity is concerned with whether or not the test covers a representative sample of behaviour domain to be measured (Anastasi, 1961). This was ensured during the preparation of the scale itself during which time, utmost care was taken to include all the items to represent the universe of contents. It includes both face validity and sampling validity. The main criterion is to determine whether the test contains items that are related to the variable being measured and appropriate to the mentioned purpose, and how best the contents of the scale sample the subject matter under study.

For the present study, six dimensions were identified with different number of items that were selected meticulously through scientific procedures to represent these dimensions. The items had been further subjected to item analysis to determine their relevancy to assess the IEI of AES. Such a way of meticulous and rigorous procedures followed in developing the scale automatically ensured it with high facing and sampling validity.

3.8.3.3.3.8 Knowledge test

To assess the knowledge gain among the respondents from AES, the respondents were subjected to 15 items twice on plant protection aspects of rice, coconut and banana as pre exposure and post exposure sessions on AES. The difference in gain in knowledge was assessed as the knowledge gained from the system. A knowledge test was constructed as suggested by Anastasi (1961). In order to measure the knowledge provided by the expert systems on plant protection technologies of rice, coconut and banana, a knowledge test was developed using the steps as given under:

3.8.3.3.3.8.1 Item analysis

Based on the relevant studies, frequently asked questions noticed in the related journals, discussion with scientists, extension personnel, observations and experience of the researcher, 20 items each from the plant protection technologies of rice, coconut and banana constituting 60 items were chosen for item analysis.

These items were presented before a group of scientists and extension personnel to ascertain the relevancy of the items (Appendix: VII). Four choices were given as response options for each item. Every correct answer received one score while the incorrect answers were given with zero score.

3.8.3.3.3.8.2 Administration of items

Sixty items were administered among respondents in the non sample area. The total score for each item was calculated and then the items were arranged in the descending order of the obtained score. Among the 60 items, the top 20 items and bottom 20 items were deleted. The 20 items in the middle category were selected.

3.8.3.3.3.8.3 Difficulty Index

The difficulty value of an item refers to the proportion or per centage of individuals who answer the item correctly (Garrett, 1966, Guilford, 1971). Various methods have been suggested to arrive at difficulty index of items. The difficulty index was computed by averaging the proportion of correct answers in high group and the proportion of correct answers in low group. The formula for determining the index on the basis of the extreme groups as recommended by Singh (1986) was adopted in this study as given below:

$$P = \frac{R_U + R_L}{N_U + N_L}$$

Where,

P = Index of difficulty

R_u = Number of examinees answering correctly in the upper group

R_L = Number of examinees answering correctly in the lower group

N_U = Number of examinees in upper group

N_L = Number of examinees in lower group

3.8.3.3.3.8.4 Discrimination Index

Discrimination index referred to the extent to which an item discriminates well informed individual from the poorly informed ones. Marshall and Hales (1972) called this index as "Net D index of discrimination". They defined "Net D" as "an unbiased index of absolute difference in the number of discriminations made between the upper group and the lower group it is proportional to the net discriminations made by the item between the two groups", i.e., the difference between the proportion of correct answers of the high group 27 per cent and the low group 27 per cent examinees. Discrimination index was calculated, by adopting the procedure suggested by Marshall and Hales (1972).

$$V = \frac{R_U}{N_U} - \frac{R_L}{N_L}$$

Where,

R_u = Number of examinees giving correct answers in the high group

R_L = Number of examinees giving correct answers in the low group

N_U = Number of examinees in the high group

N_L = Number of examinees in the low group

V = The discriminatory power or validity

3.8.3.3.3.8.5 Item validity

The power of an item and its consistency with total score in the test was gauged by correlation of the item score and whole test score. Since the items were scored by assigning '1' for correct answer and '0' for incorrect answer, point biserial correlation coefficient was calculated to measure the validity of the item as recommended by Garrett (1966).

3.8.3.3.3.8.6 Final Selection of Items

At the first stage, the items having discrimination index above 0.2 were selected. For the difficulty index, the items having values ranging between 0.25 to

0.75 were selected as suggested by Singh (1986). In the computation of point-biserial analysis, still more 5 items were eliminated. Those items showing significance at five and one per cent level were selected finally. Taking into consideration of all these guidelines, finally 15 knowledge items were selected for the information efficiency test and administered to the respondents. The value of discrimination index and difficulty index are presented in Appendix-VIII.

Four choices were given for each of the 15 items. Every correct answer was assigned one score, while incorrect response was given zero score. All such scores on 15 items were summed up to obtain the information score of an individual respondent. The possible range of score in this study was 0 to 15. Maximum score would indicate high information efficiency of the 'Diagnos –4' to provide information to the users based on their demand.

3.8.3.4 Problem solving capacity of AES

Problem solving was defined as the man's ability to form concepts, to think, or to use language to solve problems (Stanger and Charles, 1970). Problem solving was a form of directed activity or thought in which both the cognitive representation of prior experience and the components of a current problem situation were reorganized, transformed, or recombined in order to achieve a designated objective, involved the generation of problem solving strategies that transcend the mere application of principles to self evident exemplars (Ausubel *et al*, 1978). Stoner *et al.* (1998) defined a problem as a situation that occurred when an actual state of affairs differed from a desired state of affairs. Problem solving process was referred to the methods of dealing with the treats and opportunities in the environment. Vinayagam (1998) described problem solving as the tendency to solve problems rather than yield to the pressure of the problems. Srinivasa (2006) illustrated that problem solving involved taking a 'yes' or 'no' decision to a given problem.

In the present study, problem solving capacity of AES was operationalised as ability of the 'Diagnos-4' to provide solutions for the technical problems faced by the respondents in the field of plant protection aspects of rice, coconut and banana cultivation.

Technical problems faced by extension personnel and farmers were inherent to each region. Technical problems were limited to plant protection aspects of rice, coconut and banana. A standard format or interview schedule may not serve the purpose. Therefore the respondents in each treatment were grouped into three groups constituting ten respondents in each group. They were asked to discuss and prioritise the plant protection problems in rice, coconut and banana cultivation experienced by them. They were guided to prioritise in a five- point continuum. '5' indicated 'most experienced' and '1' indicated 'least experienced'. The scores in between in the decreasing order show the degree of decrease in the level of the problems experienced.

After scoring the identified problems, the respondents were oriented on the use of 'Diagnos-4' to diagnose the field problems and retrieve solutions. The respondents were allowed to use 'Diagnos-4' to retrieve solutions for their field problems. They were requested to fill the schedule against the prioritized field problems indicating the sufficiency of solutions provided by the AES. They were advised to indicate in a five-point continuum '5' as the 'most sufficient' and '1' as 'least sufficient'. The common problems discussed by the different treatment groups were considered for further analysis. Total scores obtained by each problem were obtained by the summation of scores offered by the respondents. The total scores assigned to each problem by the different treatment groups during pre and post exposures were compared by working out per centage analysis.

Different treatment groups were as follows:

T_1 – Groups discussed and prioritise their problems before any exposure

T_2 - Groups exposed to human expertise alone

T_3 - Groups exposed to AES alone

T_4 - Groups exposed to both human expertise and AES

3.9 Procedure used for data collection

A pilot study was conducted to pre-test the questionnaire and interview schedule to test verify the applicability of the content of them separately among researchers, extension personnel and farmers. Based on the response, the interview schedule was perfected according to the objectives of the study. Utmost care and special attention had been given in finalizing the wording and format of the questionnaire to eliminate mistakes and ambiguity regarding the various items. A standardized questionnaire complete in all respects with an addressing letter and clear instructions were sent by mail to the selected researchers in the development of AES and the researchers in TOT during March 2006. Timely remainders were sent regularly and collected their responses.

As an experimental study among extension personnel and farmers, two interview schedules containing the standardised tests were used among the respondents twice i.e., before and immediately after exposure of 'Diagnos-4' for collecting the data. The data regarding the profile of the selected respondents, cognitive and connotative domains of users and their assessment about the performance of AES were collected from the extension personnel and farmers with the help of a well-structured and pre-tested interview schedule. Slight modifications were made in the interview schedule according to the category of respondents (Appendix-IX).

3.10 Statistical tools used for the study

The data collected from the respondents were tabulated and the following appropriate parametric and non-parametric tools were used to analyse the data and draw relevant inferences.

3.10.1 Percentage Analysis

Percentage distribution of respondents on all the variables was worked out by dividing the frequency of response in each category with the total number of respondents and multiplying by hundred. Problems faced by the respondents in the field of plant protection of rice, coconut and banana and sufficiency of solutions in the form of recommendations provided by AES were assessed using percentage analysis. It was done to make simple comparison wherever necessary.

3.10.2 Kendall's Co-efficient of Concordance

Kendall's co-efficient of concordance was used to verify whether there was agreement among the respondents in providing their responses to the study. It was calculated by the formula:

$$W = \frac{S}{1/12\ K^2\ (N^3 - N)}$$

S = Sum of squares of the observed deviation from the mean of R_j

$$S = \sum Rj^2 - \frac{(\sum R_j)^2}{N}$$

K= Number of sets of ranking

N= Number of individuals or object ranked

$1/12\ K^2\ (N^3\text{-}N)$ = Maximum possible sum of the squared deviations the sum S which would occur with perfect agreement among K rankings.

The computed value of 'W' was tested for its significance by using X^2= K (n-1) w with N-1 degrees of freedom.

3.10.3 Binary Logistic Regression

Binary Logistic regression was used to predict a categorical variable from a set of predictor variables (Wuensch, 2006). The respondents were categorized into two viz; who expressed satisfaction about the performance of AES and dissatisfaction about the performance of AES. Binary Logical Regression was worked out to assess the factors influencing the prospective users on their perception regarding the performance of AES.

The behavioural model used to examine the factors influencing the prospective users on their perception regarding the performance of AES was a logit model based on logistic cumulative distribution function. The model can be specified as:

$$Y_i = g(Z_i) \qquad \text{.................................. (1)}$$

$$Z_i = \alpha + \beta_k X_{ki} \qquad \text{.................................. (2)}$$

Where

Y_i = Satisfaction level of the respondent (Y=1 for accepting AES and Y =0 for non accepting the performance of AES)

Z_i = An underlying and unobserved response for the i^{th} respondents when Z exceeds threshold Z*, the respondent tends to accept the performance of AES, otherwise he/she tends to non accept the performance of it.

X_{ki} = k^{th} explanatory variable for the i^{th} respondent

i = 1, 2, 3…., N, where N is the number of respondents

K = 1, 2, 3….., M, where M is the total number of explanatory variables

α = constant

β = unknown parameter

The logit model postulates that P_1, the probability of the i^{th} respondent to respond satisfaction about the performance of AES, which is a function of an index variable Z; summarizing a set of the explanatory variables. In fact, Z, is equal to the logarithm of the odds ratio, i.e., the ratio of the probability of a respondent reacting satisfaction about the performance of AES to the probability that he/ she does not accept AES and it can be estimated as a linear function of explanatory variables (X_{ki}). Formally, it can be expressed as:

$$Z_i = \ln\left(\frac{P_i}{1-P_i}\right) = \alpha + \beta_k X_{ki} \qquad \text{.................................(3)}$$

$$P_i = F(Z_i) = F(X_i) = \frac{1}{1+e^{-Z_i}} \qquad \text{.................................(4)}$$

$$= \frac{1}{1+e^{-(\alpha + \beta k\, Xki)}} \qquad \text{.................................(5)}$$

Where, e denotes the base of natural logarithm with a value approximating 2.718.

The parameters of the logit model were estimated directly using the maximum likelihood method. This estimation procedure has a number of desirable statistical propertie. All parameters estimators were consistent and also efficient asymptotically (Chow, 1985; Maddala, 1986). The logistic coefficients can be interpreted as the change in log odds ratio associated with one unit change in the independent variable.

3.10.3 't' test

Comparison of mean scores between various categories of the respondents was arrived at using t-test for two samples assuming equal variances. It was done to test the hypotheses set for the study.

Besides, the above mentioned statistical tools, analyses were done using mean, rank and index. Analysis of the data were carried out using the SPSS-15, statistical package available in the College of Horticulture, Vellanikkara. The findings of this study have been reported in the succeeding chapter along with discussion.

Results and Discussion

CHAPTER IV

RESULTS AND DISCUSSION

This chapter deals with the findings of the study. Keeping the objectives in view, the results are presented in the following sequence:

4.1 Appraisal of the AES available in India.
4.2 Distribution of respondents according to their personal characteristics.
4.3 Cognitive domains of prospective users of AES.
4.4 Perception of prospective users regarding the performance of AES.
4.5 Perception of prospective users regarding the potential of AES.
4.6 Factors influencing prospective users in using AES.
4.7 Information efficiency of the AES as assessed by prospective users.
4.8 Problem solving capacity of the AES as assessed by prospective users.
4.9 Case studies on the applications of AES.
4.10 Empirical model of the study.

4.1 Appraisal of the AES available in India

An attempt to gather information on the details of Agricultural Expert System related to crops in India, was made by contacting the researchers involved in developing Agricultural Expert System through post and E-mail. Nine central research institutes, three State Agricultural Universities and a university of arts and science were found to be involved in the development of AES during the period of the study.

Table 4.1 presents the details of AES available in India. 'Rice crop doctor' was the AES, developed in India by MANAGE, Hyderabad and released during 1994. It was developed to diagnose plant protection problems in rice cultivation. The program used in the AES was level 5-shell. In 1996, Indian Institute of Horticultural Research (IIHR), Bangalore, started developing AES on all south

Table 4.1. Available Agricultural Expert Systems in India

Sl. No.	Name of the AES	Name of the institution	Subject /Topic	Program used	Year of development	Details of release
1	Rice crop doctor	MANAGE, Hyderabad	Rice cultivation	LEVEL 5-SHELL	1994	Released
2	AES on South Indian Horticultural crops	IIHR, Bangalore	All South Indian Horticultural crops	MS-DOS	1994-2000	Released
3	AES on Grapes and Mushroom	IIHR, Bangalore	Cultivation of Grapes and Mushroom	BASICS	2000-2003	Released
4	Expert system based DSS for SLM	NISTADS(CSIR), New Delhi	Sustainable Land Management	EXPERT SYSTEM SHELL	1998	Not released
5	e-sagu	IIIT, Hyderabad	Cotton		2000	Released
6	DIAGNOS-4	Kerala Agricultural University, Thrissur	Pests and diseases identification and IPM recommendations for nine major crops of Kerala	EXPERT SYSTEM SHELL	2004	Not released
7	RUBEXS-04	Tamil Nadu Agricultural University, Coimbatore	Rubber protection technology	VISUAL BASICS	2004	Developed as part of PhD programme
8	E-agrotech	Director of instrumentation, JNKVV, Jabalpur	Agricultural technology	VISUAL BASICS	2004	Released
9	SUGAREX	Sugarcane Breeding Institute, Coimbatore	Sugarcane cultivation	NA	2005	Released
10	Bio rice, biocot, sugar biocontrol, bioveg, helico-info	Project Directorate of Biological control, Bangalore	Biological pest control in rice, cotton, sugarcane and vegetables	NA	2005	Released
11	Banana Technology Manager	IARI, New Delhi	Cultivation of banana	JAVA&HTML	2006	Developed as part of PhD programme
12	CROP-9-DSS	Kerala Agricultural University, Thrissur	Cultivational practices of nine major crops of Kerala	FLASH	Completed	To be released shortly
13	NRSR	Kerala Agricultural University, Thrissur	Nutrient Management in Rice	FLASH	Completed	To be released shortly
14	SOYEX	NRC for Soyabean (ICAR), Bhopal	Soyabean cultivation	NA	Under development	-
15	Expert System of Extension	IARI, New Delhi	Location specific agricultural technologies	NA	Under development	-
16	Expert System for pulses cultivation	Indian Institute of Pulses Research, Kanpur	Pulses cultivation	JAVA SCRIPT	Under development	-
17	KISAN	B.R. Ambedkar Bihar University, Bihar	Soil Nutrient Management	VISUAL PROLOG	Under development	-
18	Amrapalika	B.R. Ambedkar Bihar University, Bihar	Diseases of Indian mango	EXPERT SYSTEM SHELL FOR TEXT ANIMATION	Under development	-
19	AGRIKIOSK	Kerala Agricultural University, Thrissur	DSS software for cereals, millets, pulses and tuber crops	DOT NET	Under development	-
20	AES on five crops	Kerala Agricultural University, Thrissur	Package of practices of rice, coconut, banana, cashew and pepper	HTML	Under development	-

Indian Horticultural crops and released the system during 2000. The program used in the system was MS-DOS. Expert system based Decision Support System for sustainable land management was developed by NISTADS (National Institute of Science, Technology and Development Studies), New Delhi during 1998 on sustainable Land Management. EXPERT SYSTEM SHELL was the program used in the software. But it was not released for public use. IIHR, Bangalore, worked on developing AES on grapes and mushroom during 2000 – 2003. It was released in a program called BASICS.

Indian Institute of Information Technology (IIIT), Hyderabad, released an agricultural dissemination system in cotton crop called e-sagu during 2000. Reddy *et al.* (2005) field-tested e-sagu in villages among farmers and reported that it helped farmers in improving input efficiency and saved Rs. 3800/- per acre.

As part of doctoral programme, RUBEXS-04 was developed at Tamilnadu Agricultural University, Coimbatore. It was on rubber protection technology with a programme called VISUAL BASICS 6.0. The computer-based **RUB**ber **EX**pert System was abbreviated as RUBEXS-04. The numerical value 04 indicated, the year of designing i.e.2004. RUBEXS-04 was designed to simulate the pest and disease diagnosing behaviour of human expert in rubber trees to aid rubber growers in making the best plant protection decisions for their crop. This user friendly Expert System was having a knowledge base for about 25 items on major leaf, stem, root diseases and non-microbial maladies and pests of rubber. It was designed in such a way that questions were asked about the problem based on the interaction with the user, the RUBEXS-04 gave its diagnostic result, control measures and detailed information about the cause. It was prepared in Malayalam language with audio aiming to assist the existing experts and extension personnel for improved decision making on insect pest management in rubber.

E-agrotech was the AES developed on general agricultural technologies by the Directorate of Instrumentation, JNKVV, Jabalpur. It was released during 2004 with VISUAL BASICS program.

Sugarcane Breeding Institute, Coimbatore released SUGAREX on sugarcane cultivation during 2005. In the same year the Project Directorate of Biological Control, Bangalore released AES such as Bio rice, biocot, sugar biocontrol, bioveg and helico-info during 2005. These softwares were about biological pest control in rice, cotton, sugarcane, vegetables and control of *Helicoverpa armegira*.

Banana Technology Manager was developed as part of PhD Programme on the cultivational aspects of banana during the year 2006. The software for the system was developed in HTML, FLASH and JAVA. Three base layers were used in the design of the software component. The three layers include the user side interface layer, business logic layer and a data base layer at the bottom.

Kerala Agricultural University, Thrissur had been working on developing Agricultural Expert System (AES) on the cultivation of nine major crops of Kerala. 'Diagnos-4' was developed in 2004 to identify pests and diseases of nine major crops with Expert System SHELL as the program. A modified version of it will be released soon. In addition, CROP-9-DSS had been developed on the cultivational aspects of nine major crops of Kerala with FLASH as the program. NRSR (Nutrient Recommendation System for Rice) had also been developed in FLASH on the nutrient management of rice. Both of them are to be released shortly.

Kerala Agricultural University has also released an information system in the form of DVD during May, 2007 entitled *Karshika Jalakam*. It contained the technologies related to coconut based farming systems in Kerala in general, and Palakkad district in specific. It included the monthly cultivational practices of 44 inter crops along with animal husbandry, fisheries and agro based enterprises suitable under coconut based cropping systems. FLASH was the program provided in the DVD and allowed space with modifications in future. It was a farmer friendly extension tool for easy access to information.

The following systems were also in the pipeline during the term of present study. They were:

National Research Centre for Soya bean, Bhopal were engaged in developing software on soyabean cultivation called SOYEX. IARI, New Delhi was developing a software called Expert System of Extension to provide demand based information to the millions of farmers through website. It was designed using HYPERTEXT MARKUP LANGUAGE (HTML). There was a possibility to disseminate the same information to all the farmers at the same time. Farmers' needs, resources, infrastructure, market facilities etc. were considered while recommending information.

Indian Institute of Pulses Research, Kanpur was working on an expert system for pulses cultivation on JAVA SCRIPT. B. R. Ambedkar Bihar University, Bihar, was developing an expert system called KISAN on soil nutrient management with VISUAL PROLOG program. The same university was also engaged in developing an expert system to diagnose diseases of Indian mangoes called Amrapalika. The program followed in the system was SHELL for text animation.

CD-ROM on Integrated Pest Management (IPM) in coconut was designed and developed in VISUAL BASIC 6.0 by CPCRI, Kasargode. It was available on a CD-ROM format. It was released in 2001. The CD included description of pests, life cycle, symptoms and control methods (Chemical, Mechanical, Cultural and Biological) of the ten major pests of coconut. A special feature of the CD-ROM was the inclusion of video clippings in it.

Preparation of 'Expert system on coconut pests and disease management' in collaboration with Crop Protection Division was under progress in CPCRI, Kasargode. Questionnaire format has been finalized for this programme wherein all the anticipated questions on pest and disease management were to be included from which farmers and extension personnel could get the required information. Literature and related photographs were also being collected. Touch screen applications were developed on mandatory crops(CPCRI, 2007).

Kerala Agricultural University had just started the development of DSS software for Cereals, Millets, Pulses and Tuber Crops and establishment of an Agriculture Digital Information Centre as "AGRIKIOSK" with the program called DOTNET. The final software for each crop with multimedia effect would be made available in the form of CD/ DVD sample version without Graphics would be made available in the KAU site. The site would be managed by KAU, updating as and when required would be done by identified panel of experts in each crop. Another AES on five crops such as rice, coconut, banana, cashew and pepper was also under progress with a program on HTML.

It is also understood that many research institutions are actively engaged in the development of AES, as part of research projects and few expert systems are being developed as part of doctoral programmes. Applications of majority of the systems were restricted only to limited groups of users and they were yet to be popularized among the ultimate users. Applications of technologies provided in the AES might be limited to an agro ecological region. Therefore applications of AES in one region might not be relevant to another region. The users also needed a thorough orientation to operate the system and retrieve information at an easiest way. Use of English language posed another problem among common people. Use of regional language might be useful to the people in the region, whereas it might not be understandable in other regions. Therefore AES had not become popular among users in a wider perspective during the period of the study.

4.2 Distribution of respondents according to their personal profile:

A clear understanding of the personal characteristics of the respondents enables the investigator to interpret the data in an appropriate way. In the present study, 14 explanatory variables were taken into consideration for analyzing the data.

4.2.1 Age:

Table 4. 2. Distribution of respondents according to their age (Per cent)

Sl. No.	Category	Researchers in AES development(n=25)	Researchers in TOT(n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Young	20.00	22.50	38.89	10.00
2	Middle	44.00	42.50	47.78	28.89
3	Senior	36.00	35.00	13.33	61.11

Perusal of the table 4.2 reveals the distribution of respondents according to their age. Majority of the respondents from both the groups of researchers and extension personnel belonged to middle age whereas in the farmers' group majority belonged to the senior category. Baby (2001) and Nehru (1993) supported these findings respectively. Only negligible per cent of the farmer respondents belonged to young category. It was observed that declining profitability coupled with laborious nature of farm activities forced farm youths to off- farm avocations. At the same time, retired government employees and gulf-returnees were taking care of farm activities. This finding is in concordance with the findings of Helen *et al.* (2007).

4.2.2 Educational status

Table 4.3. Distribution of respondents according to their education (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)*	Researchers in TOT (n=40) *	Extension personnel (n=90) * *	Farmers (n=90) ***
1.	Up to Secondary school	-	-	-	40.00
2.	Secondary school completed	-	-	-	44.44
3.	Graduate	-	-	55.56	13.33
4.	Post graduate	24.00	22.50	43.33	2.23
5	Doctorate	68.00	75.00	1.11	-
6	Post doctorate	8.00	2.50	-	-

*- Basic qualification was post graduation in Agriculture
**- Basic qualification was graduation in Agriculture
***- Basic qualification was up to secondary school as considered in the study

Distribution of respondents according to their educational qualification is given in the table: 4.3. It could be observed from the table that majority of the researchers were holding doctoral degrees whereas most of the extension personnel were graduates and farmers completed Secondary School level.

The higher literacy level witnessed throughout the state could be the rational behind the higher educational status realized with majority of the respondents considered for the study. It is evident from the fact that Kerala State had attained 100 per cent literacy level and hence farmer respondents had appreciable level of education. Balasubramani (2004) and Thomas (2004) were also of this view.

4.2.3 Experience

Table 4.4. Distribution of respondents according to their experience (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Up to 10 years	22.00	30.00	45.56	11.11
2	11-20years	44.00	47.50	40.00	41.11
3	Above 21years	34.00	22.50	14.44	47.78

Analysis of the data in the table: 4.4 evidenced that the majority of all the categories of the respondents' experience were between 11-20 years except the extension personnel (45.56per cent), nearly half of whose experience was below 10 years. George (1996) also reported that majority of the researchers (42per cent) had medium level of experience in their profession. A little less per cent of extension personnel (40.00 per cent) had the experience of 11-20 years. The respondents with experience of more than 21 years were high among farmers (47.78 per cent). Whereas Jabbar (1996) found that majority of the farmers (53per cent) had low level of experience in vegetable cultivation. Reasonable per cent of the farmers belonged to senior category might be the reason for having more years of experience in farming.

4.2.4 Awareness about AES

Table 4.5. Distribution of respondents according to the awareness about AES
(Per cent)

Sl. No.	Category	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	25.00	62.22	87.78
2	Medium	45.00	24.44	12.22
3	High	30.00	13.33	-

Nearly half the per cent of the researchers in TOT (45.00 per cent) expressed that they had medium level of awareness about AES. While 30.00 per cent of them had high and one-fourth of them had low level of awareness about the performance of AES. Majority of the extension personnel (62.22 per cent) and farmers (87.78 per cent) had low level of awareness about AES. Almost one-fourth of the extension personnel (24.44 per cent) had medium level of awareness about AES. Negligible per cent of extension personnel (13.33 per cent) had high level of awareness and farmers (12.22 per cent) had medium level of awareness about AES and none of the farmer respondents had high level of awareness about AES. They complained that they did not have any opportunity in getting acquaintance with AES. Kerala Agricultural University has not released AES so far. The AES released by the Central Institutes were also not common among the users. These findings are in agreement with the observations of Rao *et al* (1999) expressed that potential clients were not aware of expert systems since it was a relatively new aid for transfer of technology.

4.2.5 Trainings undergone related to ICT

Modern farming practice has been undergoing several changes due to the increasing application of science and technology; hence technology users in order to be efficient must be trained. Education and training broadens outlook and skill development which may reduce frustration on the part of users in retrieving required information from the system.

Table 4.6. Distribution of respondents according to the trainings undergone related to ICT (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	24.00	40.00	56.67	46.67
2	Medium	56.00	50.00	33.33	23.33
3	High	20.00	10.00	10.00	30.00

It is evident from the Table 4.6 that majority of the respondents from research category had undergone medium level of trainings related to ICT whereas majority of the extension personnel (56.67 per cent) and farmers (46.67 per cent) had undergone low level of trainings related to ICT. Considerable per cent of extension personnel (33.33 per cent) and farmers (23.33 per cent) had medium level of trainings related to ICT. Very low per cent of respondents such as researchers in AES development and farmers (30.00 per cent each) and researchers in TOT and extension personnel (10.00 per cent each) had the opportunity of high level of trainings related to ICT. This result contradicts with the findings of Balasubramani (2004). He reported that the farmer respondents had not undergone trainings related to computer operations. The reason might be that either the research area might be backward in the implementation of ICT development projects or the difference in years might have led to the implementation of ICT development projects in the present study area, which in turn might have created opportunity for them to attend training programmes related to ICT.

4.2.6 Proficiency in computers

Table 4.7. Distribution of respondents according to their proficiency in computers (Per cent)

Sl. No.	Category	Researchers in AES development(n=25)	Researchers in TOT(n=40)	Extension personnel(n=90)	Farmers (n=90)
1	Low	8.00	14.00	30.00	70.00
2	Medium	72.00	75.00	50.00	13.33
3	High	20.00	16.00	20.00	16.67

Distribution of respondents according to their proficiency in computers is presented in Table 4.7. It could be inferred from the table that three-fourth of the respondent researchers were exposed to medium-level proficiency in computer operations and so were fifty per cent of the extension personnel. As per a survey, 90 per cent of the ICAR Institutes and SAUs had already connected LAN in place.

Practically, all the institutes and SAUs (99per cent) were connected to internet and 70 per cent of them had developed their web sites (ICAR, 2004). This might be the reason that majority of the researchers fall under the category of medium and high proficiency in computer operations. Nearly three-fourth of the farmer respondents stayed in the low proficiency category in computer operations, the reason being either the trainings imparted to them were insufficient or they did not have the opportunity to continue with computer use afterwards.

4.2.7 Experience in computer use

Table 4.8. Distribution of respondents according to the experience in computer use (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Not using	-	-	-	56.67
2	< 5 years	-	-	86.67	40.00
3	5-10 years	28.00	52.50	13.33	3.33
4	11-15 years	52.00	30.00	-	-
5	16-20 years	12.00	12.50	-	-
6	> 20 years	8.00	5.00	-	-

Table 4.8 tangibly reveals that a little more than half (52.00 per cent) of the researchers involved in developing AES had an experience of 11 to 15 years with computers whereas more than half (52.50 per cent) of the researchers in TOT had 5 to 10 years of computer experience. Almost one third of the researchers in TOT (30.00 per cent) were familiar with computers for 11 to 15 years. In the case of extension personnel, more than two third of them (86.67) were exposed to computers for less than five years and a negligible per cent of respondents had an experience of 5 to 10 years with computers. More than half of the farmer respondents (56.67 per cent) reported that they did not have any experience in using computers and 40.00 per cent of the farmers had the experience of using computers for less than five years. This finding is in accordance with the findings of Rao *et al* (1999) who stated that majority of the respondents including extension personnel expressed that they had no access to computers.

4.2.8 Perception about ICT

Table 4.9. Distribution of respondents according to the perception about ICT (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	-	10.00	12.22	6.67
2	Medium	92.00	75.00	64.44	52.22
3	High	8.00	15.00	23.33	41.11

The results in the Table 4.9 indicate that most of the researchers in AES development (92.00 per cent) were found to have medium level of perception about modern information communication technologies. Exactly three-fourth of the researchers in TOT (75.00 per cent) expressed that they had medium level of perception about ICT. More than fifty per cent of the extension personnel (64.44 per cent) showed their medium level of perception towards ICT. More than fifty per cent of the farmer respondents (52.22 per cent) felt medium level of perception towards ICT and above one third of the farmer respondents (41.11per cent) reported that they had high level of perception towards ICT. The result contradicts the findings of Babu (2005) who reported that majority of farmers exhibited low level of perception about ICTs. The reason might be due to the fact that though majority of the farmers were not proficient in computers, they could feel the rapidity of development on information technology taking place in their surrounding environment through Akshya programme implemented by the Kerala Government. Majority of the respondents also reported that their children were studying computer courses and therefore they were capable of operating and accessing the information from computer and other modern information and communication technologies. Farmers started realising the positive impact of ICTs in their lives especially in the field of agriculture and rural development.

4.2.9 Rationality in decision-making

Table 4.10. Distribution of respondents according to the rationality in decision making (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	8.00	17.50	20.00	16.67
2	Medium	72.00	62.50	55.56	73.33
3	High	20.00	20.00	24.44	10.00

From the Table 4.10 it is evident that nearly three- fourth of the researchers in AES development (72.00 per cent) were found to have medium level of rationality in decision making. Less than three-fourth of the researchers in TOT (62.50 per cent) had medium level of rationality in decision-making. (20.00 per cent) of both categories of researchers had high level of rationality in decision-making. A little more than half the number of extension personnel also had medium level of rationality in decision-making. Nearly three-fourth of the farmers (73.33 per cent) were found to have medium level of rationality in decision-making. Parimaladevi (2004) found that majority of the agricultural graduates as prospective entrepreneurs had low level of decision making ability since mostly fresh graduates from colleges were exposed to theoretical knowledge and they were in the process of equipping themselves in practising the business. Geethakutty (1993) found that rationality in decision-making made a positive significant correlation with the composite fertilizer use behaviour of farmers. A technology user who is rational in decision making will be analyzing and weighing the different alternatives available before taking a final decision. AES will help the users by providing possible options to take a decision.

4.2.10 Information source utilisation behaviour

Table 4.11. Distribution of respondents according to the information source utilization behaviour (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	12.00	17.50	12.22	32.22
2	Medium	64.00	52.50	64.44	52.56
3	High	24.00	30.00	23.33	17.78

Table 4.11 depicts the distribution of respondents according to the behaviour of information source utilization. It could be inferred from the table that majority of the researchers involved in developing AES had medium level of information source utilization behaviour. Very lesser number of researchers belonged to the low and high category of information source utilization behaviour. More than half the number of the researchers in TOT (52.50 per cent) had the behaviour of medium level of information source utilization. One-third of the researchers in TOT had come under the category of high level of information source utilization. Majority of the extension personnel (64.44 per cent) had the behaviour of medium level of information source utilization. Farmers also expressed the same trend of information source utilization behaviour. But at the same time one-third of the farmers had low level of information source utilization behaviour. Pandyaraj (1978) revealed that Junior Agricultural Officers received most of the information from Agricultural guide/diary. Kareem (1984) observed that contact farmers received most of the information on coconut cultivation from Agricultural Demonstrators of the Department of Agriculture and local leaders were the least consulted source of information. All the categories of respondents realized the importance of information to carry out their activities in their respective profession and hence they were utilizing information sources at the medium level.

Researchers utilized research journals and internet as the most utilized information sources, followed by scientific seminars/conferences and discussion with fellow scientists. Extension personnel expressed that their own field experience and newspapers were the most utilized information sources and least utilized information sources were e-mails and internet. Farmers reported that newspapers and discussion with fellow farmers were the most utilized information sources and least utilized were e-mails and internet as that of extension personnel. The respondents were found utilizing information sources which were considered by them as reliable and easily available to them.

4.2.11 Information utilisation behaviour

Table 4.12. Distribution of respondents according to the information utilization behaviour (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	24.00	17.50	13.33	-
2	Medium	60.00	50.00	76.67	10.00
3	High	16.00	32.50	10.00	90.00

Distribution of respondents according to the behaviour of information utilization is given in the table: 4.12. Analysis of the data shows that sixty per cent of the researchers involved in developing AES had the habit of medium level of information utilization. Fifty per cent of researchers in TOT belonged to the medium level of information utilization category. More than three-fourth of extension personnel (76.67 per cent) belonged to the medium level of information utilization, whereas most of the farmer respondents (90.00 per cent) belonged to the high category of information utilization. The reason might be that the ultimate users of the technical information were the farmers. Extension personnel and farmers reported that they were in quest of latest technical information and they had fewer opportunities to utilize the same. In this situation, AES has lot of potentials in satisfying users' requirement. Rajendran (1992) found that more than

50 per cent of the respondents were distributed in the medium category with respect to the level of utilization of the selected technologies. Jabbar (1996) also established that majority of the agricultural labourers (59.00 per cent) belonged to the medium category in the extent of utilization of integrated vegetable production technologies.

Among the researchers in TOT, characteristics of HYVs and plant protection technologies were the most utilized information. Extension personnel utilized plant protection technologies and dose of manures and fertilizers for dissemination of information as the most demanding information. Just like researchers in TOT, farmers utilized characteristics of HYVs and plant protection technologies as the most utilised information. Majority of the farmers expressed that they needed market information such as demand for the produce, price of the produce, availability of inputs. etc were the most demanding which was not available to them even after the implementation of so many programmes related to ICT. Days were not too far to provide all these information through on –line system of E-krishi web site integrated with the Karshaka Information Systems Services and Networking (KISSAN) as stated by Mathew (2007).

4.2.12 Information output behaviour

Table 4.13. Distribution of respondents according to the information output behaviour (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	16.00	10.00	10.00	8.89
2	Medium	48.00	75.00	80.00	73.33
3	High	36.00	15.00	10.00	17.78

The Table 4.13 presents the distribution of respondents according to the behaviour of information output. Nearly 50.00 per cent of the researchers in AES development belonged to the medium level of communication of information and more than one third of the same class of respondents had high level of information output behaviour. Three-fourth of the researchers in TOT had the behaviour of medium level of information output. More than three-fourth of the extension personnel (80.00 per cent) also had the medium level of information output behaviour. Nearly three-fourth of the farmers (73.33 per cent) belonged to the medium category of information output behaviour. It showed that all the categories of respondents transferred technical information appreciably to their clients or fellow members as it was mandatory in their profession. Farmers felt that they used to share technical information with fellow farmers when they found better performance of the technology in their own farm.

Researchers usually transferred technology related information through seminars, publications, to their clients and least utilized was radio for disseminating technologies. Extension personnel provided the technologies to farmers and subordinates through field visits and meeting with farmers. Farmers shared the newly received information with fellow farmers and labourers through personal discussion. E-mail was the least medium used by extension personnel and farmers to transfer the technologies. Pandyaraj (1978) revealed that extension personnel used personal talks most often to transfer technologies to farmers. Kareem (1984) also reported that personal talks during casual everyday meeting emerged as the most often used method by contact farmers for communicating with other farmers.

4.2.13 Information feed back behaviour

Table 4.14. Distribution of respondents according to their information feed back behaviour (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	8.00	-	-	20.00
2	Medium	64.00	70.00	73.33	73.33
3	High	28.00	30.00	26.67	6.67

From the Table 4.14, it could be derived that 64.00 per cent of the researchers in AES development were in the category of medium level of behaviour of feed back of information. Majority of the researchers in TOT (70.00

per cent), extension personnel (73.33 per cent) and farmers (73.33 per cent) belonged to the medium level of the behaviour of information feedback. Nearly one-third of the researchers in AES development (28.00 per cent), researchers in TOT (30.00 per cent), extension personnel (26.67 per cent) had high level of the behaviour of information feedback. Majority of the respondents were found to have medium and high information feedback behaviour. High educational level of respondents, better exposure to different kinds of media and interest in farming might be the reason for the medium and high information feedback behaviour. This finding contradicts the findings of Kareem (1984) who reported that respondents had low level of feedback behaviour. The development efforts taken place during these years might have brought change in the feedback behaviour of the respondents.

Researchers gave feedback through phone calls and publishing in farm magazines. Extension personnel provided feedback through phone calls and workshops or seminars. Farmers furnished feedback through workshops or seminars and personal letters.

4.2.14 Information backstop

Table 4.15. Distribution of respondents according to the information backstop (Per cent)

Sl. No.	Category	Researchers in AES development (n=25)	Researchers in TOT (n=40)	Extension personnel (n=90)	Farmers (n=90)
1	Low	28.00	20.00	23.33	31.11
2	Medium	60.00	67.50	68.89	62.22
3	High	12.00	12.50	7.78	6.67

A glimpse of the table: 4.15 explains that majority of the respondents such as researchers in AES development (60.00 per cent), researchers in TOT (67.500 per cent), extension personnel (68.89 per cent) and farmers (62.22 per cent) reported that they had medium level of information backstop in their respective organizations. Negligible per cent of the respondents contented with the information backstop and hence came under the category of high level of information backstop. This finding is in agreement with the findings of Surendran (2000) who also stated that respondents experienced medium level of information backstop.

Researchers consented that they were provided with internet facilities to gather information on their subject area of interest and majority had opportunities to undergo training on computer operations. However, regular trainings were not arranged to them. Generally extension personnel were not that much satisfied with the facilities provided to them to collect information on latest technologies. Seminars were organized regularly to make them abreast of latest developments in the field of agriculture. But they complained that majority of the Krishi Bhavans had not been connected with internet. Farmers were also not satisfied with the facilities provided to them to collect information on latest technologies. Extension programmes organized by the Department of Agriculture were the only opportunity to update them on latest technologies. Nevertheless majority of the farmers did not have the facilities of utilizing computers in the local level institutions.

4.3 Cognitive domains of prospective users of AES

Table 4.16.Cognitive domains of extension personnel and farmers on the plant protection aspects of rice, coconut and banana (n=30/group)

Sl. No.	Experimental groups before exposure	Extension personnel		Farmers	
		Mean scores	Percentage	Mean scores	Percentage
1	I	5.77	38.47	3.60	24.00
2	II	5.27	35.13	4.17	27.80
3	III	5.17	34.47	3.28	21.87
	Mean	5.40	36.02	3.68	24.55

The subject on major pests and diseases affecting rice, coconut and banana and their management measures was chosen for assessing the cognitive domains of prospective users. The experimental groups before exposure to AES were subjected to knowledge test. The table 4.16 presents the present status of knowledge of selected extension personnel and farmers related to the diagnosis and management measures for the pests and diseases of rice, coconut and banana. The maximum attainable score was 15. Three groups of extension personnel obtained a mean score of 5.40 and showed a percentage of 36.02, whereas farmers scored a mean of 3.68 with a percentage of 24.56. Hiranand and Singh (1981), Ganesan (1982), Meera (1995), Thomas (2004) and Ahire and Kiran (2007) also reported that farmers had low and medium level of knowledge in the integrated pest and disease management practices in different crops.

It is evident from the results that extension personnel and farmers possessed low level of knowledge especially in the areas of plant protection aspects of crops and they were in need of information on the same. Majority of the respondents agreed that they experienced confusion in identifying symptoms, in recommending or using a particular input, calculation of dosages of inputs and combination of input use. Farmers also complained that they often depended on pesticides dealers for identifying pests and diseases and choosing inputs for managing them. Deepa (1999) also reported that the major constraint encountered by the farmers was the lack of expert guidance regarding the plant protection practices in crops. Hence, there is a lot of scope for the application of AES among extension personnel and farmers on plant protection aspects of crops that help the users to clarify their doubts, confirm their knowledge and provide real time information to the technology users.

Table 4.17. Perception of researchers in TOT regarding the performance of the Agricultural Expert System

Sl. No.	Performance related attributes	Researchers in TOT (n=40)	
		Mean	Rank
1	Settings in the AES	9.45	I
2	Future prospects	9.27	II
3	Practicability of information	8.23	III
4	Retrievability of information	6.30	IV
5	Serviceability of the system	6.18	V
6	Provision for updating information	5.05	VI
7	Relevancy of information	2.86	VII
8	Information content	2.81	VIII
9	Information treatment	2.54	IX
10	Mode of presentation	2.31	X

4.4 Perception of prospective users regarding the performance of the AES

4.4.1 Perception of researchers in TOT regarding the performance of the Agricultural Expert System

The results of the perception of researchers regarding the performance of AES are presented in table 4.17. Kendall's Coefficient was worked out and ensured the significance of dimensions included in the study. Analysis of the data in the table showed that the researchers in TOT ranked first (9.45 mean scores) to the attribute 'settings in the AES'. It could be inferred that researchers were satisfied with the settings of the AES that they had seen. They were of the opinion that the AES were able to provide complete guidance for the user to make use of the system. They expressed satisfaction over the appropriateness of the pictures given in the system to the subject and the colour combination of background, pictures and letters. Second rank was given to (9.27 mean scores) the 'future prospects of the AES'. They perceived that AES would strengthen the expertise of the researchers because of the synergetic effect of the expertise of several human experts. They presumed that AES would provide greater information support for taking suitable decisions, acting as a complementary extension tool for disseminating agricultural technologies.

'Practicability of information' was ranked as third (8.23 mean scores) by the researchers in TOT. They felt that information given in AES was feasible and applicable to the users' situations.

'Retrievability of information' was ranked fourth (6.30 mean scores) by the researchers in TOT. They did not feel any difficulty in locating and retrieving information from AES. 'Serviceability of information' was given fifth rank with a mean score of 6.18. Researchers in TOT substantiated that AES could serve the information needs of users like researchers, teachers, students, extension personnel and farmers. Rao *et al.* (1999) reported that majority of the respondents felt that expert systems were relatively easy to handle and use.

Table 4.18. Perception of extension personnel and farmers regarding the performance of the Agricultural Expert System

Sl. No.	Performance related attributes	Extension personnel(n=60)*		Farmers (n=60)*	
		Mean	Rank	Mean	Rank
1	Future Prospects	8.95	I	9.00	I
2	Mode of presentation	8.03	II	8.00	II
3	Settings in the AES	7.02	III	6.82	III
4	Practicability of information	6.00	IV	6.15	IV
5	Serviceability of the system	4.62	V	4.55	V
6	Information treatment	4.38	VI	4.45	VI
7	Relevancy of information	2.24	VIII	1.66	VII
8	Information content	2.90	VII	1.55	VIII
9	Retrievability of information	2.21	IX	1.48	IX

* Two groups of extension personnel and farmers, thirty in each group were exposed to AES and hence n= 60.

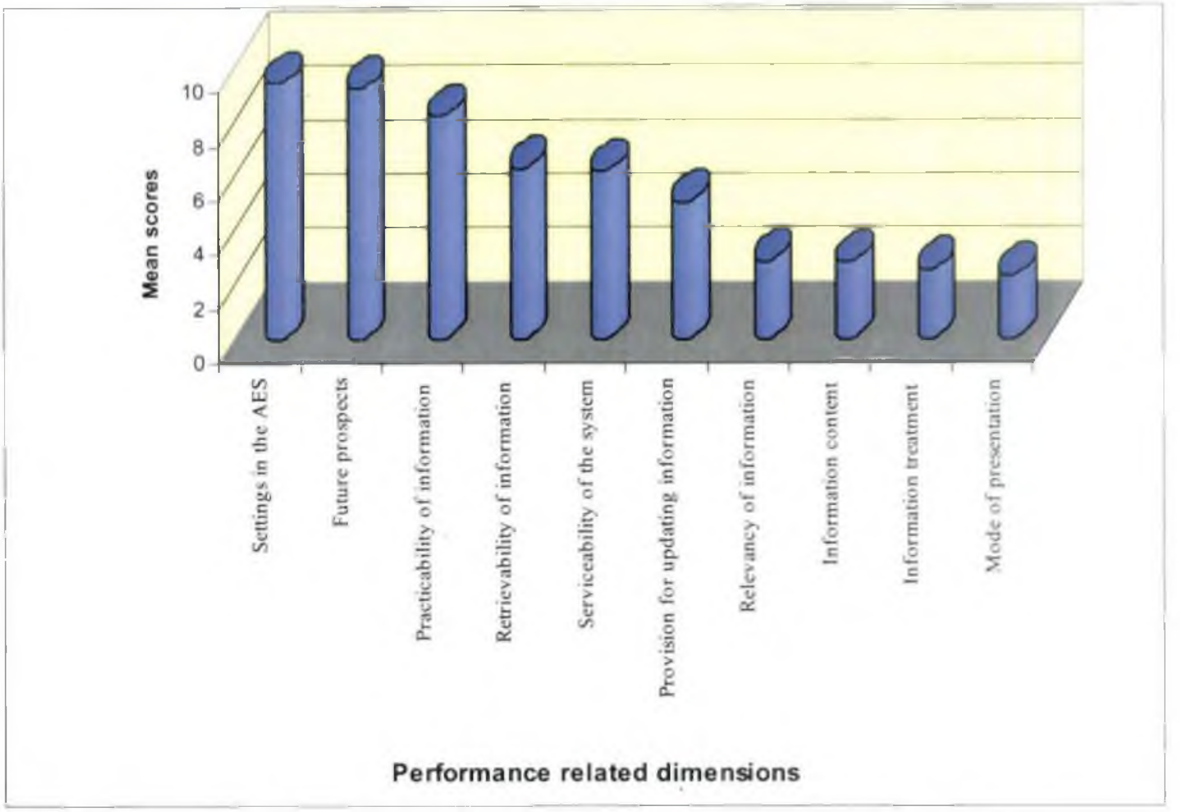

Fig: 5 Perception of researchers in TOT regarding the performance of the AES

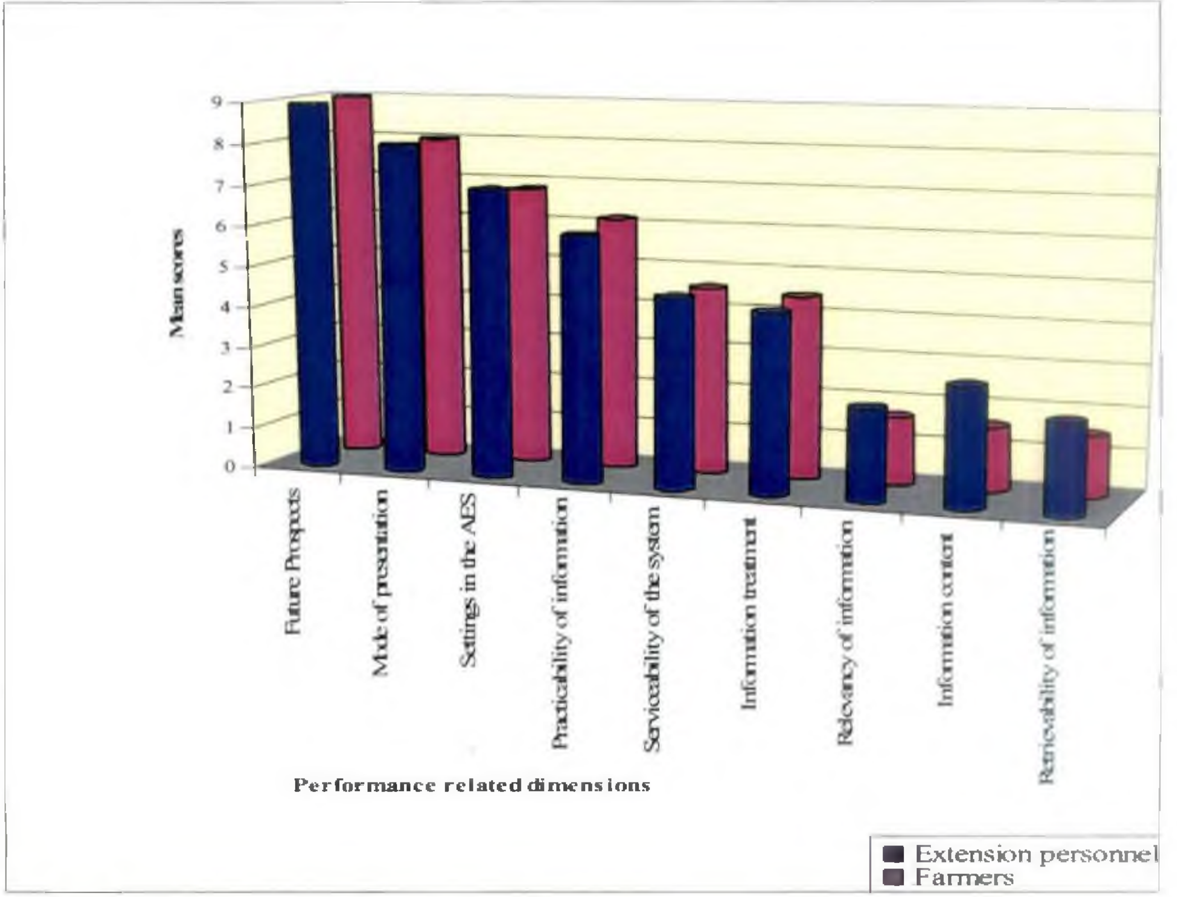

Fig: 6 Perception of extension personnel and farmers regarding the performance of the AES

'Provision for updating information' in the system was ranked sixth (5.05mean scores) by researchers in TOT. They suggested to create a permanent mechanism to up date the information as and when package of practices were revised. The last ranked dimensions such as 'relevancy of information', 'information content', 'information treatment' and 'mode of presentation' needed modifications. These dimensions could be modified by involving the prospective users during the development process of AES. Perception of researchers in TOT about the performance of AES is depicted in Fig: 5

4.4.2 Perception of extension personnel and farmers regarding the performance of the Agricultural Expert System

Perception of extension personnel and farmers regarding the performance of the Agricultural Expert System is given in the table: 4.18. Extension personnel and farmers ranked first the future prospects of AES among all the nine dimensions with a mean score of 8.95 and 9.00 respectively. It clearly indicated that the extension personnel and farmers perceived that AES would perform best of its functions for taking suitable decisions and would be an efficient extension tool in disseminating agricultural technologies. They also believed that AES would serve the purpose of confirming technical recommendations in the absence of human experts. Mode of presentation was ranked second by extension personnel and farmers with a mean score of 8.03 and 8.00 respectively. 'Settings in AES' was ranked third by extension personnel (7.02 mean scores) and farmers (6.82 mean scores). Extension personnel and farmer respondents perceived that the instructions given in tutorial page had to be improved for more clarity. Systematized presentation of information would enhance users' understanding. The system should be included with more real photographs wherever needed, especially the symptoms with more clarity and zooming effect.

'Practicability of information' was ranked fourth by both categories of respondents. They agreed that the information provided in AES was adoptable and feasible to users' situations. 'Retrievability of information', 'relevancy of information', 'information content' and 'information treatment' were the dimensions ranked last by extension personnel and farmers. It indicated that extension personnel and farmers were not satisfied with the 'retrievability of information'. Therefore the pathway of retrieving information should be made easier. They suggested to include an index page next to tutorial page with appropriate, clear photographs of symptoms with the label listed from seed to seed stage along with subcategories of problems from root, stem, leaf, flower, fruit and seed. Each sub category should be linked to the list of symptoms and management measures. Extension personnel and farmers criticized that the users could not locate the information easily, it grabbed more time of users in diagnosing symptoms and getting suitable solutions and therefore users required a thorough orientation to retrieve the required information easily. Rao *et al.* (1999) reported that majority of the respondents felt that expert systems were relatively easy to handle and use, which was differing to the findings of the study.

Regarding the information content, both categories of respondents were in need of biological control measures in detail and that was found lacking in the system. Few respondents pointed out that some of the chemicals that earlier created several issues in the field were still included in the package, eg: Endosulfan. Majority of the respondents complained that few chemicals given in the system were not available locally eg: Ediphenfos. Their complaint was that the system did not consider the users' resources and could not provide reasons for the given solutions. They felt that the system with little modifications would become acceptable by the users. Specific recommendations based on users' available resources were expected by both categories of respondents. Rao *et al.* (1999) reported that expert systems which were highly crop specific or technology specific were preferred over the general packages.

With regard to information treatment, all the respondents felt that AES should be released in local language that is in Malayalam. The interpretation of

Table 4.19.Comparison of Mean scores between the perception of researchers in TOT and extension personnel regarding the performance of AES

Sl. No	Category of respondents	Mean scores	Std. error mean	t- value
1	Researchers in TOT (n=40)	17.7928	0.7955	7.684*
2	Extension personnel (n=60)	24.8110	0.4488	

*- Significant at 5 % level

Table 4.20.Comparison of Mean scores between the perception of researchers in TOT and farmers regarding the performance of AES

Sl.No	Category of respondents	Mean scores	Std. error mean	t- value
1	Researchers in TOT (n=40)	17.7928	0.7955	12.879*
2	Farmers (n=60)	30.4940	0.5829	

*- Significant at 5 % level

Table 4.21. Comparison of Mean scores between the perception of extension personnel and farmers regarding the performance of AES

Sl.No	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=60)	24.8110	0.4488	7.725*
2	Farmers (n=60)	30.4940	0.5829	

*- Significant at 5 % level

scientific or technical terms needed more attention of the scientists who were involved in developing AES.

It could be concluded that extension personnel and farmers were very confident of the future prospects of the better performance of the 'Diagnos-4'. They were also very much satisfied with the mode of presentation, settings in the AES, practicability of information and serviceability of the AES. The areas that needed modifications were: retrievability, relevancy and content of information. At the same time, content and relevancy of information provided in the 'Diagnos-4' should be improved by providing more information on preventive measures, biological control measures and cultural practices considering chemical control methods as the last option. (Fig: 6)

4.4.3 Comparison of mean scores between the perception of researchers in TOT, extension personnel and farmers regarding the performance of AES

The results of agreement between the perception of researchers in TOT, extension personnel and farmers towards the performance of AES are given in the tables: 4.19, 4.20 and 4.21. The table showed that there was highly significant agreement among the perception of researchers in TOT, extension personnel and farmers towards the performance of AES. Therefore the null hypothesis of no significant agreement among the perception of farmers, extension personnel and researchers towards the performance of the AES would get rejected. Among the prospective users, farmers ranked (30.49 mean scores) higher towards the performance of AES, followed by extension personnel (24.81 mean scores) and researchers in TOT (17.79 mean scores). The reason might be that extension personnel were expected to be the main users of AES. They realized the potentials of AES and hence perceived higher about the performance of AES. From the light of above findings, it could be concluded that as we trickle down the different

Table 4.22. Potential of Agricultural Expert System as perceived by researchers

Sl. No	Attributes related to the potential of AES	Researchers involved in developing AES (n=25)		Researchers in TOT (n=40)	
		Mean scores	Rank	Mean scores	Rank
1	AES strengthens TOT process	3.57	II	4.06	II
2	AES provides information support	3.70	I	3.86	III
3	AES promotes empowerment	3.24	V	3.57	IV
4	AES helps to solve field problems	3.49	III	4.32	I
5	AES supports to increase farm income	3.30	IV	3.38	V

Table 4.23. Potential of Agricultural Expert System as perceived by extension personnel and farmers

Sl. No	Attributes related to the potential of AES	Extension personnel (n=60)		Farmers (n=60)	
		Mean scores	Rank	Mean scores	Rank
1	AES strengthens TOT process	4.19	II	3.11	V
2	AES provides information support	4.04	III	4.31	IV
3	AES promotes empowerment	4.01	IV	4.41	II
4	AES helps to solve field problems	4.56	I	4.56	I
5	AES supports to increase farm income	3.62	V	4.37	III

categories of stakeholders in the TOT system, the prospects and performance of AES was perceived more at the lower category of stakeholders in the dissemination of agricultural information (Fig. 7).

4.5 Perception of prospective users towards the potential of AES

4.5.1 Potential of AES as perceived by researchers

Analysis of the table 4.22 points out the potential of Agricultural Expert System as perceived by the researchers. Researchers in AES development ranked first to the attribute 'information support' with a mean score of 3.70. The attribute 'AES strengthens TOT process' was ranked second with a mean score of 3.57. The potential of solving field problems and it supports to increase farm income were ranked third and fourth respectively. Fifth rank was given to the attribute 'AES promotes empowerment'.

Researchers in TOT perceived the potential of AES slightly in a different way. The attribute 'AES helps to solve field problems' was raked first with mean score of 4.32 by the researchers in TOT followed by the attribute 'AES strengthens TOT process' with a mean score of 4.06. Third rank was given to the attribute 'AES provides information support' with a mean score of 3.86 and fourth rank was given to the attribute 'AES promotes empowerment' with a mean score of 3.57. Fifth rank was given to the attribute 'AES supports to increase farm income'.

Both the categories of researchers ranked the attribute, 'AES strengthens TOT process' second. They had shown that AES had the potential of transferring knowledge from scientists to extension workers and in turn to farmers. They also agreed that AES had the potential of reducing the time gap of transferring technologies from scientists to farmers and the distortion of message in transfer of technologies from researchers to users. Rao *et al.* (1999) commented that AES would supplement all modes of TOT due to selective, updated instantaneous

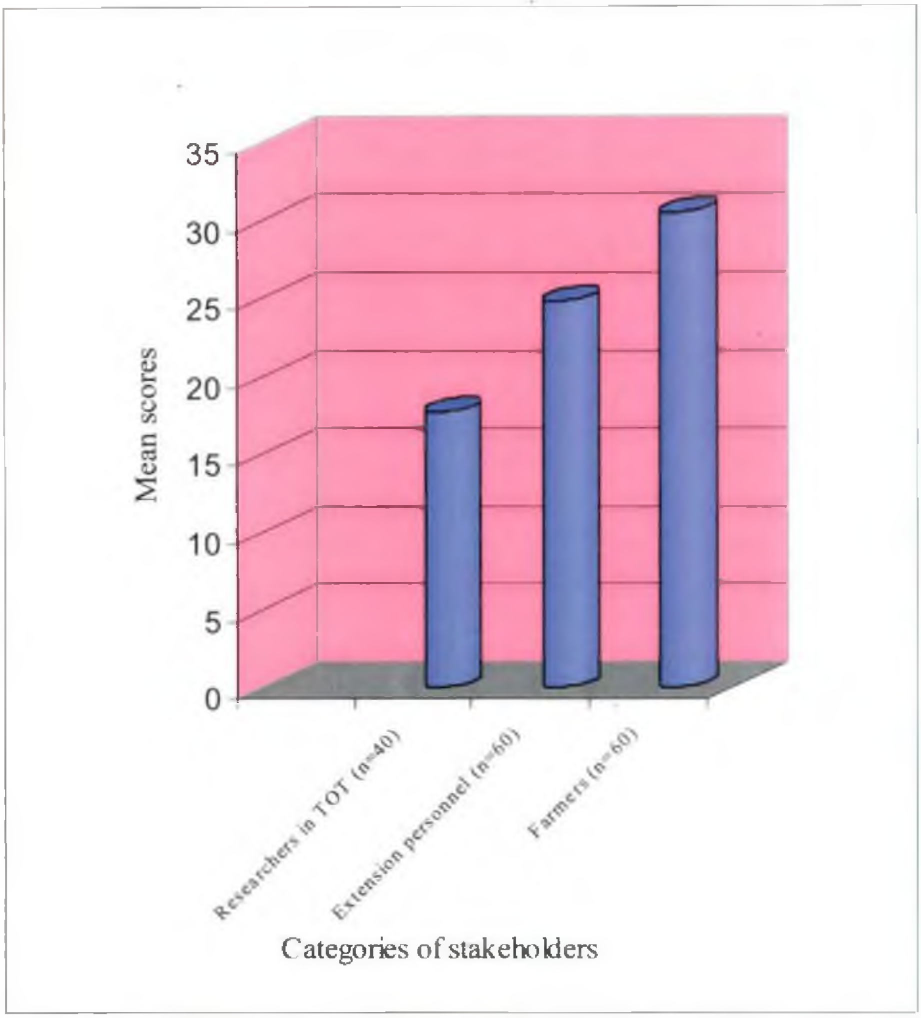

Fig: 7 Comparison of mean scores between the perception of researchers in TOT extension personnel and farmers regarding the performance of AES

retrieval which was easy to that of complex literature retrieval with drudgery when done manually. Raju *et al.* (2006) also stated that AES was a new aid of transfer of technology for most of the professionally sound respondents.

Researchers perceived that AES the potential of providing information support to users by offering expertise wherever required when human expertise was scarce. They had also foreseen that AES had the potential of capturing the expertise of retiring scientists and preserving the knowledge for future use by the prospective users. Further they anticipated that AES could promote sharing of technical knowledge by supporting the farm advisory services extended by extension personnel (Fig. 8).

4.5.2 Potential of Agricultural Expert System as perceived by extension personnel and farmers

The table 4.23 displays the potential of Agricultural Expert System as perceived by extension personnel and farmers. Extension personnel perceived that AES had the potential of solving field problems and hence they ranked first to the same with a mean score of 4.56. 'AES strengthens TOT process' was ranked second by extension personnel. AES provides 'information support' (4.04 mean scores) 'promotes empowerment' and supports to increase farm income (3.62 mean scores) were ranked third, fourth and fifth respectively.

Similar to extension personnel, farmers also perceived that AES had more potential in solving field problems by scoring a maximum of 4.56 mean scores and secured first rank. The attribute of 'AES promotes empowerment' (4.41 mean scores) was ranked second, followed by the potentials of 'increase farm income' (4.37 mean scores), 'information support' (4.31 mean scores), and strengthens TOT process (3.11 mean scores).

Extension personnel and farmers were the category of respondents who directly experience the field problems and need technical knowledge to solve field

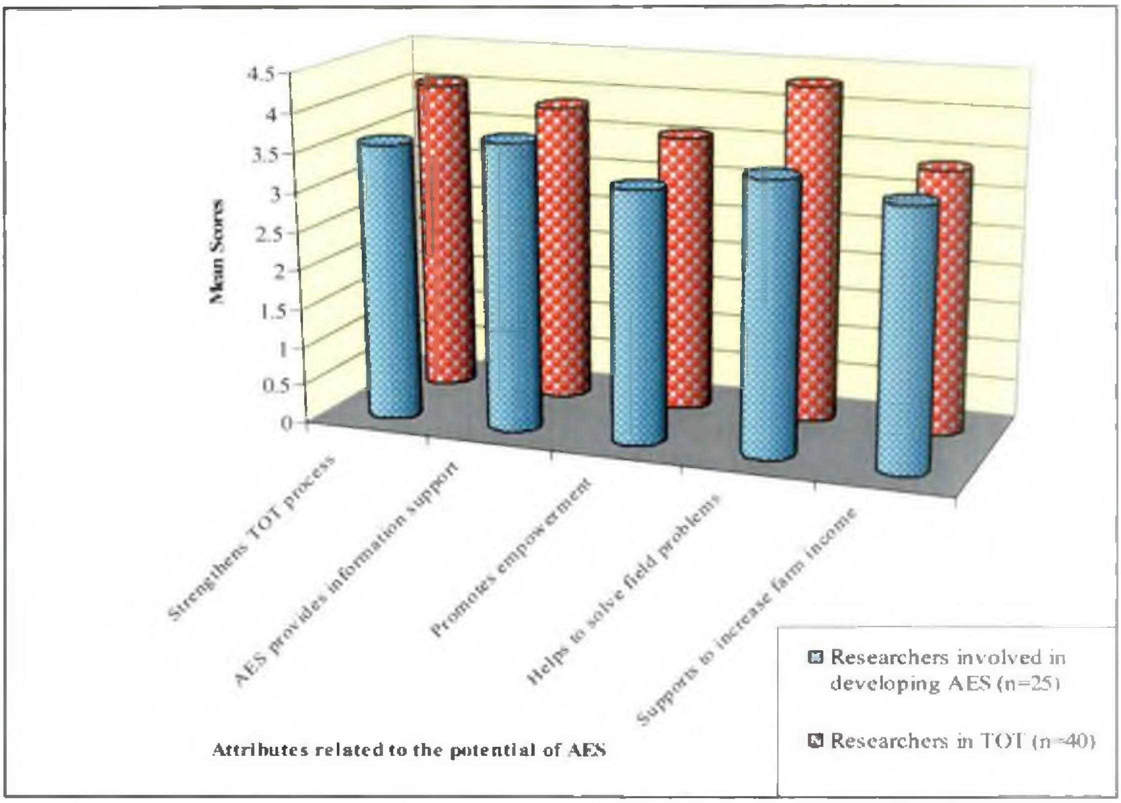

Fig: 8 Potential of Agricultural Expert System as perceived by researchers

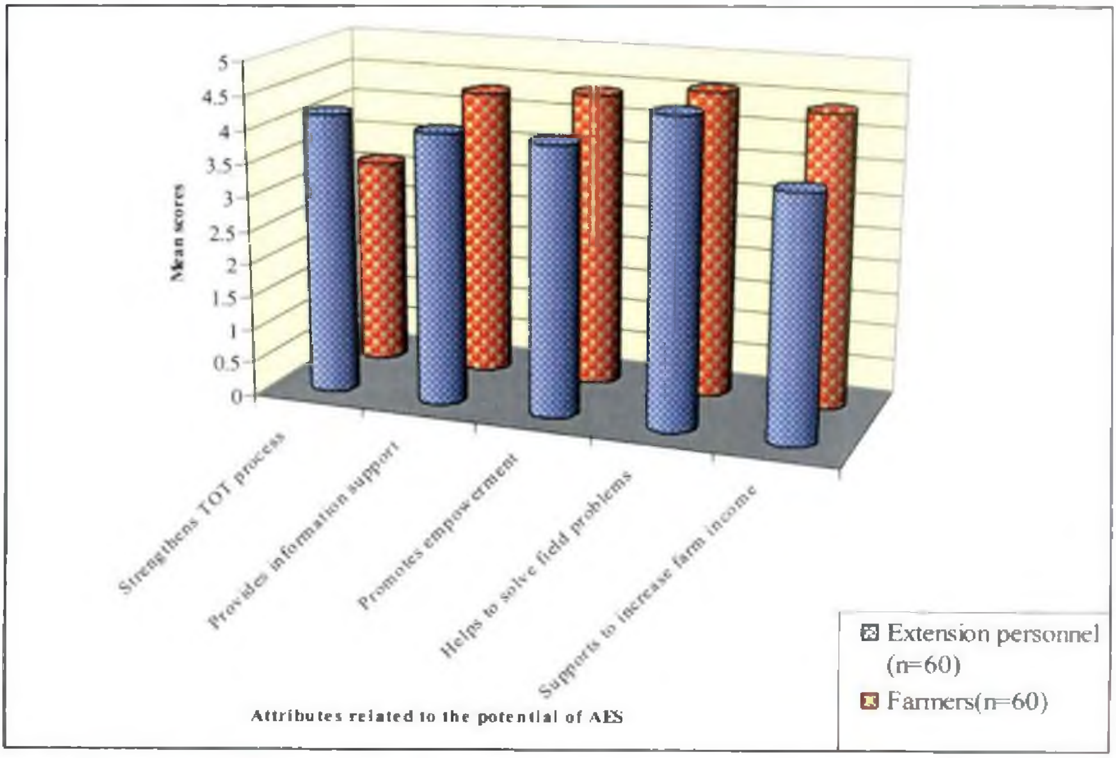

Fig: 9 Potential of Agricultural Expert System as perceived by extension personnel and farmers

problems. After experiencing the functioning of AES, they perceived that AES had the potential of solving field problems by helping the users to diagnose and offer suitable solutions to solve the field problems. It was also perceived that users had the different options of technologies so that users could choose the technology according to the users' needs and available resources.

Extension personnel ranked second to the attribute of 'AES strengthens TOT process'. They might have visualized that AES was a composite of knowledge shared by several experts and foreseen that AES could fill the knowledge gap between the experts and users. They had also forecasted that AES would reduce the time gap of waiting for an expert to receive suitable technologies. Raju *et al.* (2006) supported the finding and stated that AES was a new aid of transfer of technology for most of the professionally sound respondents.

Extension personnel as well as farmers ranked third to the attribute 'AES provides information support'. Both of these categories need precise technical information when they were directly involved either in the dissemination of information or using the information themselves in their own field. Therefore they might have showed agreement among the respondents. They also perceived that AES would build the capacity of experts, it would help the users to remain competitive by providing need based information, reduce the dependence of extension personnel and farmers on subject matter specialists or human experts, provision of need based information would build confidence among users.

Farmers ranked 'AES strengthens TOT process' fifth because they complained that still they could not avail a copy of package of practices in printed form and therefore they had doubt in getting the facilities of AES. Raju *et al.* (2006) also stated that farmers had still to correlate their experience with the new aid, AES. Only 50 to 60 per cent of the respondents were confident about the usage of AES at the farmers' level. Dependence on the traditional means, lack of

Table 4.24. Factors influencing the perception of researchers in TOT regarding the performance of AES

Sl. No	Explanatory variables	Odds ratio	Ranking
1	Trainings attended related to ICT	2.330	I
2	Information backstop	1. 811	II
3	Utilisation of information sources	1. 807	III
4	Rationality in decision making	1.155	IV
5	Proficiency in computer use	1.134	V
6	Perception about ICT	1.105	VI
7	Information output behaviour	1.021	VII
8	Information utilisation behaviour	1.014	VIII
9	Experience	0.981	IX
10	Feedback of information	0.974	X

exposure to the emerging dissemination systems, use of English language in user interface were some of the reasons for such response pattern.

The respondents especially farmers and extension personnel felt that by receiving required information at the right time would enhance the yield of crops and thereby increase farm income. It could be concluded that stakeholders perceived that AES had better potentials in solving field problems and transfer of technology in terms of disseminating information to the users. Potential of Agricultural Expert system as perceived by the respondents is presented in pictorial form in the Fig. 9.

4.6 Factors influencing the perception of prospective users regarding the performance of AES

4.6.1 Factors influencing the perception of researchers in TOT regarding the performance of AES

In order to identify the explanatory variables explaining the influence on the perception of researchers regarding the performance of AES, Binary Logistic Regression analysis was carried out and the results of the same are presented in table 4.24. Out of the fourteen explanatory variables, four variables which showed insignificant relationship were rejected initially and further analysis was explained by ten variables selected for the study.

'Trainings attended related to ICT' was identified with an odds ratio of 2.330 as the most important factor influencing the perception of researchers in TOT regarding the performance of AES. The factors such as 'information backstop', 'utilisation of information sources', 'rationality in decision making', and 'perception about ICT' were found as the important factors influencing the perception of researchers in TOT regarding the performance of AES as they had odds in favour of 1811, 1807, 1155, 1105 against 1000 respectively. Other factors such as 'information output behaviour'(1021), 'information utilization

Table 4.25. Factors influencing the perception of extension personnel regarding the performance of AES

Sl. No.	Explanatory variables	Odds ratio	Ranking
1	Trainings attended related to ICT	1. 823	I
2	Proficiency in computer use	1.686	II
3	Utilisation of information sources	1. 400	III
4	Information backstop	1.360	IV
5	Perception about ICT	1.300	V
6	Rationality in decision making	1.220	VI
7	Experience	1.054	VII
8	Age	1.014	VIII
9	Information utilisation behaviour	1.014	VIII
10	Feedback of information	1.008	IX
11	Experience in computer use	0.995	X
12	Awareness about AES	0.986	XI
13	Information output behaviour	0.983	XII

behaviour'(1014), 'feedback of information'(0974) and experience'(0981) showed lesser degree of influence on the perception of researchers in TOT regarding the performance of AES.

The trainings related to ICT participated by the researchers in TOT might have created a positive influence on the functioning of AES. This showed that training programmes formed a learning platform by creating more understanding about the performance and developments in the field of AES. Provision of better infrastructural facilities for retrieving information, information source utilization behaviour, rationality in decision making and perception about ICT had influenced the probing approach of the respondent researchers in TOT about the performance of AES. Therefore the mentioned factors such as 'trainings attended related to ICT', 'information backstop', 'utilisation of information sources', 'rationality in decision making' and 'perception about ICT' and may be considered before introducing AES among the researchers in TOT.

4.6.2 Factors influencing the perception of extension personnel regarding the performance of AES

The results of the Binary Logistic Regression analysis of the explanatory variables against the perception of extension personnel regarding the performance of AES are presented in the table 4. 25. Out of the fourteen explanatory variables, thirteen variables which showed significance were selected for the study. 'Trainings attended related to ICT' was identified as the most important influencing factor about the perception of extension personnel regarding the performance of AES since it had shown odds in favour of 1823 against 1000. It was also found that 'proficiency in computer use', 'utilisation of information sources', 'information backstop', 'perception about ICT' and rationality in decision making were the factors influencing the perception of extension personnel regarding the performance of AES with odds in favour of 1823, 1686, 1400, 1360, 1300 and 1220 against 1000 respectively. Among extension personnel, the role of information output behaviour, awareness about AES and

Table 4.26. Factors influencing the perception of farmers regarding the performance of AES

Sl. No.	Explanatory variables	Odds ratio	Ranking
1	Trainings attended related to ICT	3.022	I
2	Education	2.229	II
3	Information backstop	1.566	III
4	Utilisation of information sources	1.401	IV
5	Proficiency in computer use	1.126	V
6	Feedback of information	1.106	VI
7	Information utilisation behaviour	1.011	VII
8	Rationality in decision making	0.999	VIII
9	Information output behaviour	0.965	IX
10	Experience	0.957	X
11	Perception about ICT	0.956	XI

experience in computer use were found as supplementary factors with an odds ratio of 0.983, 0.986 and 0.995 respectively.

This showed that training programmes were the better option in providing information regarding the functioning of AES among extension personnel. As extension personnel were more proficient in computer use, they were very confident of the functioning of AES. Their behaviour of utilizing more and more information sources might have prompted them to perceive higher about the performance of AES. They had also expressed that provision of better facilities for retrieving information would let them experience with the performance of AES. From the above discussion, it can be concluded that improvement in the mentioned factors would enhance the perception of extension personnel regarding the performance of AES. Therefore the identified factors such as 'trainings attended related to ICT', 'proficiency in computer use', 'utilisation of information sources', 'information backstop', 'perception about ICT' and rationality in decision making may be taken care of among extension personnel before releasing AES which would in turn improve the performance of AES.

4.6.3 Factors influencing the perception of farmers regarding the performance of AES

The factors influencing the perception of farmers regarding the performance of AES was assessed using Binary Logistic Regression analysis and the results are presented in the table: 4.26. It was found that out of fourteen variables, eleven variables were selected based on significance to study the influence on the perception of farmers regarding the performance of AES.

The results showed that among farmers, 'trainings related to ICT' had 3022 odds in favour against 1000 as it influenced greatly on the perception of farmers regarding the performance of AES. Further analysis revealed that 'trainings related to ICT' was found as the most influencing factor on the perception of farmers regarding the performance of AES as observed among researchers in TOT and extension personnel. Other factors such as 'education' (2229), 'information backstop' (1556), 'utilisation of information sources' (1401) and 'proficiency in computer use' (1126) showed reasonable influence on the perception of farmers regarding the performance of AES. Along with the training programmes, education of farmers also showed high influence on the perception of farmers regarding the performance of AES. 'Education' was found as insignificant factor among the other two categories of respondents viz, researchers in TOT and extension personnel. Considerable variation among farmers in education might be the reason for this trend. Therefore, 'education' was one of the additional factors which had shown more influence on the perception of farmers regarding the performance of AES along with 'trainings related to ICT', 'information backstop', 'utilisation of information sources' and 'proficiency in computer use'. The mentioned factors which were more influential in nature may be improved among farmers for popularizing the use of AES among farmers. Nuthall and Bishop-Hurley (1996) found that farmers' personality, age and education level were the major factors in explaining the views held related to the performance of expert systems. Babu (2005) also observed that income, number of years of schooling, media exposure, innovation proneness, attitude towards ICTs, achievement motivation, level of aspiration were having positive relationship with the perception and e-readiness of the farmers in the study area.

From the above results, it could be derived that the factors influencing the users regarding the performance of AES varied with the category of respondents. Therefore each category of prospective users may be targeted separately for orienting them in using AES, before it is released. The factors such as trainings attended related to ICT and information backstop were found as the common factors with high odds ratio, influencing all the categories of users. Hence these two factors may be given foremost importance in improving the use of AES among the prospective users.

Table 4.27. Treatment wise Information Efficiency Index of AES as assessed by extension personnel

Sl.No	Dimensions	AES alone T3 (n=30)	AES+HES T4 (n=30)
1	Retrievability	61.76	68.16
2	Relevancy	79.33	80.00
3	Practicability	84.00	86.00
4	Information content	63.74	78.21
5	Knowledge gain	44.35	60.44
	Mean	66.64	74.56

Overall mean: 70.60

Table 4.28. Category wise Information Efficiency Index of AES as assessed by extension personnel

Sl. No	Category	Number	Percentage
1	High	10	16.00
2	Medium	43	73.00
3	Low	7	11.00

4.7 Information efficiency of AES as assessed by prospective users

4.7.1 Information efficiency of AES as assessed by extension personnel

Information Efficiency Index (IEI) of AES as assessed by extension personnel is presented in the table 4.27. From the table it could be observed that the IEI of AES was 70.60 as assessed by extension personnel. The extension personnel who were exposed to AES alone rated AES with an IEI of 66.64 and who were exposed to AES + human experts assessed AES with an IEI of 74.56. The combination of AES and human expertise showed the higher degree of information efficiency between the treatment groups. This finding is in concomitant with the findings of Radhakrishnan (2000), Anandaraja (2002) and Balasubramani *et al.* (2005).

Knowledge gain was the appreciable component that showed a wide difference between the T_3 and T_4 groups. The reason might be that the influence of human experts prompted the extension personnel to rate AES with higher IEI.

Among the dimensions of IEI, practicability of information was assessed as the maximum mean score percentage of 86.00 by T_4 group of extension personnel and 84.00 by T_3 group of extension personnel. It indicated that the management measures given in AES were highly adoptable and feasible in the field situation.

Relevancy of the information was assessed as almost same with the mean score percentage of 79.33 and 80.00 by both (T_3& T_4) groups respectively. From the above result, it could be interpreted that both groups were satisfied about the relevancy of the information provided in AES. They agreed that the presented information was suitable to the users' resources and appropriate to the end users.

Information content was rated with the mean score percentage of 63.74 and 78.21 respectively by T_3 and T_4 group of extension personnel. They were of the opinion that the content would become adequate if some more information on biological control measures were to be added. They also suggested to include a ready reckoner for working out the dosage of inputs to be used in an available area.

Retrievability was assessed with the mean score percentage of 61.76 and 68.16 respectively by T_3 and T_4 group of extension personnel. It was assessed as the lowest mean score percentage. Therefore options should be found out to improve the retrievability of AES. Therefore easily accessible pathways should be identified. Few respondents suggested to include single click and avoid double click in all the links to avoid tediousness in getting the required pages (Fig. 10).

4.7.2 Category wise Information Efficiency Index of AES as assessed by extension personnel

Table 4.28 presents category wise Information Efficiency Index of AES as assessed by extension personnel. It could be inferred from the table that 16.00 per cent of the extension personnel rated AES with high IEI, 73.00 per cent of them rated medium IEI and the remaining 11.00 per cent rated it with lower IEI. It showed that majority of them favoured for the IEI of AES and the lower percentage of extension personnel rated as low IEI. These findings are in agreement with the findings of CLAES (2006). The reason might be that AES was built with the accumulated expertise of several human experts and the presentation of the message systematically with attractive colours and photographs which involve both the senses of hearing and seeing.

The delivery of information systematically through text, pictures and audio were tailored to its users to retrieve information on their own pace. The pictures and attractive colorful presentation would have attracted the attention of the respondents and made them more receptive to the idea, which was exposed. The principle of 'seeing is believing', holds good, because one picture was worth more than thousand words'. More over the sense of seeing and hearing might have created enough impact of providing more information. This finding derives

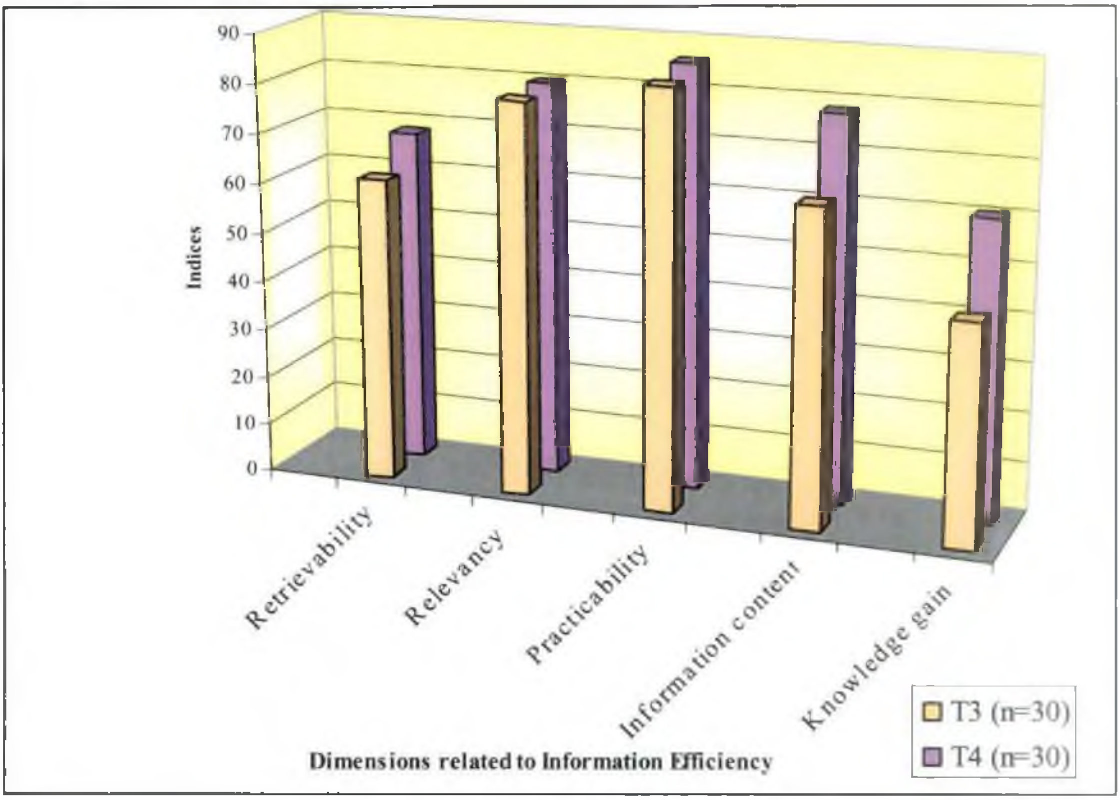

Fig: 10 Treatment wise Information Efficiency Index of AES as assessed by extension personnel

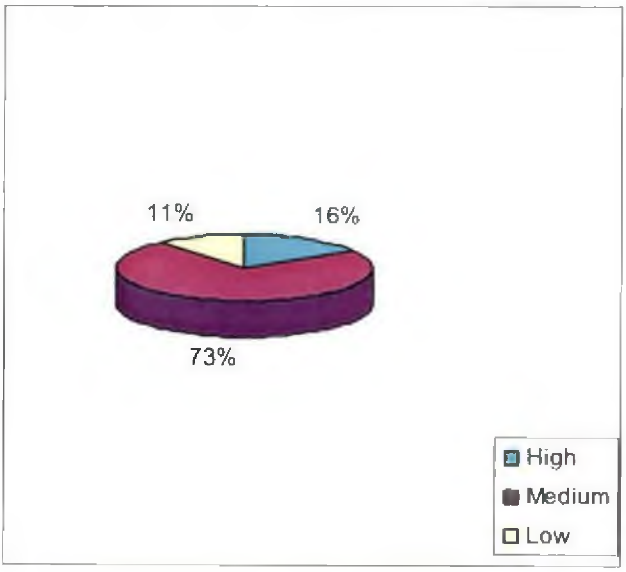

Fig: 11 Category wise Information Efficiency Index of AES as assessed by extension personnel

Table 4.29.Treatment wise Information Efficiency Index of AES as assessed by farmers

Sl. No	Dimensions	AES alone T3 (n=30)	AES+HES T4 (n=30)
1	Retrievability	55.52	57.6
2	Relevancy	70.67	72.67
3	Practicability	69.33	72.67
4	Information content	62.08	62.46
5	Knowledge gain	35.11	42.08
	Mean	58.54	61.50

Overall mean: 60.02

Table 4.30.Category wise Information Efficiency Index of AES as assessed by farmers

Sl. No	Category	Number	Percentage
1	High	9	15.00
2	Medium	28	46.70
3	Low	23	38.30

support from the results of Balasubramani (2004). Information Efficiency Index of AES as assessed by extension personnel is depicted in the Fig. 11.

4.7.2 Information efficiency of AES as assessed by farmers

From the table 4.29, it could be inferred that the IEI of AES was 60.02 as assessed by farmer respondents. The farmer group who were exposed to AES alone assessed AES with an IEI of 58.54 and those who were exposed to AES + human experts assessed AES with an IEI of 61.50. The same trends of responses of extension personnel were reflected in the case of farmers' responses also.

Among the dimensions of IEI, relevancy and practicability of the information provided in AES were assessed and the maximum mean score percentage of 72.67 by T_4 group of farmers and 70.00 by T_3 group of farmers. It showed that the farmers from both group were satisfied with feasibility and appropriateness of information provided in AES. Information content was assessed the same mean score percentage of 62.00 by both the group of farmers. It could be derived that both treatment groups of farmers were in agreement about the information content provided in AES irrespective of their exposure given to them. Farmers suggested to include more crops such as mango and some more vegetable crops. They also urged to include more of biological control measures and also to include all micro nutrient deficiency symptoms and recommended control measures. Retrievability of the information was rated as last as indicated by extension personnel.

It was quite impressive to note that the respondents gained substantial information when they were exposed to AES and human expertise. Since AES is in the initial stages of introduction to the users, it was found more effective only when guidance was offered to the users in using AES. It was obvious that though the 'Diagnos-4' was with text, audio and photographs, the absence of interaction prevented the respondents to discuss and clarify their doubts, which naturally created boredom and would have declined their interest to learn more. The reason might be that farmers were not familiar with the retrieval of information from computers and when they received expertise directly from individual human expert, they could get more information.

The 'Diagnos-4' enabled the respondents to visually observe as well as to hear messages. It not only aroused interest among the users but also enriched learning situation by sustaining interest, thus promoting better learning in terms of information efficiency. Discussion with experts directly might have paved way for clarification of doubts, better diagnosis of the field problems and conviction by themselves with individual human expert. This might be because of the higher number of senses of the learners involved in combination and hence the result. It could therefore be inferred that AES should be introduced to the farmer users along with imparting a skill-oriented training in using the system. Once they familiarize with the AES, human expertise will be needed in situations which require natural intelligence. Introduction of touch screen facility and installing the software in all the krishibhavans will make the AES more user friendly.

Proper identification of the insect pests, selection of chemical pesticides and their discriminate use, need human expertise, experience and judgment. But, sufficient numbers of competent human experts are not available to cover the large area. To mitigate the scarcity of human expertise and assist the existing experts for improved decision–making, this kind of 'Diagnos-4' for insect pest management would be useful (Fig. 12).

4.7.2.1 Category wise IEI of AES as assessed by farmers

Table 4.30 presents the category wise IEI of AES as assessed by farmers. It could be observed from the table that 15.00 per cent of the farmer respondents rated AES as high IEI, 46.70 per cent of them assessed AES as medium IEI and 38.30 per cent rated AES as less IEI. Farmers expressed the problem of presentation of information in English language. Majority of the farmer

Table 4.31. Comparison of Mean scores between extension personnel and farmers regarding the information efficiency of AES as perceived by them after the exposure of AES alone

Sl. No	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	76.8727	2.3644	5.701*
2	Farmers (n=30)	59.7171	1.8617	

*- Significant at 5 % level

Table 4.32. Comparison of Mean scores between extension personnel and farmers regarding the information efficiency of AES as perceived by them after the exposure of AES and Human experts

Sl. No	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	77.0013	2.3832	2.507*
2	Farmers (n=30)	63.0557	2.0886	

*- Significant at 5 % level

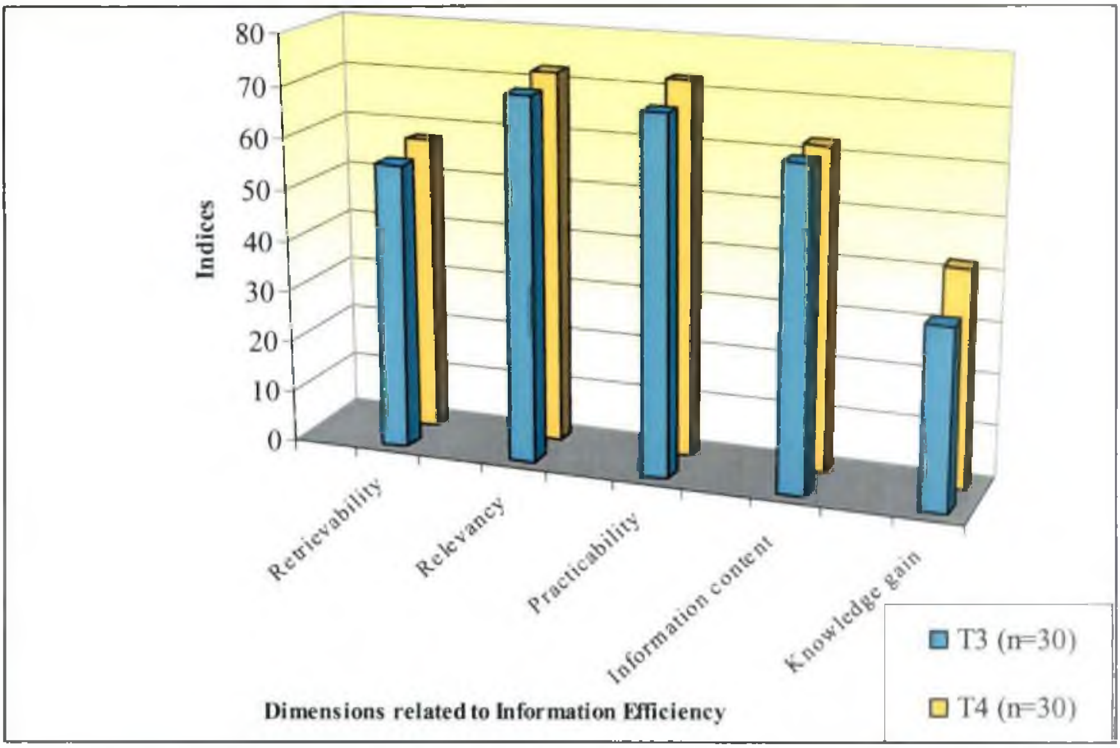

Fig: 12 Treatment wise Information Efficiency Index of AES as assessed by farmers

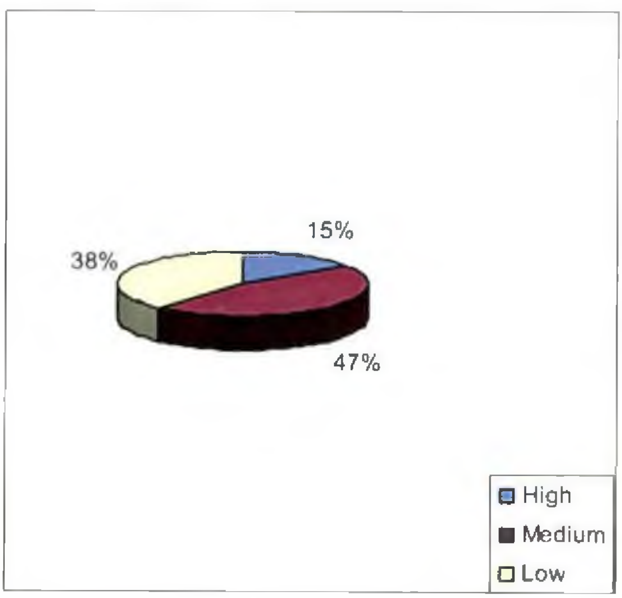

Fig: 13 Category wise Information Efficiency Index of AES as assessed by farmers

respondents in the low proficiency of computer operations might be the reason for finding it difficult to locate the required information. At the same time, the complicated path way of locating required information as reported by majority of the farmers need modifications. Information Efficiency Index of AES as assessed by extension personnel is depicted in the Fig. 13.

4.7.2.2 Comparison of mean scores between extension personnel and farmers towards the information efficiency of AES as perceived by them after the exposure of AES alone

In the table 4.31, comparison of mean scores between extension personnel and farmers towards the information efficiency of AES as perceived by them after the exposure of AES alone is presented. It was clear from the table that extension personnel assessed an information efficiency of 76.87 mean scores and farmers furnished an information efficiency of 59.71 mean scores. They showed a highly significant agreement in the efficiency of AES after the exposure of AES alone at 5 per cent level of probability. The main problems expressed by farmers were that the information was presented in English language and information efficiency would be higher if it was presented in local language, viz., Malayalam.

4.7.2.1 Comparison of mean scores between extension personnel and farmers towards the information efficiency of AES as perceived by them after the exposure of AES and human experts

Table 4.32 shows the results of comparison of mean scores between extension personnel and farmers towards the information efficiency of AES as perceived by them after the exposure of AES and human experts. From the table, it can be inferred that extension personnel assessed an information efficiency of 77.00 mean scores and farmers endowed an information efficiency of 63.05 mean scores. They showed a highly significant information efficiency of AES after the exposure of AES and human expert at 5 per cent level of probability. Information efficiency of AES as assessed by extension personnel was almost on par when a group of them were exposed to AES alone and another group was exposed with

Table 4.33. Problem solving capacity of the system as assessed by extension personnel

Sl. No.	Experienced problems	Problems quantified		Solutions received					
				HES alone T_2		AES alone T_3		AES+HES T_4	
		Mean scores	Percentage	Mean scores	Percentage	Mean scores	Percentage	Mean scores	Percentage
	Rice								
1	Stem borer	4.64	92.8	3.44	74.14	3.03	65.30	4.23	91.16
2	Bacterial leaf blight	3.86	77.14	3.26	84.52	2.14	89.70	3.42	93.19
3	Brown plant hopper	3.67	73.40	3.46	58.31	2.14	55.48	3.56	97.00
4	Gall midge	4.50	90.00	3.32	73.78	3.41	75.78	3.91	86.89
5	Leaf folder	4.50	90.00	4.07	90.44	4.32	96.00	4.46	99.11
6	Ear head bug	3.33	66.67	3.12	93.60	3.20	96.00	3.28	98.40
	Mean	4.08	81.67	3.45	79.13	3.04	79.71	3.81	94.29
	Coconut								
1	Stem bleeding	3.60	72.00	2.54	70.56	3.14	87.22	3.45	95.83
2	Eryophid mite	4.50	90.00	3.23	71.78	3.43	76.22	4.27	94.89
3	Termites	3.00	60.00	2.43	81.00	1.56	52.00	2.21	73.67
4	Bud rot	4.00	80.00	2.36	59.00	2.45	61.25	2.82	70.50
5	Root wilt	2.00	40.00	1.12	56.00	1.24	62.00	1.42	71.00
	Mean	3.42	68.4	2.34	67.67	2.36	67.74	2.83	81.18
	Banana								
1	Pseudostem weevil	4.00	80.00	3.64	91.00	3.82	95.50	3.83	95.75
2	Bacterial wilt	3.50	70.00	3.00	85.71	3.32	94.86	3.45	98.57
3	Leaf spot	4.50	90.00	4.21	93.56	3.42	76.00	3.61	80.22
4	Bract mosaic virus	3.00	60.00	2.50	83.33	2.62	87.33	2.74	91.33
5	Bunchy top	4.67	93.33	3.52	75.43	4.34	93.00	4.46	95.57
	Mean	3.93	78.67	3.37	85.81	3.50	89.34	3.62	92.29

AES and human experts, whereas farmers showed a slight increase in information efficiency of AES when a group was exposed to AES and human experts. The influence of the presence of human expert was more pronounced among farmers when compared to extension personnel. The reason might be that farmers would require adequate training to hone their skills in using the system, whereas extension personnel might require a brief orientation in handling the system. Rao *et al.* (1999) also suggested that majority of the farmers and extension personnel were willing to undergo training for using expert system in TOT as it directly concerns them. The potential for designing short training session for using expert system for TOT and related activities need to be exploited on a priority basis.

4.8 Problem solving capacity of AES as assessed by prospective users

4.8.1 Problem solving capacity of AES as assessed by extension personnel

The problem solving capacity of the AES assessed by extension personnel is furnished in the table 4.33. Careful examination of the data showed that stem borer (92.80 per cent) was the most important problem followed by gall midge and leaf folder (90.00 per cent each), bacterial leaf blight (77.14 per cent), brown plant hopper (73.40 per cent) and earhead bug (66.67 per cent) in rice cultivation. Human expert was able to offer solution to the control of stem borer at a tune of 74.14 per cent. AES could provide solution only to 65.30 per cent. The group which was exposed to AES alone complained that biological control measures of stem borer was not explained in detail, which might be the reason for the lower percentage of solutions offered by AES. At the same time the group that was exposed to both AES and human expert recorded a gain of 91.16 per cent solutions. This group was able to get the information on biological control measures from human expertise and reported increase in percentage of solutions. In all other cases of problems in rice AES could provide better solutions than the human expert, but the combination of AES and human expert served much more solutions to the extension personnel. When the overall percentage of solutions

Table 4.34. Problem solving capacity of the system as assessed by farmers

Sl. No.	Experienced problems	Problems quantified		Solutions received					
				HES alone T_2		AES alone T_3		AES+HES T_4	
		Mean scores	Percentage	Mean scores	Percentage	Mean scores	Percentage	Mean scores	Percentage
	Rice								
1	Stem borer	4.81	96.2	4.53	94.18	4.21	87.53	4.60	95.63
2	Bacterial leaf blight	5.00	100.00	4.86	96.80	4.86	97.20	5.00	100.00
3	Brown plant hopper	3.94	78.80	3.32	84.26	3.56	90.36	3.77	95.69
4	Gall midge	3.82	76.40	3.16	82.72	3.34	87.43	3.63	95.03
5	Leaf folder	4.60	92.00	4.23	91.96	4.57	99.35	4.55	98.91
6	Ear head bug	4.65	93.00	4.31	92.69	4.24	91.18	4.40	94.62
7	Sheath rot	4.72	94.40	3.80	80.51	4.49	95.13	4.68	99.15
8	Blast	4.33	86.60	4.15	95.84	4.26	98.38	4.30	99.31
9	Yellowing	3.50	70.00	2.62	74.86	2.63	75.14	2.81	80.29
10	Nematode	4.83	96.60	4.20	86.96	3.27	67.70	4.22	87.37
	Mean	4.42	88.40	3.92	88.08	3.94	88.94	4.20	94.6
	Coconut								
1	Stem bleeding	4.72	94.40	3.71	78.60	4.37	92.58	4.57	96.82
2	Eryophid mite	5.00	100.00	4.13	82.60	4.72	94.40	4.81	97.84
3	Termites	4.21	92.40	3.93	81.00	2.45	58.19	4.01	95.25
4	Bud rot	4.62	93.60	2.43	52.60	3.64	78.79	4.52	97.84
5	Root wilt	4.68	90.40	3.91	83.55	4.10	87.61	4.55	97.22
6	Red palm weevil	4.52	91.20	3.40	75.22	4.00	88.50	4.30	95.13
7	Rhinocerous beetle	4.56	84.20	3.63	79.61	3.84	84.21	4.36	95.61
	Mean	4.62	92.31	3.59	76.17	3.87	83.47	4.45	96.53
	Banana								
1	Pseudostem weevil	4.82	96.40	4.12	85.48	4.63	96.06	4.72	97.93
2	Bacterial wilt	4.50	90.00	3.46	77.11	3.46	76.89	3.87	82.74
3	Leaf spot	4.72	96.40	3.24	68.64	2.43	51.48	3.36	71.19
4	Yellowing of leaves	4.76	95.20	3.48	73.11	3.25	68.28	3.57	76.91
5	Bunchy top	5.00	100.00	3.24	64.80	3.78	75.60	4.47	89.40
6	Mealy bugs	4.72	94.40	3.52	74.58	1.41	29.87	3.63	86.00
	Mean	4.75	95.07	3.51	73.95	3.16	66.36	3.94	84.03

offered by AES was worked out, it was almost on par with the solutions given by human experts. However, it served better in combination with human experts.

In coconut cultivation, eryophid mite, (90.00 per cent) was the most important problem followed by bud rot (80.00 per cent), stem bleeding (72.00 per cent), termites (60.00 per cent) and root wilt (40.00 per cent). For almost all the problems, AES could offer better solutions on par with human expertise, except the termite problem for which users could not find satisfactory solutions. Similar to paddy cultivation, AES could also furnish details of control measures for the plant protection problems in coconut cultivation on par with human expert.

Bunchy top was (93.33 per cent) the common and most intensively reported problem followed by leaf spot (90.00 per cent), pseudostem weevil (80.00 per cent), bacterial wilt (70.00 per cent), and bract mosaic virus (60.00 per cent) in banana cultivation. Except leaf spot (76.00 per cent), all other problems could be served better solutions by AES than human expertise. This is in agreement with the findings of CLAES (2004). Just like the other two crops, the combination of AES and human expertise could render best solutions among all the treatment groups.

4.8.2 Problem solving capacity of AES as assessed by farmers

Farmers' assessment on the problem solving capacity of the AES is given in the table 4.34. Farmer respondents listed ten plant protection problems in rice cultivation. They reported that the bacterial leaf blight (100.00 per cent) was the acute problem existed in their fields, followed by nematode (96.60 per cent), stem borer (96.20 per cent), sheath rot (94.40 per cent), ear head bug (93.00 per cent) leaf folder (92.00 per cent) etc. Out of ten problems reported, eight problems were served with better solutions by AES. AES was found better in providing solutions to the problem of stem borer to a per cent of 91.18 whereas human expertise could offer solutions to the tune of 92.69 per cent with a difference of 1.51 per cent. Another problem was nematode infestation in rice for which AES could provide solutions only to a tune of 67.70 per cent, whereas, human expertise could provide solutions to a percentage of 86.96. For all other problems, AES could show better performance when compared to human expertise. When the overall performance of AES was compared with human expertise in plant protection of rice, AES was slightly better in providing solutions to the farmers. However the combination of AES and human expertise showed superior performance in offering solutions to the users, among all the treatment groups of farmers as in the case of extension personnel.

In coconut cultivation, farmer respondents marked cent per cent severity of eryophid mite incidence in their field. It was recorded as low as 94.40 per cent in the case of stem bleeding, 93.60 per cent bud rot, 92.40 per cent termites, 91.20 per cent red palm weevil, 90.40 per cent root wilt, and 84.20 per cent of attack by rhinocerous beetle. Except for termite attack, AES could provide better solutions to the farmers. As in the case of rice cultivation, the AES could provide better solutions for the plant protection problems in coconut cultivation when compared to human expertise and the combination of both proved the best in rendering solutions to the farmers.

In the case of banana cultivation, farmers expressed cent per cent severity of bunchy top incidence followed by equal severity of problems of pseudostem weevil and leaf rot (96.40 per cent each), yellowing of leaves (95.20 per cent), mealy bugs (94.40 per cent) and bacterial wilt (90.00 per cent). Farmers were satisfied more in getting solutions from AES for pseudostem weevil (96.06 per cent) whereas they reported that they could not diagnose leaf spot (51.48 per cent) and mealy bugs (29.87 per cent) using AES alone and thereby could not find suitable solutions. Therefore farmers assessed that AES could provide lesser percentage (66.36 per cent) of solutions for the field problems faced in banana cultivation when compared to human expertise. However the combination of AES with human expertise rendered solutions best of all other treatment groups as observed in other crops. AES was the combined effort of several human experts, symptoms were given in the photographs as seen in the real situation, and information was presented systematically in which the user could see and understand the information according to individual pace. In the case of human expertise, a single expert's knowledge was heard by the farmer respondents and tried to understand according to the speed of delivery of human expert's lecture. Here the principle of seeing made more impact than hearing was justified (Reddy, 1987).

It was also realized that AES could provide whatever information was fed into the system whereas a human expert had the capacity of providing information according to the requirement of the user. This was what happened in few cases where AES had been fed with maximum information on chemical control measures but the users needed more of biological control measures where human experts could provide necessary information.

This result is in line with Rafea (1996). They reported that Lime Expert System (LIMEX) was able to correctly assess 16 out of 20 cases. The result also suggested LIMEX as a significant and useful tool for lime cultivation. This finding is also in agreement with the findings of Batchelor *et al.* (1991) who reported that pest management recommendation from extension bulletins and the Expert System were compared with an expert's recommendations and the results indicated the potential improvement in decision-making processes with the adoption of Expert Systems. It was also in accordance with Nuthall and Bishop-Hurley (1996) who found that the farmers in general agreed with the advice and explanations provided by the three computer-based Expert Systems developed for components of the overall feed management problems.

Table 4.38. Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of human experts as perceived by them in the plant protection of rice cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	3.2343	0.1688	3.111*
2	Farmers (n=30)	3.9167	0.1400	

*- Significant at 5 % level

Table 4.39. Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of human experts as perceived by them in the plant protection of coconut cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	2.3413	0.0088	8.791*
2	Farmers (n=30)	3.5900	0.6116	

*- Significant at 5 % level

Table 4.40. Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of human experts as perceived by them in the plant protection of banana cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	3.2540	0.1366	1.381*
2	Farmers (n=30)	3.5167	0.1324	

*- Significant at 5 % level

4.8.2.1 Comparison of mean scores between extension personnel and farmers regarding the problems faced by them in the plant protection of rice, coconut and banana cultivation

The results of the comparison of mean scores between extension personnel and farmers towards the problems faced by them in the plant protection of rice cultivation, coconut and banana cultivation are presented in the tables 4.35, 4.36 and 4.37. It could be inferred from the tables that there was no significant variation in the agreement between extension personnel and farmers towards the problems faced by them in the plant protection aspects of rice cultivation. While there was significant difference in the problems reported by extension personnel and farmers in the plant protection aspects of coconut and banana cultivation. Among all the three crops, farmers expressed higher magnitude of problems when compared to extension personnel. It was quite natural that farmers were the category of respondents who cultivated crops themselves, directly experiencing the mentioned problems in the field and hence the result (Fig. 14).

4.8.2.2 Comparison of mean scores between extension personnel and farmers regarding the problem solving capacity of human expert as perceived by them in the plant protection of rice, coconut and banana cultivation

Comparison of mean scores between extension personnel and farmers towards the problem solving capacity of human expert as perceived by them in the plant protection of rice, coconut and banana cultivation are provided in the tables 4.38, 4.39 and 4.40. The problem solving capacity of human expert in the plant protection aspects of rice, coconut and banana, extension personnel and farmers showed significant difference in rice and coconut. No significant difference had been observed among extension personnel and farmers in the plant protection aspects of banana cultivation at 5 per cent level of probability. Higher sufficiency of solutions was reported by farmers when compared to extension personnel in the plant protection aspects of rice, coconut and banana cultivation. Among the three crops, plant protection of rice and banana crop was found to offer solutions in the same trend among extension personnel and farmers. Information provided on the

Table 4.41.Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of AES as perceived by them in the plant protection of rice cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	2.3553	0.1079	9.306*
2	Farmers (n=30)	3.9400	0.1345	

*- Significant at 5 % level

Table 4.42.Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of AES as perceived by them in the plant protection of coconut cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	2.3700	0.0094	10.006*
2	Farmers (n=30)	3.8667	0.1148	

*- Significant at 5 % level

Table 4.43.Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of AES as perceived by them in the plant protection of banana cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	3.5367	0.1156	2.790*
2	Farmers (n=30)	3.1667	0.0065	

*- Significant at 5 % level

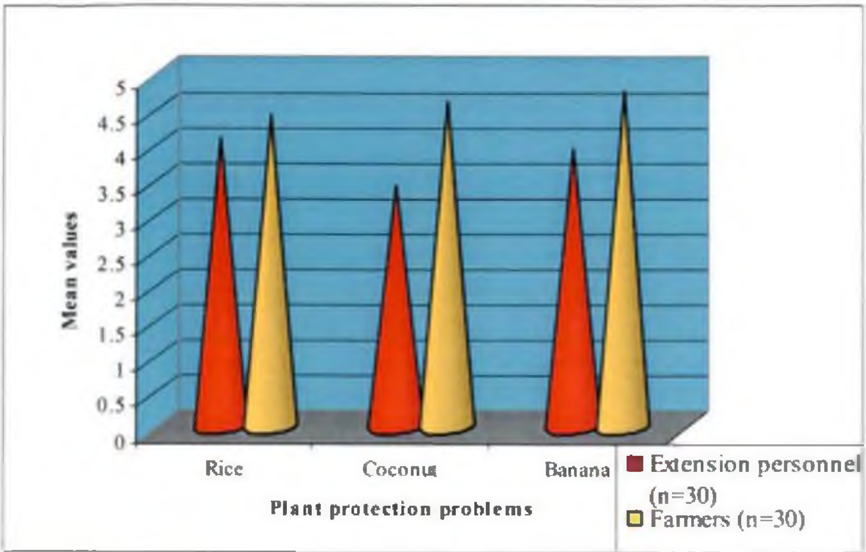

Fig: 14 Comparison of mean scores between extension personnel and farmers regarding the problems faced by them in the plant protection of rice, coconut and banana cultivation

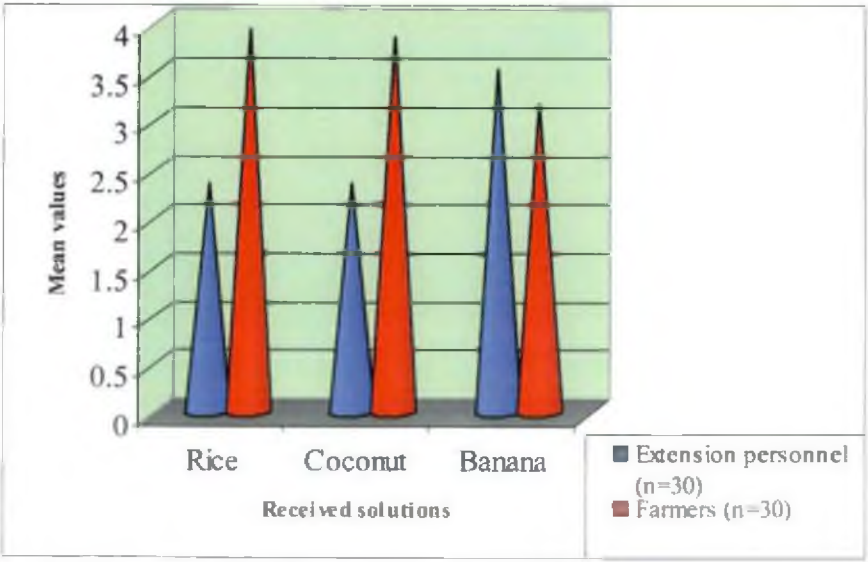

Fig: 16 Comparison of mean scores between extension personnel and farmers regarding the problem solving capacity of AES as perceived by them in the plant protection of rice, coconut and banana cultivation

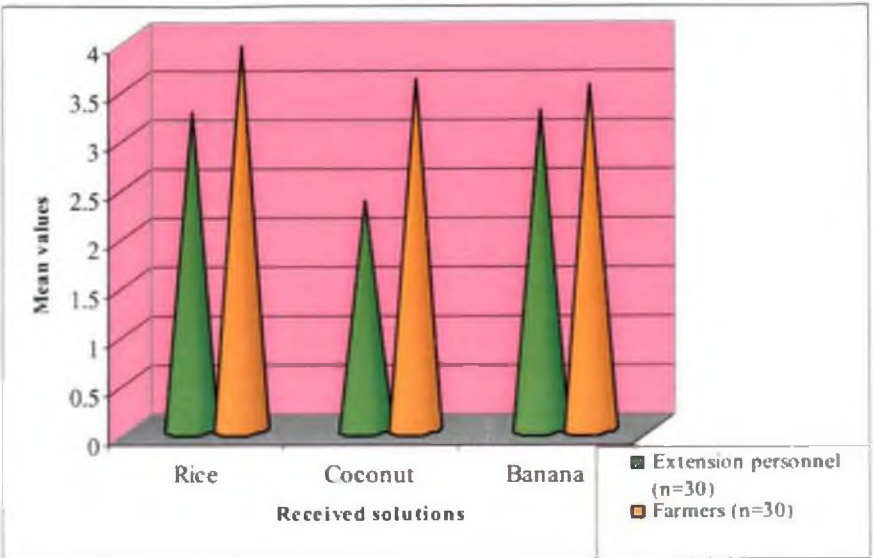

Fig: 15 Comparison of mean scores between extension personnel and farmers regarding the problem solving capacity of human experts as perceived by them in the plant protection of rice, coconut and banana cultivation

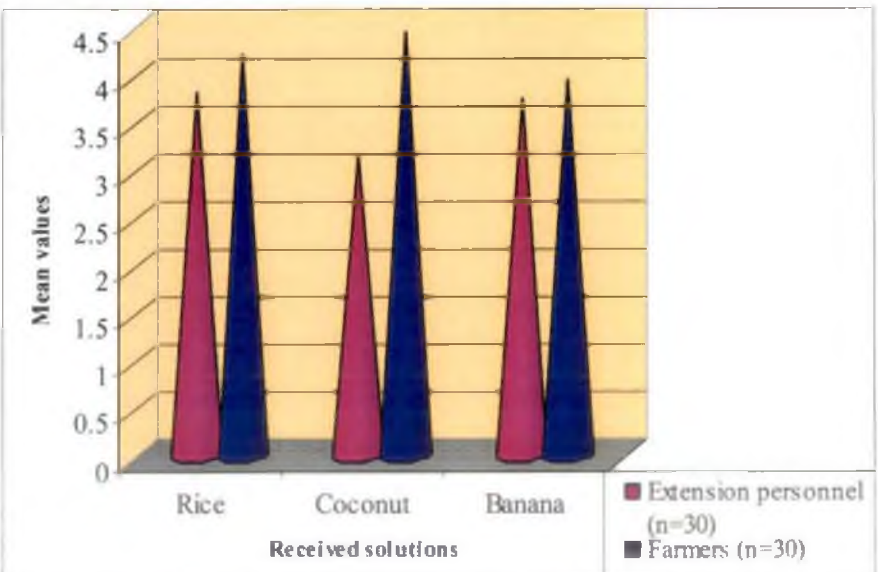

Fig: 17 Comparison of mean scores between extension personnel and farmers regarding the problem solving capacity of AES+ Human expert as perceived by them in the plant protection of rice, coconut and banana cultivation

plant protection of coconut showed significant variation among extension personnel and farmers (Fig. 15).

4.8.2.3 Comparison of mean scores between extension personnel and farmers towards the problem solving capacity of AES alone as perceived by them in the plant protection of rice, coconut and banana cultivation

Comparison of mean scores between extension personnel and farmers towards the problem solving capacity of AES alone as perceived by them in the plant protection of rice, coconut and banana cultivation are given in the tables 4.41, 4.42 and 4.43. In expressing the sufficiency of solutions provided by AES, extension personnel and farmers showed highly significant difference at 5 per cent level of probability. When compared to extension personnel, farmers expressed higher sufficiency of solutions in the plant protection aspects of rice and coconut cultivation. In banana crop alone, extension personnel showed higher sufficiency of solutions when compared to farmers. The reason might be that farmers brought out minor problems of banana such as incidence of mealy bugs, leaf spot, yellowing of leaves as major problems that were not explained clearly in the knowledge base of AES. Whereas, extension personnel pointed out the major problems for which they could retrieve solutions hence they could earn higher sufficiency of solutions from AES.

When crops were compared, extension personnel assessed that problem solving capacity of AES alone, banana crop provided maximum solution (3.8167 mean scores), followed by coconut (2.33 mean scores) and rice (2.3553 mean scores). Farmers' assessment was in such away that problem solving capacity was higher in rice (3.9400 mean scores) followed by coconut (3.8667 mean scores) and banana (3.1667 mean scores) (Fig. 16).

Table 4.44.Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of AES+ Human expert as perceived by them in the plant protection of rice cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	3.8167	0.0074	2.433*
2	Farmers (n=30)	4.1933	0.1361	

*- Significant at 5 % level

Table 4.45.Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of AES+ Human expert as perceived by them in the plant protection of coconut cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	3.1667	0.1523	6.340*
2	Farmers (n=30)	4.4400	0.1310	

*- Significant at 5 % level

Table 4.46.Comparison of Mean scores between extension personnel and farmers regarding the problem solving capacity of AES+ Human expert as perceived by them in the plant protection of banana cultivation

Sl. No.	Category of respondents	Mean scores	Std. error mean	t- value
1	Extension personnel (n=30)	3.7433	0.0082	1.300*
2	Farmers (n=30)	3.9300	0.1179	

*- Significant at 5 % level

4.8.2.4 Comparison of mean scores between extension personnel and farmers regarding the problem solving capacity of AES + Human expert as perceived by them in the plant protection of rice, coconut and banana cultivation

The tables 4.44, 4.45 and 4.46 shows the comparison of mean scores between extension personnel and farmers towards the problem solving capacity of AES + Human expert as perceived by them in the plant protection of rice, coconut and banana cultivation. Thorough examination of the tables indicated that farmers assessed that problem solving capacity of AES + Human experts was higher in all the three crops viz., rice (4.1933 mean scores), coconut (4.4400 mean scores) and banana (3.9300 mean scores). Extension personnel assessed that AES + Human expert was lower in providing solutions in all the three crops viz., rice (3.8167 mean scores), coconut (3.1667 mean scores) and banana (3.7433 mean scores). Extension personnel and farmers showed highly significant difference in their agreement towards the problem solving capacity of AES and human expert at 5 per cent level of probability. Hence the hypothesis that there is no significant difference between extension personnel and farmers towards the problem solving capacity AES + Human expert as perceived by them in the plant protection of rice, coconut and banana cultivation would get rejected.

When crops were compared, extension personnel assessed that problem solving capacity of AES + HES in rice was slightly higher (3.8167 mean scores) followed by banana (3.7433 mean scores) and last by coconut (3.1667 mean scores). Whereas farmers assessed that problem solving capacity of AES + HES in coconut was higher (4.4400 mean scores), followed by rice (4.1933 mean scores) and last in banana (3.9300 mean scores) (Fig. 17).

4.9 Case studies on the applications of AES

4.9.1 Extension personnel

To analyse the applications of 'Diagnos-4' in detail a case study was conducted among agricultural officers. One of the cases is presented here:

Mr. N.V. Baby Raphael is an Agricultural officer in Krishi Bhavan, Mattathur, Thrissur District. He secured post graduation in plant protection from Annamalai University, Chidambaram. He has got 15 years of experience in the field of Agricultural Extension. He has been using computers for the past ten years for documenting, storing and retrieving necessary information.

Recently, he participated in a week training programmes on computer documentation and video production of Integrated Pest Management (IPM) Technologies from Tamil Nadu Agricultural University, Coimbatore, Software development in IPM in vegetable cultivation from Indian Institute of Horticultural Research, Bangalore and Agricultural Extension system from Rural Agricultural Technology Training Centre, Malampuzha. He expressed that he had medium level of proficiency in computer operations. Major crops in Mattathur panchayat are rice, coconut and banana. He expressed that at present, problems in the field were diagnosed by him based on his own knowledge and field experience. If he could not identify the problems, he discussed with his fellow officials or the experts from Kerala Agricultural University. When he was administered to the knowledge test he could score 8 out of 15 and after exposure to AES, could gain 12 out of 15 with a gain of 27 per cent of knowledge from AES.

He had higher level of (3.6 mean scores) perception towards the performance of modern Information and Communication Technologies (ICT). His rationality in decision-making was scored at higher level (4.16 mean scores). His level of information source utilization was 3.7 mean scores. He gained information from his own field experience, discussion with fellow officials and trainings. He utilized technical information related to rice, coconut, banana, vegetables and spices. He utilized and disseminated maximum information related to plant protection measures and least utilized information was technologies related to post harvesting. He expressed medium level of information output behaviour. He always communicated technical information to fellow officials, subordinates, farmers and entrepreneurs. He frequently presented programmes through All India Radio and often wrote to the print media. He rarely communicated with students, presented television programmes and wrote personal letters. He never used 'E- mail' for communicating technical information. He gave feed back through phone calls and through workshops and seminars. He had medium level of information feedback behaviour (3.6 mean scores). With regard to the information backstop in his institution, he was not satisfied with the infrastructural facilities provided for retrieving information. He offered a mean score of only 1.8, indicating least facilities were available to him to refresh himself in the subject area.

After exposure to 'Diagnos-4', he provided a perception index of 46.67. He was satisfied with the settings in the system. He suggested to improve the colour combination of background and the letters given in the system. He suggested modifying the retrievability of the system by presenting an index page next to tutorial page with list of symptoms and clear photographs. Identification of symptoms should happen in the index page. After diagnosis, clicking the identified symptom should lead to link pages with management measures. He agreed that the AES would serve the needs of users like researchers, teachers, students, extension personnel and farmers. He urged to create a permanent mechanism to update the information periodically and expressed satisfaction over the relevancy and practicability of provided information in AES.

With regard to information content, he advised to improve the presentation of information systematically to help for easy decision making. He felt that the information on biocontrol measures was inadequate and hence this area required the attention of scientists involved in developing 'Diagnos-4'. He also felt that it would be better if the system considers users resources and give solutions with reasons. He predicted that it would be better if the system considers users resources and give solutions with reasons. He also predicted that it would be greatly acceptable by users.

About the information treatment in 'Diagnos-4', he was satisfied with the information treatment in the system. He was very impressed about the design, layout and the presentation of scientific terms in an understandable form. He also agreed that language used was simple and messages given in the entire module was bestowed with much clarity.

He was moderately satisfied with the mode of information delivery in the system. He reported that the expert level recommendations given in the system were understandable to users, icons in the home page and over all user friendliness of the system were satisfactory. He advised to update the provided information to the users and to improve the level of interactiveness of the system.

Regarding the future prospects of AES, he was very much confident that it would be an efficient extension aid, it would provide greater support to take suitable decisions, it would be a complementary extension tool for disseminating agricultural technologies and interactive AES would be more effective.

He reported that the Tetranychid mite (*Oligonychus oryzae*) and Fusarium root rot diseases were the most experienced problems in rice crop. Also, Eryophid mite and root wilt in coconut were the most experienced problems in coconut. Similarly Bract mosaic virus, Erwinia rot and cucumber mosaic virus diseases were experienced in banana. He expressed that he could retrieve information for 75 per cent of the problems. He was confident that in future AES would be an extension tool in precision farming, wherein indiscriminate use of chemical input could be reduced. He suggested the following measures to improve the performance of AES:

1. Expert system should be defined in the tutorial page as a tool /aid for the user and suggested not to define it at the level of human expert, since human expertise has its own merits and demerits.
2. Diagnosis of diseases should be given parts wise of a plant along with photographs next to tutorial page as index page.

3. After diagnosis, precautionary measures for each problem should be given first priority, followed by cultural control methods, bio control methods and chemical control measures as the last option.
4. Photographs should be given with a provision for magnification. Scanned photographs must be avoided.
5. He was not satisfied with the diagnostic options provided. He suggested including key diagnostic features of each problem through which the user may identify the correct problem. Bore hole on the pseudostem and mucilagenous exudates were the specific symptom for infestation of pseudostem weevil, which should be highlighted in the AES. In coconut, liming was important measure for controlling basal stem rot, which was not given in the system.
6. It was not necessary to include minor problems like hard scale in banana to avoid confusion among users.
7. Chemical name along with trade names and provision should be given to retrieve the information on the quantity of chemical required for the available area. Concentration and dosage of all the chemicals should be given.
8. Colour of fonts should be contradictory to the background colour.
9. The icons that require double click may be converted to single click for easy retrieval of information.
10. The information provided in AES may be translated into Malayalam.
11. Provision may be given in the system to receive information on the management measures if the user was able to identify the symptom and if the user knows the name of the chemical, provision may be added directly to retrieve the dosage of the chemical and quantity required for the available area.
12. It would be better if touch screen facility along with AES were installed in Krishi bhavans to retrieve the information like the facility installed in Railways.

He concluded that the developed expert system would be highly useful to extension personnel. It should be released at the earliest after updating it with latest information on details of minor pests turned major pests, biological control measures, adding a calculator to estimate inputs require for the available area and improving the user friendliness of the system.

4.9.2 Farmers

A case study conducted among farmers is presented here:

The selected farmer for the case study was Mr. K. Mohanan, Polanikalam, Thathamangalam. He is the secretary of Poongodu Padasekara Paddy Producers Samithy. He is 48 years old. He has completed SSLC. He has been using computers for the past three years. He owns a computer at home, mainly for the purpose of his son who is undergoing graduation in Engineering. He has got medium orientation to operate computers to retrieve information related to farming from Internet. He was not familiar with the AES earlier. After getting exposed to the 'Diagnos-4', he appreciated very much the efforts of the scientists of KAU in developing such a decision support system.

He has got very high perception towards ICT and rationality in decision-making. As information sources, he participated in trainings regularly at Krishi Vigyan Kendra, Pattambi and the seminars organized by the Department of Agriculture. He also regularly reads farm magazines and gained information from radio, television and newspapers. He moderately used information from his own experience, seminars and Internet. He neither attended scientific conferences and nor used e- mail for obtaining information. He reported that he utilized all aspects of farm information as and when needed. Researchers from KAU usually laid out experiments in his field and he reported back the results to scientists. He always provided information to scientists, officials from the department of Agriculture, students, labourers, entreprenures, print media, television and radio. He was not using e- mail, personal letters and organizations to transfer the information. Except e- mail, he utilized all other media to give feedback to the sources. He was satisfied with the trainings and extension programmes organized by panchayat level organizations. But he complained that computer based programmes were rarely organized by local level institutions. He could score only three out of 15 scores before the exposure of 'Diagnos-4'. After the exposure he could obtain a score 9 out of 15 with the knowledge gain of 40.00 per cent.

He was satisfied with the settings in the system, serviceability, relevancy, practicability, information content, information treatment, mode of information delivery and future prospects of AES –'Diagnos-4'. He suggested including more of clear and relevant photos wherever necessary and improving the retrievability of information from the system and information should be presented in such a way so that less literate farmers could understand into easily. Information should be translated into Malayalam.

He predicted that AES would be an efficient extension tool in the near future. Realising the importance of organic inputs, he urged to present the management measures with due emphasis on preventive and bio-control methods. He quoted an adage "Prevention is better than cure", and commented that rarely followed this saying in farm situation. He wanted the tutorial of AES should guide an average farmer to operate his resources in a highly erratic and resource crunch situation. He offered the following suggestions to improve the system:

1. AES should be developed in the local language of Malayalam so that maximum users could benefit.
2. More clear photographs should be included to diagnose the symptoms easily.
3. Programming should be in such a way that users could retrieve the required information at the earliest and easiest way.
4. Important information should be given in bold letters with attractive colours or underlined.
5. Instructions to the users given in the tutorial page should be listed step by step so that the users could follow accordingly.

6. AES should be linked and updated according to weather forecast and given in the web to access by all kinds of users at any time.
7. He advised to include macro and micro nutrient deficiency symptoms with more emphasis on clear photographs and management measures.
8. AES should be released in CD form and create an awareness among farmers about its use. All Krishi Bhavans and farmers' organizations could possess a copy to keep it for the users who are socially and economically weak.
9. The development of AES should not be limited to nine crops but also developed and released covering all other crops.

To conclude, he was very much impressed after experiencing the functioning of AES in retrieving information. He wanted a copy of AES at the earliest for his farmers' organization after modifying suitably, especially converting it into Malayalam Version.

4.10 Empirical model of the study

In the light of the results, the empirical model of the study is presented in Fig: 18. The performance of AES was assessed among the prospective users in terms of perception of prospective users regarding the performance and potential of AES. Factors influencing the perception of prospective users about the performance of AES were identified. Information efficiency and problem solving capacity of the system was assessed by prospective users and represented in the empirical model.

Factors influencing the perception of prospective users about the performance of AES are denoted as x series from x_1 to x_{14}, drawn in different coloured lines from each category of respondents to their perception about AES. Different coloured lines indicate the ranks given to each factor. Even though the factors influencing prospective users about the performance of AES varied according to the category of respondents, two factors such as 'ICT related trainings attended' and 'information backstop' were found as common factors

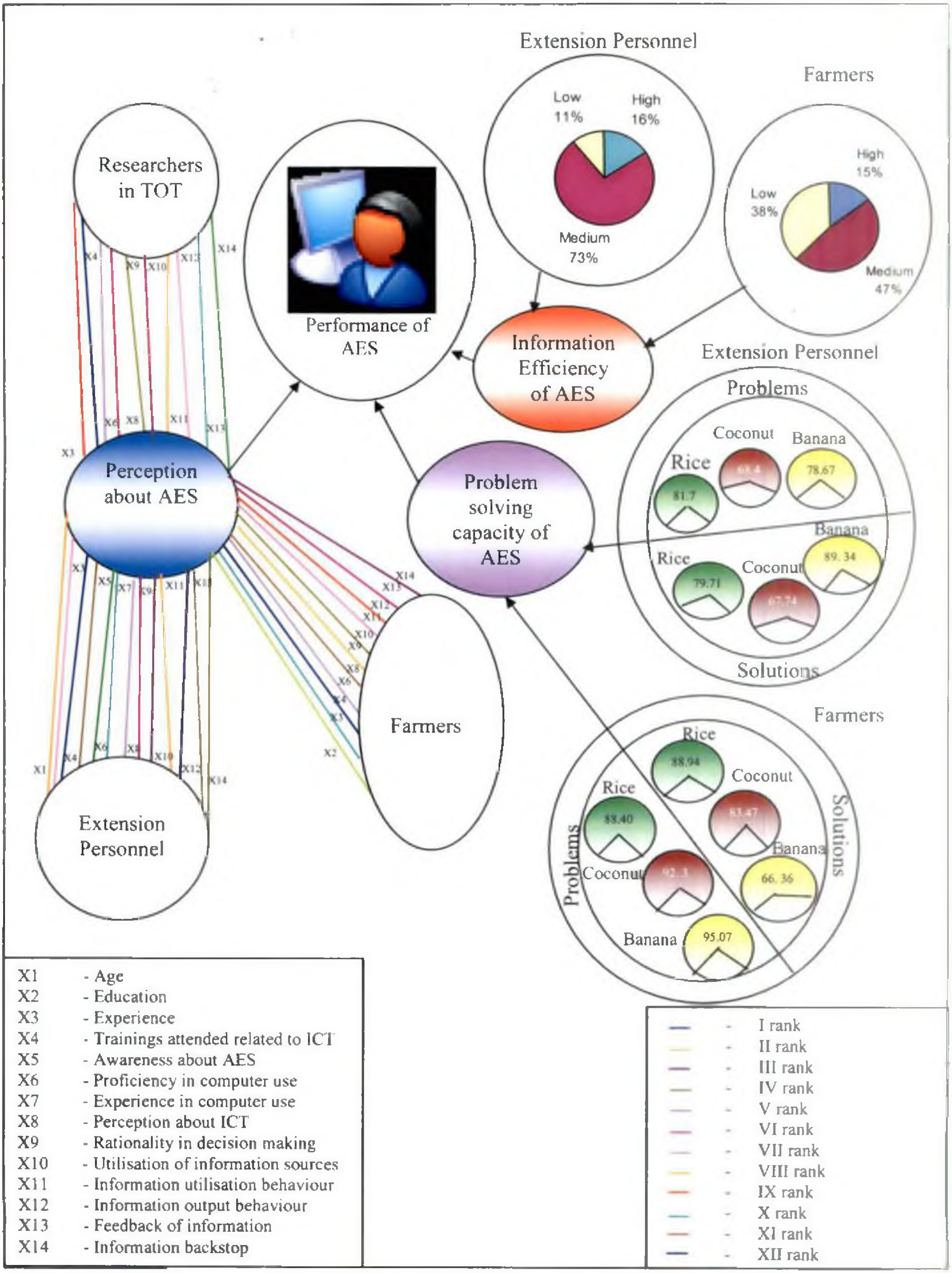

Fig: 18 Empirical model of the study

influencing the prospective users. It was also found that these two factors had shown higher odds in favour against the perception of users about the performance of AES. Hence these two factors need to be given due thrust while releasing AES.

It was found that 16.00 per cent of the extension personnel rated AES with high IEI, 73.00 per cent of them rated medium IEI and the remaining 11.00 per cent rated it with lower IEI. While, 15.00 per cent of the farmer respondents rated AES as high IEI, 46.70 per cent of them assessed AES as medium IEI and 38.30 per cent rated AES as low IEI. English version of the software and low proficiency of respondents might be the reasons for rating low IEI.

In assessing the problem solving capacity of AES in the plant protection problems of rice, coconut and banana are depicted separately with the responses of extension personnel and farmers. Extension personnel stated the plant protection problems with a mean percentage of 81.67, 68.40 and 78.67 in rice, coconut and banana respectively. The sufficiency of solutions was accounted as the mean percentage to the tune of 79.71, 67.74 and 89.34 in rice, coconut and banana respectively. When the mean percentage of the problems reported and the sufficiency of solutions received from AES were compared, the solutions provided for rice and coconut were satisfactory, while the solutions provided for banana crop needed improvement in the knowledge base.

Farmers reported the plant protection problems with a mean percentage of 88.40, 92.31 and 95.07 in rice, coconut and banana respectively. The sufficiency of solutions was accounted to a mean percentage of 88.94 in rice, 83.47 in coconut and 66.36 in banana. When the mean percentage of the problems reported and the sufficiency of solutions received from AES were compared, the solutions provided for rice was satisfactory, while the solutions provided for coconut and banana crops needed modifications in terms of information content and retrievability of information. Summary and conclusion of the study is presented in the succeeding chapter.

Summary and Conclusion

CHAPTER V

SUMMARY AND CONCLUSION

Farming community is facing a multitude of problems to maximize crop productivity as well as to increase farm income. In spite of successful research on new agricultural practices concerning crop cultivation, majority of the farmers are not getting upper-bound yield and not earning profit due to several constraints. One of them is that expert advice regarding crop cultivation is not reaching the farming community in a timely manner. It is true that India possesses valuable agricultural knowledge and expertise. However, a wide information gap exists between research and practice. Farmers need timely expert advice to make farming more productive and competitive.

The world is witnessing a revolution in communication technology leading to the swift and accurate transfer of message from source to the receiver. The advances in the field of Information Technology has evolved a number of new modes of communication, and the evolution is so rapid that it is becoming difficult to keep pace with acquiring and utilizing the new tool. The educational technology, starting with chalk and blackboard, now has the most advanced Expert System with multimedia involving a number of combinations of media available in communication. Local information resource centers are gaining importance with computers carrying expert systems to help farmers to make decisions. It is known that many Agricultural Research Institutes are involved in the development of AES to satisfy the information needs of farmers. The research studies at the users' level in assessing the performance of the system are limited.

Kerala is one of the leading states in the country in the field of implementing ICT projects. Kerala Agricultural University developed an AES to identify the pests and diseases of nine major crops of Kerala named 'Diagnos-4', is likely to be released shortly for the benefit of all the stakeholders involved in agricultural development. Before releasing 'Diagnos-4', it is appropriate to assess the performance of it among its prospective users. With this in view, the present study framed following specific objectives:

1. To make an appraisal of the AES available in India.
2. To probe the cognitive and connotative domains of potential users in using AES.
3. To identify the factors influencing the potential users in using AES.
4. To analyze the information efficiency and problem solving capacity of AES.
5. To conduct a case study on the applications of AES.

Keeping in view of the objectives of the study, research was conducted among the prospective users in two phases viz., exploratory design among researchers and experimental design among extension personnel and farmers. Since technology users need much information on plant protection measures and 'Diagnos- 4', the first developed AES in KAU was selected purposively for assessing its performance among the prospective users.

As stakeholders of AES, the first phase of the research was conducted among the researchers from the Research Institutes, who are involved in developing AES development and TOT, all over India. Second phase of the research was conducted among the extension personnel and farmers in the Palakkad district of Kerala. The responses of Twenty-five researchers in AES development and 40 researchers in TOT were collected through standardized questionnaire. Between-group randomized design was considered in the second phase of the study among extension personnel and farmers. Selected extension personnel and farmers were categorized into four treatment groups. A group of thirty respondents formed each treatment group. The four treatment groups are as follows:

T_1 - Status of respondents before the advice of expert system/human expert

T_2 - Status of respondents after the advice of human expert alone

T_3 - Status of respondents after the advice of expert system alone

T_4 - Status of respondents after the advice of expert system + advice of human expert

Age, education, experience, ICT related trainings attended, awareness about AES, proficiency in computer use, experience in computer use, perception about ICT, rationality in decision making, behaviour of information sources utilization behaviour, information utilization, information output, feedback of information behaviour and information backstop were the explanatory variables used in the study. Except, proficiency in computer use, experience in computer use and information utilization behaviour, all other variables were operationalised according to the study and measured based on the procedure followed by the authors of other studies. The variables such as proficiency in computer use, experience in computer use and information utilization behaviour were measured with the schedule developed exclusively for the study. Dependent variables for the study were: expectations of researchers on the potential of AES, perception of stakeholders about the performance and potential of AES, information efficiency of AES and problem solving capacity of AES.

Expectations and perception of respondents were measured using a standardized questionnaire. Information efficiency scale was developed to measure the information efficiency of AES. The dimensions such as retrievability, relevancy, practicability, information content and knowledge gained by users were selected based on stages of application to measure the information efficiency of AES. Problem solving capacity of AES was assessed among the various treatment groups of extension personnel and farmers through group discussion on a five-point continuum.

Mean scores were calculated for assessing the expectations of researchers in AES development and the potential of AES. Kendall's coefficient of concordance was applied to assess the perception of respondents about the performance of AES. Index was worked out to assess the Information Efficiency of AES. Percentage analysis was used to analyse the profile of the respondents and the problem solving capacity of AES. Binary Logistic Regression was followed to identify the factors influencing the prospective users of AES. Agreement among the perception of respondents about the performance was analysed using t-test of significance.

The salient findings of this study are as follows:

1. MANAGE, Hyderabad was the pioneering institution in the development of AES in India. 'Rice crop doctor' was the AES released by MANAGE, Hyderabad during 1994. Majority of the agricultural research institutions have started working on developing AES to transfer the technologies developed by the institutes. In this study, twenty AES were identified, developed by different agricultural institutions, plant protection in rice, cultivation aspects of South Indian Horticultural crops, SLM, AES on grapes and mushroom, e-sagu, RUBEXS-04, E-agrotech, SUGAREX, Banana Technology Manager, SOYEX, KISAN, etc. were the AES developed by various institutes. Primitive programs such as MS-DOS was used in earlier softwares. On further development SHELL, VISUAL BASICS, FLASH, were the programs used in AES with the improvement in interactiveness of the system applications. Majority of the systems were restricted only to limited groups of users and they were yet to be popularized among the ultimate users. It is sure that once they are popularized among users, it will be a major contributor in disseminating agricultural technologies from the research system to the technology users.

2. Majority of the researchers and extension personnel belonged to middle age whereas farmer respondents belonged to the senior category.

3. Majority of the researchers were holding doctoral degrees whereas most of the extension personnel were graduates and farmers completed Secondary School level.

4. Majority of all the categories of the respondents, experience were between 11-20 years except the extension personnel, nearly half of whose experience was below 10 years. Reasonable per cent of the farmer respondents had the experience of more than 21 years in farming.

5. Nearly half the percentage of the researchers in TOT had medium level of awareness about AES. Majority of the extension personnel and farmers had low level of awareness about AES.

6. Majority of the researchers group had undergone medium level of trainings related to ICT, while majority of the extension personnel and farmers had low level of trainings related to ICT.

7. Three-fourth of the respondents from researchers' category had medium level proficiency in computer operations and so were fifty per cent of the extension personnel. Three-fourth of farmer respondents stayed in the low proficiency category in computer operations.

8. More than half (52.00 per cent) of the researchers in developing AES had an experience of 11 to 15 years and the researchers in TOT had 5 to10 years of experience in computer operations. More than half of the farmer respondents (56.67 per cent) informed that they did not have any experience in using computers.

9. Most of the researchers in AES development (92.00 per cent), exactly three-fourth of the researchers in TOT, more than fifty per cent of the extension personnel (64.44 per cent) and farmers expressed (52.22 per cent) that they had medium level of perception about ICT. Above one-third of farmer

respondents (41.11 per cent) reported that they had high level of perception regarding ICT.

10. Three- fourth of the researchers in AES development (72.00 per cent), a little less than three-fourth of the researchers in TOT (62.50 per cent), a little more than half the number of extension personnel (55.56 per cent) and nearly three-fourth of the farmers (73.33 per cent) had medium level of rationality in decision-making. Twenty per cent of both categories of researchers had high level of rationality in decision-making.

11. Majority of the researchers involved in developing AES (64.00 per cent), more than half the number of the researchers in TOT (52.50 per cent), majority of the extension personnel (64.44 per cent) and farmers (52.56 per cent) had medium level of information source utilization behaviour.

12. Sixty per cent of the researchers involved in developing AES, fifty per cent of researchers in TOT, more than three-fourth of extension personnel (76.67 per cent) and farmers (10.00 per cent) had the habit of medium level of information utilization. Whereas, most of the farmer respondents (90.00 per cent) belonged to the high category of information utilization.

13. Nearly 50.00 per cent of the researchers in AES development, three-fourth of the researchers in TOT (75.00 per cent), more than three-fourth of the extension personnel (80.00 per cent) and nearly three-fourth of the farmers (73.33 per cent) belonged to the medium category of information output behaviour.

14. Majority of the researchers in AES development (64.00 per cent), researchers in TOT (70.00 per cent), extension personnel and farmers (73.33 per cent each) were in the category of medium level of behaviour of information feed back.

15. Majority of the respondents such as researchers in AES development (60.00 per cent), researchers in TOT (67.500 per cent), extension personnel (68.89 per cent) and farmers (62.22 per cent) reported that they had medium level of information backstop in their respective organizations.

16. Extension personnel and farmers possessed low level of knowledge especially in the areas of plant protection aspects of crops and they were in need of information on the same. Majority of the respondents agreed that they experienced confusion in identifying symptoms, in recommending or using a particular input, calculation of dosages of inputs and use of combination of inputs. Hence there is a lot of scope for the application of AES among extension personnel and farmers on plant protection aspects of crops that help the users to clarify their doubts, confirm their knowledge and provide real time information to the technology users.

17. The researchers in TOT ranked first (9.45 mean scores) to the attribute 'settings in the AES'. The last ranked dimensions such as 'relevancy of information', 'information content', 'information treatment' and 'mode of presentation' need modifications by involving the prospective users during the development process of AES.

18. Extension personnel and farmers ranked first the future prospects of AES among all the nine dimensions with a mean score of 8.95 and 9.00 respectively. The areas that need modifications were: retrievability, relevancy and content of information. At the same time, content and relevancy of information provided in the 'Diagnos-4' should be improved by providing more information on preventive measures, biological control measures and cultural practices considering chemical control methods as the last option.

19. The expectations of researchers involved in AES development were significantly different from the perception of researchers in TOT towards the performance of AES. The higher perception of researchers in TOT indicated that they perceived that the performance of AES would make a sea change in

the dissemination of technologies in the Transfer of Technology in terms of providing need based information in a precise form to the users.

20. Highly significant agreement among the perception of researchers in TOT, extension personnel and farmers about the performance of AES was observed. The prospects and performance of AES was perceived more at the lower category of stakeholders in the dissemination of agricultural information.

21. Researchers perceived that AES had the potential of providing information support to users by offering expertise wherever required when human expertise was scarce. They had also foreseen that AES had the potential of capturing the expertise of retiring scientists and preserving the knowledge for future use by the prospective users. The respondents especially farmers and extension personnel felt that by receiving required information at the right time would enhance the yield of crops and thereby increase farm income. It could be concluded that stakeholders perceived that AES had better potentials in solving field problems and transfer of technology in terms of disseminating information to the users.

22. The factors influencing the users regarding the performance of AES had varied with the category of respondents. Therefore each category of prospective users may be targeted separately for introducing AES among them. The factors such as 'trainings attended related to ICT' and 'information backstop' was found as the common factors with high odds in favour of influencing the perception of all the categories of users regarding the performance of AES. Hence these two factors may be given foremost importance in improving the use of AES among the prospective users.

23. The IEI of AES was 70.60 as assessed by extension personnel. The extension personnel who were exposed to AES alone rated AES with an IEI of 66.64 and who were exposed to AES + human experts assessed AES with an IEI of 74.56. The combination of AES and human expertise showed the higher degree of information efficiency between the treatment groups.

24. Among the dimensions of IEI, practicability of information was assessed as the maximum mean score percentage of 86.00 and 84.00 by T_4 and T_3 group of extension personnel respectively. It indicated that the management measures given in AES were highly adoptable and feasible in the field situation. Relevancy of the information was assessed as almost same with the mean score percentage of 79.33 and 80.00 by both (T_3& T_4) groups respectively. Information content was rated with the mean score percentage of 63.74 and 78.21 by T_3 and T_4 group of extension personnel respectively. Retrievability was assessed with the lowest mean score percentage of 61.76 and 68.16 respectively by T_3 and T_4 group of extension personnel.

25. It could be inferred that 16.00 per cent of the extension personnel rated AES with high IEI, 73.00 per cent of them rated medium IEI and the remaining 11.00 per cent rated it with lower IEI.

26. The IEI of AES was 60.02 as assessed by farmer respondents. The farmer group who were exposed to AES alone assessed AES with an IEI of 58.54 and who were exposed to AES + human experts assessed AES with an IEI of 61.50.

27. Among the dimensions of IEI, relevancy and practicability of the information provided in AES were assessed and the maximum mean score percentage of 72.67 by T_4 group of farmers and 70.00 by T_3 group of farmers. Both treatment groups of farmers were in agreement about the information content provided in AES irrespective of their exposure given to them. Farmers suggested to include more crops such as mango and some more vegetable crops. They urged to include more of biological control measures and also to contain all micro nutrient deficiency symptoms and recommended control measures. Farmers as indicated by extension personnel rated retrievability of the information as last.

28. The respondents gained substantial information when they were exposed to AES and human expertise. Since AES is in the initial stages of introduction to

the users, it was found more effective only when guidance was offered to the users in using AES. Therefore, prospective users need an orientation before introducing AES.

29. It could be observed that 15.00 per cent of the farmer respondents rated AES as high IEI, 46.70 per cent of them assessed AES as medium IEI and 38.30 per cent rated AES as less IEI.

30. Extension personnel assessed with 76.87 mean scores and farmers furnished an information efficiency of 59.71 mean scores, showing a highly significant difference in agreement in the efficiency of AES after the exposure of AES alone.

31. Extension personnel offered 77.00 mean scores and farmers endowed an information efficiency of 63.05 mean scores staging a highly significant information efficiency of AES after the exposure of AES and human expert. Information efficiency of AES as assessed by extension personnel was almost on par when a group of them were exposed to AES alone and another group was exposed with AES and human experts. Whereas, farmers showed a slight increase in information efficiency of AES when a group was exposed to AES and human experts. The influence of the presence of human expert was more pronounced among farmers when compared to extension personnel.

32. In paddy cultivation, stem borer (92.80per cent) attack was the most experienced problem followed by gall midge and leaf folder (90.00per cent each), bacterial leaf blight (77.14per cent), brown plant hopper (73.40per cent) and earhead bug (66.67per cent). Human expert was able to offer solution to the control of stem borer at a tune of 74.14 per cent. AES could provide solution only to 65.30 per cent. The group that was exposed to both AES and human expert recorded a gain of 91.6 per cent solutions.

33. In coconut cultivation, eryophid mite, (90.00per cent) was the most experienced problem followed by bud rot (80.00per cent), stem bleeding

(72.00per cent), termites (60.00per cent) and root wilt (40.00per cent). For almost all the problems, AES could offer better solutions on par with human expertise, except the termite problem for which users could not find satisfactory solutions.

34. In banana cultivation, bunchy top was (93.33per cent) the common and most intensively experienced problem followed by leaf spot (90.00per cent), pseudostem weevil (80.00per cent), bacterial wilt (70.00per cent), and bract mosaic virus (60.00per cent). Except leaf spot (76.00per cent), all other problems could be served better solutions than human expertise.

35. Farmer respondents listed ten plant protection problems in rice cultivation. They reported that the bacterial leaf blight (100.00 per cent) was the acute problem existed in their fields, followed by nematode (96.60per cent), stem borer (96.20per cent), sheath rot (94.40per cent), ear head bug (93.00per cent) leaf folder (92.00per cent) etc. Out of ten problems reported, eight problems were served with better solutions by AES.

36. In coconut cultivation, farmer respondents marked cent per cent severity of eryophid mite incidence in their field. It was recorded as low as 94.40 per cent in the case of stem bleeding, 93.60 per cent bud rot, 92.40 per cent termites, 91.20 per cent red palm weevil, 90.40 per cent root wilt, and 84.20 per cent of attack by rhinocerous beetle. Except for termite attack, AES could provide better solutions to the farmers.

37. In the case of banana cultivation, farmers expressed cent per cent severity of bunchy top incidence followed by equal severity of problems of pseudostem weevil and leaf rot (96.40per cent each), yellowing of leaves (95.20per cent), mealy bugs (94.40per cent) and bacterial wilt (90.00per cent). Farmers were satisfied more in getting solutions from AES for pseudostem weevil (96.06per cent) whereas they reported that they did not get practicable solutions for leaf spot (51.48per cent) and mealy bugs (29.87per cent). Therefore farmers assessed that AES could provide lesser percentage (66.36per cent) of solutions

for the field problems faced in banana cultivation when compared to human expertise.

38. The combination of AES and human expertise showed better performance of offering solutions to the users among all the treatment groups of farmers as well as extension personnel.

39. There was no significant variation in the agreement between extension personnel and farmers towards the problems faced by them in the plant protection aspects of rice cultivation. While there was significant difference in the problems reported by extension personnel and farmers in the plant protection aspects of coconut and banana cultivation.

40. The problem solving capacity of human expert in the plant protection aspects of rice, coconut and banana, extension personnel and farmers showed significant difference in rice and coconut. No significant difference had been observed among extension personnel and farmers in the plant protection aspects of banana cultivation. Higher sufficiency of solution was reported by farmers when compared to extension personnel in the plant protection aspects of rice, coconut and banana cultivation.

41. In expressing the sufficiency of solutions provided by AES, extension personnel and farmers showed highly significant difference at 5 per cent level of probability. When compared to extension personnel, farmers expressed higher sufficiency of solutions in the plant protection aspects of rice and coconut cultivation. In banana crop alone, extension personnel showed higher sufficiency of solutions when compared to farmers.

42. Extension personnel and farmers showed highly significant difference in their agreement towards the problem solving capacity of AES and human expert.

To conclude, twenty AES were identified during this study, developed by various agricultural research institutions. Majority of the systems were restricted only to limited groups of users and they were yet to be popularized among the ultimate users. It is sure that once they are popularized among users, it will be a major contributor in disseminating agricultural technologies from the research system to the technology users. Extension personnel and farmers possessed low level of knowledge especially in the areas of plant protection aspects of crops and they were in need of information on the same. They were very confident of the future prospects towards the better performance of AES, settings in the AES, mode of presentation, practicability of information and serviceability of the system. The areas that need modifications were: retrievability of information, relevancy of information and information content. Information content and relevancy of information provided in the 'Diagnos-4' should be improved by providing more information on preventive measures, biological control measures and cultural practices considering last option as chemical control methods. Release of Malayalam Version needs immediate attention of the researchers. The respondents perceived that AES has got better potential in the transfer of technology in terms of disseminating information to the users. The combination of AES and human expertise provided better information efficiency and the problem solving capacity of AES among the respondents. It was therefore felt that AES could not substitute human expertise in agricultural extension activities. Rather, it can be used to strengthen the existing extension activities as a supplementary extension tool in combination with human expertise.

Implications of the study

1. Results of the study emphasize the need for conducting still more comprehensive explorations among the different categories of users separately regarding the performance of AES in providing knowledge, solving problems and supporting for decision making.

2. The study has pointed out that the application of AES has got tremendous scope among extension personnel and farmers to clarify their doubts,

confirm their knowledge and provide real time information to the technology users. It could be used as a distance-learning tool.

3. The study suggests that prospective users perceived that the retrievability and content of information given in AES need modifications with the conversion of language into local language would improve the user friendliness of AES. Researchers in AES development would consider the suggestions of the users to improve the user friendliness of the AES in future.

4. The factors such as trainings attended related to ICT and information backstop were found as the common factors with high odds ratio influencing all the categories of users. Hence, special emphasis is to be laid out on these factors before introducing AES among users.

5. The Information Efficiency Scale developed in this study can be used to assess the information efficiency of AES as the items of the scale were so chosen to suit various dimensions.

6. Before releasing AES among users, it is necessary to orient the prospective users about the operations of AES in diagnosing and retrieving information to maximize the strengths and tap its opportunities effectively.

Suggestions for future research

1. As the present AES covers only nine crops, Expert System shall be developed on other crops and subjects using advanced software packages and its performance shall be assessed among the users before and after release.

2. The merits and demerits of AES in the TOT process may be evaluated ex ante and ex post.

3. Possibilities of developing separate AES for extension personnel and farmers may be explored.

4. Research activities can be initiated to develop more location and language specific versions of soft ware on different crops to cater the needs of various categories of users.

5. As this study was conducted in only one district of Kerala, similar studies should be carried out in other parts of the state.

6. Thorough orientation regarding the use of AES is required before releasing it among the prospective users.

7. Maximum potential can be explored by making the users as partners in the development process so that user friendliness of AES can be ensured.

8. Since expert systems are viewed as tools for decision making, all the AES can be used to assess the nature of support provided by these modules in making decision among the various categories of prospective users.

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Appendices

APPENDIX-I

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KERALA AGRICULTURAL UNIVERSITY
College of Horticulture
Department of Agri. Extension
Vellanikkara – 680 656, Thrissur, Kerala, India

Dr. F. M. H. Khaleel No: PhDQ/S.H/2005 Date: 06.10.05
Major Advisor

Dear Sir/Madam,

Greetings!

This is in connection with the research study entitled "**Agricultural Expert System – A participatory assessment**" undertaken by Mrs. S. Helen (2003-21-09) doing her doctoral programme in this department under my guidance. The main objective of her study is to explore the possibilities of functioning of Agricultural Expert System (AES) under the existing extension system. The study also aims to analyse the perception of the potential users on the information efficiency and problem solving capacity of the AES. In this context, she has identified certain variables/items in relation to her study.

Considering your rich experience and expertise, you have been identified as a judge for rating the relevancy of the list of variables furnished in the enclosed appendices you may please indicate your opinion about the inclusion of each variable in the study by marking (√) against each variable under the appropriate column. You are requested to add other variables, which you may think are related and also rate them under appropriate column.

Also she intends to assess the perception of prospective users towards the performance of AES for which she has identified sixteen dimensions, please indicate your opinion about the inclusion of each dimension in the study by marking (√) against each dimension under the appropriate column.

Amidst your busy schedule, I hope that you may kindly spare sometime for us. Your kind and early action in the matter would greatly help us to complete the study in time. Kindly return the duly filled annexure to the self addressed stamped envelope enclosed herewith. Your expertise will be greatly acknowledged.

Thanking you. With kind regards,

Yours sincerely,

(F. M. H. Kaleel)

Encl: List of items.

KERALA AGRICULTURAL UNIVERSITY
FACULTY OF AGRICULTURE
COLLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

I. Title of the study: AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

Fundamental objective: To explore the possibilities of functioning of Agricultural Expert System (AES) under the existing extension system.

Working objectives:

1. To make an appraisal of the AES available in India.
2. To probe the cognitive and connotative domains of users.
3. To identify the factors influencing the potential clients in using AES.
4. To conduct a case study on the applications of AES.
5. To analyse the information efficiency and problem solving capacity of AES

I. Please mention the relevancy of the variables in terms of MOR- Most Relevant, MR- More Relevant, R- Relevant, LR- Least Relevant and NR- Not Relevant against the appropriate column:

S. no	Selected probable variables in the study	Operational definitions for the study	Category of the respondents		
			Researchers	Extension personnel	Farmers
1.	Age	Chronological age of the respondents			
2.	Educational status	Level of formal education attained by the respondent			
3.	Experience	Number of completed years of service by the respondent in the field of agriculture			
4.	Awareness about AES	The level of awareness of respondents about the functions of AES			
5.	Communication skill	Ability of the respondent in communication			
6.	Information seeking behaviour	The degree of frequency of contact by the respondent with various information sources to information regarding agriculture activities			
7.	Social participation	The degree of involvement of the respondents in formal as well as informal organizations either as a member or office bearer			
8.	Technical competence	The extent to which the respondent feels that he or she is competent in the various aspects of scientific agriculture			
9.	Trainings received related to ICT	The number of training undergone by the respondent so far in the ICT and related fields			
10.	Orientation in computer	The number of training undergone by the respondent so far in the area of computer and related fields			
11	Information utilization behaviour	Frequency of authentic use of technical subject matter related to the cultivation of rice, coconut and banana in the form of storage, retrieval and educate the technologies in the case of researchers and extension personnel and deployment of technologies in their own field in the case of farmers.			

12.	Rationality in decision making	The extent to which the respondent justifies his/her selection of most effective means from among the available alternatives on the basis of scientific criteria for achieving maximum ends.			
13.	Information backstop	Availability of facilities and opportunities to the respondent for updating information			
14.	Layout of the system	The opinion of the respondent about the layout of the information given			
15.	Scientific orientation	The degree to which the respondent is oriented to the use of scientific methods in decision making in farming			
16	Risk orientation	The degree to which the respondent is oriented towards risk and uncertainty and exhibits courage to face problems of risk.			
17.	Achievement motivation	The value associated with an individual which drives him/her to excel in the job in order to attain a sense of accomplishment.			
18.	Content management	The extent to which the messages are presented in the system for the benefit of users.			
19.	Innovativeness	The degree to which the respondent is relatively earlier in adopting new ideas.			
20.	Available facilities and resources	Facilities and resources available at the disposal of the respondent for performing his/her job			
21.	Professional commitment	The extent to which the respondent is willing to exert high level of effort through his/her profession of job to achieve the objectives			
22.	Level of aspiration	The future level of achievement desired by the respondent			
23.	Perception about ICT	Experience or understanding about the performance of information and communication technologies in extension activities			
24.	Information sources utilization	The extent of use of different information sources by the respondent to get the latest technologies on agriculture and related activities			
25.	Socially responsible behaviour	Those behaviour and decision of the respondent which are motivated not only by a desire to satisfy personal needs but also by a concern for the welfare of the society.			

26.	Management orientation	The various steps under taken in advance by the respondent in planning, co-ordinating and executing various programmes.			
27.	Information output behaviour	Frequency of the respondents to transfer technical information to the personnel at receiving end.			
28.	Information feedback behaviour	Frequency of providing opinion, feeling, doubts, ideas and thoughts as a result of information received from the source in relation to rice, coconut and banana cultivation.			
29.	Familiarity in using computer	The extent to which the respondents were familiar in operating and accessing the information through computer and other devices of information communication technologies like internet, website, portals etc.			
30.	Creativity	The degree to which the respondents are creative in finding solutions to the problems faced by them in their work situation.			

II. Please mention the relevancy of the identified dimensions for measuring the perception towards the performance of AES in terms of MOR- Most Relevant, MR- More Relevant, R-Relevant, LR- Least Relevant and NR- Not Relevant, against the appropriate column:

S. no	Identified items	Category of the respondents		
		Researchers	Extension personnel	Farmers
I	Proficiency of users			
II	Information needs of users			
III	Information content			
IV	Information treatment			
V	Precision of information			
VI	Mode of presentation			
VII	Serviceability			
VIII	Relevancy			
IX	Practicability			
X	Retrievability			
XI	Knowledge gain			
XII	Risk in utilizing information from AES			
XIII	Dependence on AES alone			
IVX	Provision for updating information			
XV	Settings in the system			
XVI	Future prospects			

Thank you very much

APPENDIX-II

Relevancy Indices of independent variables

SL. No.	Selected variables in the study	Relevancy Indices		
		Researchers	Extension personnel	Farmers
1.	**Age**	76.3	78.6	81.7
2.	**Educational status**	85.0	81.0	87.0
3.	**Experience**	87.3	78.6	76.2
4.	**Awareness about AES**	72.7	71.2	70.0
5.	Communication skill	71.7	70.2	51.3
6.	Information seeking behaviour	65.0	61.1	57.4
7.	Social participation	51.7	59.1	67.5
8.	Technical competence	58.0	75.3	43.4
9.	**Trainings undergone related to ICT**	76.0	84.2	77.7
10.	**Proficiency in computer**	79.7	75.7	73.7
11.	**Information utilization behaviour**	86.2	81.4	76.2
12.	**Rationality in decision making**	77.7	73.7	75.7
13.	**Information backstop**	81.3	87.1	88.6
14.	Layout of the system	80.7	67.0	71.6
15.	Scientific orientation	71.3	63.3	58.5
16	Risk orientation	58.6	59.5	50.8
17.	Achievement motivation	65.3	53.7	62.9
18.	Content management	55.3	59.4	59.2
19.	Innovativeness	91.0	58.0	58.0
20.	Available facilities and resources	66.0	62.5	63.0
21.	Professional commitment	67.0	67.8	65.3
22.	Level of aspiration	69.7	64.4	61.8
23.	**Perception about ICT**	78.0	78.0	76.7
24.	**Information sources utilization**	77.4	91.4	74.3
25.	Socially responsible behaviour	64.1	61.6	58.8
26.	Management orientation	68.0	64.0	58.8
27.	**Information output behaviour**	71.3	87.5	72.7
28.	**Information feedback behaviour**	70.8	81.32	77.1
29.	**Experience in computer use**	86.2	78.2	74.5
30.	Creativity	63.6	60.2	59.3

Bolded items were selected for the study.

APPENDIX-III

Relevancy Indices of identified dimensions for measuring the perception towards the performance of AES

Sl. No.	Identified items	Relevancy Indices			Mean	Rank
		Researchers	Extension personnel	Farmers		
I	Proficiency of users	59.47	60.97	62.74	61.06	XVI
II	Information needs of users	62.54	63.66	65.33	63.84	XV
*III	Information content	77.14	73.14	71.89	74.06	X
*IV	Information treatment	76.32	75.55	77.15	76.34	IX
V	Precision of information	65.86	66	64.81	65.56	IVX
*VI	Mode of presentation	78.05	84.51	77.26	79.94	VII
*VII	Serviceability	80.99	79.03	69.87	76.63	VIII
*VIII	Relevancy	81.24	83.01	82.17	82.14	VI
*IX	Practicability	80.36	79.5	87.64	82.50	V
*X	Retrievability	94.45	90.32	88.62	91.13	II
*XI	Knowledge gain from AES	93.00	95.6	92.71	93.77	I
XII	Risk in utilizing information from AES	68.17	68.32	68.69	68.39	XII
XIII	Dependence on AES alone	68.54	67.49	67.45	67.83	XIII
*IVX	Provision for updating information	73.32	68.33	68.58	70.08	XI
*XV	Settings in the system	83.88	83.52	84.85	84.08	III
*XVI	Future prospects	83.65	83.34	83.31	83.43	IV

*- Selected dimensions for further study

APPENDIX-IV

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KERALA AGRICULTURAL UNIVERSITY
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Department of Agri. Extension
Vellanikkara – 680 656, Thrissur, Kerala, India

Dr. F. M. H. Kaleel No: PhDQ/S.H/2005 Date: 04.12.05
Major Advisor

Dear Sir/Madam,

Greetings!

This is in connection with the research study entitled "**Agricultural Expert System – A participatory assessment**" undertaken by Mrs. S. Helen (2003-21-09) doing her doctoral programme in this department under my guidance. The main objective of her study is to explore the possibilities of functioning of Agricultural Expert System (AES) under the existing extension system. The study also aims to analyse the perception of the potential users on the information efficiency and problem solving capacity of the AES. In this context, she has identified certain variables/items in relation to her study.

Considering your rich experience and expertise, you have been identified as a judge for rating the relevancy of identified various items under the dimensions for assessing the expectations and perception of respondents towards the performance of AES. You are requested to add other items, which you may think are related and also rate them under appropriate column.

Amidst your busy schedule, I hope that you may kindly spare sometime for us. Your kind and early action in the matter would greatly help us to complete the study in time. Kindly return the duly filled annexure to the self addressed stamped envelope enclosed herewith. Your expertise will be greatly acknowledged.

Thanking you. With kind regards,

Yours sincerely,

(F. M. H. Kaleel)

Encl: List of items.

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FACULTY OF AGRICULTURE
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3. To identify the factors influencing the potential clients in using AES.
4. To conduct a case study on the applications of AES.
5. To analyse the information efficiency and problem solving capacity of AES.

I. Please mention the relevancy of the variables in terms of MOR- Most Relevant, MR- More Relevant, R- Relevant, LR- Least Relevant and NR- Not Relevant against the appropriate column:

Expectations from AES by the researchers

Possible items in the study	Category of the respondents		
	Researchers	Extension personnel	Farmers
AES strengthens TOT			
1) To transfer knowledge from scientists to extension workers and farmers as and when necessary			
2) To mimic the expertise of human experts			
3) To simulate the problem-solving behavior of a human who is an expert in a specific discipline			
4) To deliver need based quantitative and qualitative information			
5) To enhance user confidence because of its reasoning ability			
6) To help the less experienced extension personnel or researchers by providing recommendations			
7) Considers basic needs and resources of the farmers			
8) To support the farm advisory services extended by extension personnel			
9) To provide decision Support at the right time			
10) Diagnostics and problem-solving at the right time			
11) To analyse data			
12) To detect inconsistency of information			
13) To choose appropriate technology			
14) To provide need based information			
15) To act as a tool in building up knowledge society			
16) Offers solution for effective extension of information.			
17) Enhances teaching/learning process.			
18) Provides requisite expertise on site when human expertise is scarce			
19) Assimilates the knowledge and experience of several human experts			
20) It builds the capacity of new human experts			
21) Enables to cope up with the rapidly expanding information base and limited resources			
22) Easy retrieval of relevant information			

23) To fill the knowledge gap between the expert and the user			
24) To Capture and preserve the expertise of retiring scientists			
25) To reduce the time gap of transferring technologies from scientists to farmers			
26) Reduces the distortion of message in transfer of technologies from researchers to users			
27) Provides adequate data base on specific technologies			
28) Provides reasoning for the recommended technologies			
29) To make available the demand driven information			
30) To clarify and confirm doubtful information			
31) Any others			
Dimensions of socio-economic development expected			
1) Increases food production and farm income by providing suitable information at the right time			
2) Helps the farmer to remain competitive by providing need based information			
3) Solves the problem of message distortion which normally happens in transfer of technology			
4) Provision of need based information to extension personnel reduces dependence on subject matter specialists/ human experts			
5) Provision of need based information to extension personnel reduces waiting period of getting information from subject matter specialists/ human experts			
6) Provision of need based information makes farmers more self reliant			
7) Provision of need based information builds confidence among users			
8) Promote sharing of knowledge			
9) Empowering the users with adequate knowledge			
10) Provides better opportunity for better price by providing appropriate information at right time			
11) Increases the professional efficiency of the users			
12) Provides opportunity for self learning			
13) Any others			
Extent of problems expected to be solved			
1) Solves the problem of message distortion which normally happens in transfer of technology			
2) Reduces waiting period of getting information from subject matter specialists/ human experts			
3) The expertise of retiring scientists can be captured and reused by younger generation			
4) Any others			

II. Please mention the relevancy of the variables in terms of MOR- Most Relevant, MR- More Relevant, R- Relevant, LR- Least Relevant and NR- Not Relevant against the appropriate column:

Perception of respondents towards the performance of AES:

S. no	Identified items	Category of the respondents		
		Researchers	Extension personnel	Farmers
I	**Information content**			
1	Relevancy of the subject matter			
2	Clarity in tutorial page			
3	Design of the message			
4	Systematically classified information			
5	Supports easy learning			
6	Complete information for decision making			
7	Clarity in the messages given in the entire module			
8	Getting systematic links			
9	Easy availability of information			
10	Practical feasibility of information			
11	Message considers users resources			
12	Ability to comprehend			
13	Customized information			
14	User friendliness			
15	Suitability of the content			
16	Acceptable by the users			
17	Provides explicit information			
18	Provides reasons for the given solution			
19	Easier information search			
20	Sufficient and accurate information			
21	Content coverage			
	Any other			
II	**Information treatment**			
1	Supports easy learning			
2	Language used is simple			
3	Attractive design and layout			
4	Logical sequence			
5	Practicability of information			
6	Use of scientific/technical terms			
7	Time required to retrieve relevant information			
8	Clarity of the messages given in the entire module			
	Any other			
III	**Mode of presentation**			
1	Presents with relevant pictures			
2	Provides real time information			
3	Able to relate the pictures easily with the field situation			
4	Fine colour combination of background, pictures and letters			
5	Appropriate letter size			
6	Emphasis of points with either bold or change of			

3	To reach larger audience			
4	Interest of users in retrieving information			
	Any other			
IX	**Settings in the system:**			
1	The tutorial page provides complete guidance for the user to make use of the system without any confusion.			
2	The tutorial page can retain the interest of the user in using thesystem further.			
3	The font size of the headings is appropriate.			
4	The font size of the text is appropriate.			
5	The pictures given in the system are appropriate to the subject given.			
6	Colour combination of background, pictures and letters is appropriate.			
	Any other			
X	**Future prospects**			
1	AES will act as an efficient extension aid			
2	It will be highly user friendly			
3	Strengthens the expertise of new human experts with minimum period because of the availability of combined effect of several human experts			
4	Provides greater support to take suitable decisions			
5	Reduces the confusion and dilemma of taking decisions in farming			
6	The system will be available at low cost			
7	The cost of maintenance of the system will be available at nominal rate			
8	It will be a complementary tool for disseminating Agricultural technologies			
9	Information will reach wider audience within no time			
10	In the absence of human experts AES will serve the purpose			
	Any other			

Thank you very much

	colour or font size of letters			
7	Provides expert level recommendations understandable to users			
8	Provides learning situation that can be acquired directly from experimental data and real time examples			
9	Icons in the home page are sufficient			
10	Available features easily lead the interaction effectively			
11	Interactive ness of the system			
12	Overall user friendliness of the system			
	Any other			
IV	**Serviceability:**			
1	The system serves the needs of the users like researchers, teachers, students, extension personnel and farmers.			
2	The provided information is up to date.			
3	The provided information is need based.			
4	The system helps to find solutions to the specific problems related to the topic.			
	Any other			
V	**Relevancy:**			
1	Relevance of information about the plant protection measures.			
2	The system is able to provide information suitable to the users resources.			
3	Information provided in the system is appropriate to the users needs.			
	Any other			
VI	**Practicability:**			
1	Practicability of information about the plant protection measures.			
2	Information provided in the system is adoptable in the real situation.			
3	Information provided in the system is feasible.			
	Any other			
VII 1	**Retrievability:** The information provided in the system can be easily located by any user.			
2	The need based information can be received by the user with in less time.			
3	The received information is easily understandable by the user.			
4	The necessary information can be taken as print out for further reference.			
5	A common man can easily retrieve the information			
	Any other			
VIII	**Provision for updating information**			
1	Makes modification of knowledge base very conveniently			
2	Has the ability to guide users to handle uncertain information			

	To reach larger audience			
	Interest of users in retrieving information			
	Any other			
	Settings in the system:			
	The tutorial page provides complete guidance for the user to make use of the system without any confusion.			
	The tutorial page can retain the interest of the user in using thesystem further.			
	The font size of the headings is appropriate.			
	The font size of the text is appropriate.			
	The pictures given in the system are appropriate to the subject given.			
	Colour combination of background, pictures and letters is appropriate.			
	Any other			
	Future prospects			
	AES will act as an efficient extension aid			
	It will be highly user friendly			
	Strengthens the expertise of new human experts with minimum period because of the availability of combined effect of several human experts			
	Provides greater support to take suitable decisions			
	Reduces the confusion and dilemma of taking decisions in farming			
	The system will be available at low cost			
	The cost of maintenance of the system will be available at nominal rate			
	It will be a complementary tool for disseminating Agricultural technologies			
	Information will reach wider audience within no time			
	In the absence of human experts AES will serve the purpose			
	Any other			

Thank you very much

APPENDIX-V

Relevancy Indices of identified items for measuring the perception of the respondents towards the performance of AES

Sl. No.	Identified items	Relevancy Indices		
		Researchers	Extension personnel	Farmers
I	**Information content**			
1	Relevancy of the subject matter	66.58	69.25	59.98
2	Clarity in tutorial page	67.52	66.35	60.54
3	Design of the message	69.21	68.87	67.68
4	Systematically classified information	90.11*	66.25	69.34
5	Supports easy learning	89.54*	78.62*	64.74*
6	Complete information for decision making	88.24*	92.58*	68.39*
7	Clarity in the messages given in the entire module	92.01*	68.38	92.14*
8	Getting systematic links	66.54	69.51	66.58
9	Easy availability of information	69.58	67.26	65.05
10	Practical feasibility of information	68.32	65.45	62.15
11	Message considers users resources	91.94*	97.57*	94.54*
12	Ability to comprehend	66.68	69.41	68.17
13	Customized information	68.10	69.49	63.84
14	User friendliness	66.87	68.63	69.09
15	Suitability of the content	67.52	69.06	68.50
16	Acceptable by the users	98.38*	98.86*	89.46*
17	Provides explicit information	62.50	65.51	54.63
18	Provides reasons for the given solution	96.66*	97.49*	95.75*
19	Easier information search	76.11*	64.15	63.43
20	Sufficient and accurate information	98.69*	67.18	66.67
21	Content coverage	67.92	68.68	68.96
II	**Information treatment**			
1	Supports easy learning	67.00	72.37*	76.28*
2	Language used is simple	87.18*	85.59*	84.45*
3	Attractive design and layout	61.23	72.35*	78.31*
4	Logical sequence	84.54*	85.65	84.48
5	Practicability of information	69.58	58.95	66.89
6	Use of scientific/technical terms	85.21*	86.28*	83.56*
7	Time required to retrieve relevant information	90.58*	68.85	67.00
8	Clarity of the messages given in the entire module	65.27	74.36*	76.28*
III	**Mode of presentation**			
1	Presents with relevant pictures	62.58	66.62	65.16
2	Provides real time information	86.28*	98.03*	88.51*
3	Able to relate the pictures easily with the field situation	64.68	65.36	68.45
4	Fine colour combination of background, pictures and letters	67.30	74.33	64.46
5	Appropriate letter size	65.90	77.38	61.83
6	Emphasis of points with either bold or change of colour or font size of letters	87.42*	86.55*	74.97*
7	Provides expert level recommendations understandable to users	90.12*	95.20*	89.92*

8	Provides learning situation that can be acquired directly from experimental data and real time examples	87.71*	94.50*	86.82*
9	Icons in the home page are sufficient	85:64*	94.68*	85.32*
10	Available features easily lead the interaction effectively	84.45*	97.23*	94.36*
11	Interactive ness of the system	76.38*	88.86*	72.95*
12	Overall user friendliness of the system	78.14*	75.38*	74.45*
IV	**Serviceability:**			
1	The system serves the needs of the users like researchers, teachers, students, extension personnel and farmers.	82.35*	84.29*	85.06*
2	The provided information is up to date.	84.38*	87.12*	85.21*
3	The provided information is need based.	73.64*	74.51*	76.02*
4	The system helps to find solutions to the specific problems related to the topic.	84.57*	86.12*	82.39*
V	**Relevancy:**			
1	Relevance of information about the plant protection measures.	77.34*	75.62*	76.43*
2	The system is able to provide information suitable to the users' resources.	84.69*	85.40*	63.90
3	Information provided in the system is appropriate to the users needs.	67.06	77.47*	67.79
VI	**Practicability:**			
1	Practicability of information about the plant protection measures.	81.15*	78.46*	79.52*
2	Information provided in the system is adoptable in the real situation.	83.33*	82.35*	65.12*
3	Information provided in the system is feasible.	78.49*	76.28*	64.98
VII	**Retrievability:**			
1	The information provided in the system can be easily located by any user.	77.24*	74.38*	82.94*
2	The need based information can be received by the user with in less time.	83.27*	74.89*	78.32*
3	The received information is easily understandable by the user.	75.06*	78.44*	64.39
4	The necessary information can be taken as print out for further reference.	74.34*	77.63*	68.25*
5	A common man can easily retrieve the information	72.50*	64.63	67.41
VIII	**Provision for updating information**			
1	Makes modification of knowledge base very conveniently	86.54*	62.69	64.16
2	Has the ability to guide users to handle uncertain information	79.52*	69.85	70.38
3	To reach larger audience	78.26*	73.62	78.45
4	Interest of users in retrieving information	65.96	67.15	61.34
IX	**Settings in the system:**			
1	The tutorial page provides complete guidance for the user to make use of the system without any confusion.	89.35*	85.94*	86.54*

2	The tutorial page can retain the interest of the user in using the system further.	84.54*	77.12*	82.22*
3	The font size of the headings is appropriate.	70.51*	73.34*	74.09*
4	The font size of the text is appropriate.	90.01*	88.74*	87.52*
5	The pictures given in the system are appropriate to the subject given.	76.74*	85.46*	84.44*
6	Colour combination of background, pictures and letters is appropriate.	92.12*	90.51*	94.26*
X	**Future prospects**			
1	AES will act as an efficient extension aid	90.08*	91.35*	90.28*
2	It will be highly user friendly	89.21*	87.39*	85.49*
3	Strengthens the expertise of new human experts with minimum period because of the availability of combined effect of several human experts	85.38*	86.49*	88.55*
4	Provides greater support to take suitable decisions	88.34*	87.44*	85.67*
5	Reduces the confusion and dilemma of taking decisions in farming	85.62*	83.76*	84.58*
6	The system will be available at low cost	73.69*	81.53*	77.20*
7	The cost of maintenance of the system will be available at nominal rate	81.54*	82.69*	84.12*
8	It will be a complementary tool for disseminating Agricultural technologies	83.36*	85.05*	84.52*
9	Information will reach wider audience within no time	68.20	82.19*	85.25*
10	In the absence of human experts AES will serve the purpose	57.12	65.52	67.48

APPENDIX-VI

Discrimination Indices of identified items for measuring the perception of the respondents towards the performance of AES

Sl. No.	Identified items	Discrimination Indices
I	**Information content**	
1	Relevancy of the subject matter	0.3214
2	Clarity in tutorial page	0.2822
3	Design of the message	0.1207
4	Systematically classified information	0.4110*
5	Supports easy learning	0.4528*
6	Complete information for decision making	0.3822*
7	Clarity in the messages given in the entire module	0.7018*
8	Getting systematic links	0.1404
9	Easy availability of information	0.1636
10	Practical feasibility of information	0.0519
11	Message considers users resources	0.3611*
12	Ability to comprehend	0.0913
13	Customized information	0.0857
14	User friendliness	0.3492
15	Suitability of the content	0.1111
16	Acceptable by the users	0.2540
17	Provides explicit information	0.1101
18	Provides reasons for the given solution	0.3933*
19	Easier information search	0.1358
20	Sufficient and accurate information	0.6929*
21	Content coverage	0.1269
II	**Information treatment**	
1	Supports easy learning	0.1148
2	Language used is simple	0.3571*
3	Attractive design and layout	0.5921*
4	Logical sequence of information	0.0055
5	Practicability of information	-0.0793
6	Use of scientific/technical terms	0.3571*
7	Time required to retrieve relevant information	0.5127*
8	Clarity of the messages given in the entire module	0.1719
III	**Mode of presentation**	
1	Presents with relevant pictures	0.1904
2	Provides real time information	0.2500
3	Able to relate the pictures easily with the field situation	0.2777
4	Fine colour combination of background, pictures and letters	0.1291
5	Appropriate letter size	0.1931

6	Emphasis of points with either bold or change of colour or font size of letters	0.7058*
7	Provides expert level recommendations understandable to users	0.5079*
8	Provides learning situation that can be acquired directly from experimental data and real time examples	0.4630*
9	Icons in the home page are sufficient	0.3500*
10	Available features easily lead the interaction effectively	0.3846*
11	Interactiveness of the system	0.4271*
12	Overall user friendliness of the system	0.3540*
IV	**Serviceability:**	
1	The system serves the needs of the users like researchers, teachers, students, extension personnel and farmers.	0.3918*
2	The provided information is up to date.	0.4784*
3	The provided information is need based.	0.1292
4	The system helps to find solutions to the specific problems related to the topic.	0.7032*
V	**Relevancy:**	
1	Relevance of information about the plant protection measures.	0.3712*
2	The system is able to provide information suitable to the users' resources.	0.5730*
3	Information provided in the system is appropriate to the users needs.	0.3852*
VI	**Practicability:**	
1	Practicability of information about the plant protection measures.	0.3539*
2	Information provided in the system is adoptable in the real situation.	0.3900*
3	Information provided in the system is feasible.	0.5165*
VII	**Retrievability:**	
1	The information provided in the system can be easily located by any user.	0.6270*
2	The need based information can be received by the user with in less time.	0.3982*
3	The received information is easily understandable by the user.	0.3727*
4	The necessary information can be taken as print out for further reference.	0.3698*
5	A common man can easily retrieve the information	0. 4021*
VIII	**Provision for updating information**	
1	Makes modification of knowledge base very conveniently.	0.5011*
2	Has the ability to guide users to handle uncertain information.	0.3976*
3	To reach larger audience.	0.3863*
4	Interest of users in retrieving information.	-0.08696

IX	**Settings in the system:**	
1	The tutorial page provides complete guidance for the user to make use of the system without any confusion.	0.3840*
2	The tutorial page can retain the interest of the user in using the system further.	0.3918*
3	The font size of the headings is appropriate.	0.7655*
4	The font size of the text is appropriate.	0.4286*
5	The pictures given in the system are appropriate to the subject given.	0.4068*
6	Colour combination of background, pictures and letters is appropriate.	0.6000*
X	**Future prospects**	
1	AES will act as an efficient extension aid	0.7232*
2	It will be highly user friendly	0.4068*
3	Strengthens the expertise of new human experts with minimum period because of the availability of combined effect of several human experts	0.4286*
4	Provides greater support to take suitable decisions	0.4491*
5	Reduces the confusion and dilemma of taking decisions in farming	0.14286
6	Strength of extension personnel can be reduced	0. 3742*
7	The system will be available at low cost	0.3608*
8	The cost of maintenance of the system will be available at nominal rate	0.3862*
9	It will be a complementary tool for disseminating Agricultural technologies	0.5031*
10	Information will reach wider audience within no time	0.3711*
11	In the absence of human experts AES will serve the purpose	0.3665*

*- Items selected for preparing the questionnaire.

APPENDIX-VII

KERALA AGRICULTURAL UNIVERSITY
FACULTY OF AGRICULTURE
COLLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

Please choose your answer for the following questions. This is to test the ability of the agricultural expert system to provide information to you and not to test your knowledge:

1. Can you please identify a short duration high yielding red rice variety suitable for upland conditions as 1st crop in your area from the following varieties?
a. Aiswariya b. Swarnaprabha c. Mattatriveni d. Ponmani

2. Please choose a red rice short duration variety resistant to blight, blast and stem borer suitable for all seasons.
a. Kanchana b. Triveni c. Jayathi d. Sabari

3. Please select the phosphorous nutrient to be applied as basal dose in high yielding medium duration transplanted rice in wet lands per hectare.
a. 50Kg b. 45kg c. 30Kg d. 60Kg

4. If pH of soil in your area is 4.5, please name the input to increase the pH in rice field:
a. Lime b. Gypsum c. Wood ash d. Meal powder

5. The ear head appears completely chaffy and white in colour and come out easily when it is pulled out. What does it indicate?
a. Incidence of gall midge b. Incidence of stem borer c. Sheath blight
d. Incidence of BPH

6. What is the main precaution you recommend when there was a widespread occurrence of gallmidge during the last season?
a. Spray Acephate b. Avoid early transplantation c. Avoid late transplantation
d. Carry out the cultural operations at the right time

7. In rice, the tips of leaves get rolled longitudinally into needle like out growths and turn whitish. The lower leaves show chlorosis and scorching. Identify the problem:
a. Rice Thrips b. Leaf folder c. BPH d. Stem borer

8. What is the dosage of Carbaryl to control BPH in rice?
a. 400g of 85S/ha b. 250g of 85S/ha c. 625g of 85S/ha d. 725g of 85S/ha

9. To control Leaf Folder in rice what is your recommendation?
a. Carbofuron- 18k gcf 3G/ha b. Triazophos- 250ml of 20 EC
c. Phorate- 10kgof 10G/ha d. Quinalphos-750ml of 25EC/AF/ha

10. In rice, greenish grey irregular large lesions with dark line on margins develop mostly on older leaves. Identify the problem.
a. Foot rot b. Sheath blight c. Blast d. Bacterial leaf blight

11. What is the ETL of rice bug during flowering stage of the crop?
a) 5 bugs / hill (b) 10 bugs / hill (c) 8 bugs / hill (d) 2 bugs / hill

12. Please choose the tolerant rice variety for stem borer in endemic areas:
a) PTB 52 (b) MO16 (c) IR-20 (d) ASD-17

13. Please choose the number of pheromone traps required/ha to prevent the stem borer attack in rice:
a) 15 (b) 20 (c) 25 (d) 30

14. Please choose the tolerant rice variety for gall midge attack:
a) Deepthi (b) Kumbham (c) Neeraja (d) Pavithra

15. To protect the gall midge infestation from paddy seedlings for 30 days, what do you recommend?
a)Dimethoate-0.2 % b) Chlorpyrifos-0.2 % c) Malathion-50 EC
d) Formothion- 25 EC

16. During grain formation stage in rice, grains become chaffy showing brownish discoloured patches on the husk. Please identify the symptoms:
a) Thrips b) Brown leaf spot c) Rice bug d) Rice mealy bug

17. The favourable condition for leaf folder infestation in rice is:
a) Excess water stand b) Increase in humidity c) Closer plant population
d) Excess nitrogen

18. Yellowish circular patches appear here and there in field. The plants in these areas dry up very soon. The yellowing and drying extend rapidly. Please identify the symptom:
a) Brown plant hopper b) Thrips c) Rice root nematode
d) Brown leaf spot

19. Please choose the rice variety resistant to Brown Plant Hopper:
a) Annapoorna b) Rohini c) Jyothy d) Triveni

20. What is your recommendation against BLB in rice?
a) a) Carbendazin-500 gm / ha b) Streptocycline-15 gm / ha c) Mancozeb-2 kg / ha
d) Benomyl-500 gm / ha

21. Mirid bugs in rice fields act as:
a) Predators b) Pests c) Vectors d) Parasites

22. The ETL for Tungro virus in rice is:
a) 1 affected hill / m2 b) 2 affected hills / m2 c) 3 affected hills / m2
d) 4 affected hills / m2

23. ETL for blast in rice nursery stage is:
a)1 % disease severity b) 3 % disease severity c) 5 % disease severity
d) 7 % disease severity

24. To manage sheath rot in rice crop which is the bio-control agent?
a) Pseudomonas fluorescens b) VAM c) Trichoderma d) Trichogramma species

25. The purpose of seed treatment with chemical before sowing is
a) to kill the insects present in the seed. b) to kill the disease causing pathogens.
c) to kill the weed seeds d) to purify the seeds from external impurities

26. Malathion is a
a) Fungicide b) Weedicide c) Fertilizer d) Pesticide

27. Rice seedling dip with Dimethoate-0.2% suspension is recommended against which pest?
a) BPH b) Rice leaf folder c) Rice nematode d) Rice Thrips

28. Pesticide application should be completed how many days before harvest?
a) 15 days b) 20 days c) 25 days d) 30 days

29. Which is the better substrate for multiplying *Trichoderma* spp.?
a) Neemcake b) Sand c) Red soil d) Clay soil

30. *Pseudomonas fluorescens* controls --------------
a) Virus diseases b) Nitrogen uptake c) Fungal and bacterial diseases
d) Pest incidence

31. To prepare 1% Bordeaaux mixture, copper sulphate is mixed with --------
a) Lime b) Sand c) Dried Farmyard manure d) Neem cake

32. Please identify the acaricide used to control mite:
a) Carbaryl b) Dichlorvos c) Dicofol d) Methyl Parathion

33. What is the best time for the collection of seed nuts in coconut?
a) Jan-Feb b) April-May c) July–Aug d) Oct-Nov

34. What is the bio control inoculation used in the breeding site of Rhinocerous beetle to control it?
a. *Metarrhizium anisopliae* b. *Orcytes rhinoceros*
c. *Rhyncophorus ferrugineus* d. None of these

35. In a coconut groove, rotting of distal ends of leaflets are seen on the palms which later dried and blown off in the air. Identify the problem:
a. Grey blight b. Bud rot c. Leaf rot d. Mahali

36. Which is the best remedial measure available to control mite attack in coconut?
a. Neem oil + Garlic emulsion-2% b. Monocrotophos- 600ml
c. Neem oil-5% d. None of these

37. .Presence of holes on the coconut stem, oozing out of a viscous brown fluid and extrusion of chewed up fibrous matter through the hole, longitudinal splitting of leaf base and wilting of central shoot show the symptom of the attack of which pest?
a. Leaf eating caterpillar b. Rodents c. Red palm weevil d. Rhinocerous beetle

38. What is the curative measure you recommend for managing red palm weevil in coconut?
a. Pheromone trap
b. Leaf axil filling with sand and Naphthalene balls
c. Aluminium phosphide
d. None of these

39. The coconut buttons become deformed with characteristic crevices on the husk below the perianth with gum exudations and the tender nuts become barren. Please identify the problem:
a. Coried bug attack
b. Mealy bug attack
c. Nutritional deficiency
d. Defects in pollination and fertilization

40. The tender leaf base and soft tissues of the crown in coconut palm rot into a mass of decayed material emitting a foul smell. This is accompanied by drooping of successive leaves. Please identify the problem:
a. Leaf rot
b. Mahali
c. Root wilt
d. Bud rot

41. What is your recommendation for the management of Tanjore wilt in coconut?
a. Tridemorph-0.1%
b. Monocrotophos-500ml
c. 2% Neem oil
d. None of these

42. Stem bleeding is the problem identified in coconut palm. What do you recommend to control the disease?
a. Neem cake @5Kg/palm
b. Bordeaux mixture-1%
c. Tridemorph-1%
d. Mancozeb-4%

43. Which is the coconut hybrid recommended in root wilt affected area?
a) Lakrhaganga
b) Kerasree
c) Chandrasankara
d) Keraganga

44. To bring down the rhinoceros beetle population, please mention the name of bio-control agent to be released to infect adults:
(a) Baculovirus
(b) Pseudomonas fluorescens
(c) Trichoderma viride
(d) None of these

45. As a prophylactic measure for leaf eating caterpillar in coconut, which are the parasites to be released?
a) *Stenobracon sp.*
(b) Cotesia sp.
(c) Goniozus sp.
(d) Charops sp.

46. To control the damage caused by rodents what is your recommendation?
a) Bromad ioline-0.005 %
b) Malathion-0.05 %
c) Quinalphos-0.05 %
d) Phosalone-) 0.05 %

47. What is the percentage of moisture content you recommend to store the copra without infestation of beetles?
a)12 %
b) 10 %
c) 8 %
d) 4 %

48. Which of the following condition will aggravate stem bleeding in coconut?
a) Heavy rains
b) Cyclone
c) Cracks on the trunk
d) Nutrient deficiency

49. Please choose the less susceptible variety of banana to bunchy top disease:
a. Nendran
b. Njalipoovan
c. Palayankodan
d. Karpooravally

50. Please choose the following to manage pseudostem weevil in banana:
a. Quinalphos- 0.05% b. Phorate-12.5g c. Carbofuran- 10g
d. None of these

51. Which pest is the vector for Bunchy top disease in banana ?
a. Aphids b. Spindle leaf miner c. Nematodes d. Banana rhizome weevil

52. What is the preventive measure for aphids infestation in banana?
a. Neem cake @1Kg/plant b. Chlorpyrifos-0.03% c. Carbaryl- 0.02%
d. Phorate- 12.5g

53. Two months old Nendran banana plants show pinkish streaks on the pseudostem. Please identify the problem:
a. Cucumber mosaic virus b. Banana wilt c. Banana pseudostem weevil
d. Banana bract mosaic virus

54. To control Sigatoka leaf spot in banana, what is your recommendation?
a. Neem cake-1Kg/plant b. Carbaryl- 0.02% c. Bordeaux mixture-1%
d. None of these

55.Please choose the following banana variety, which is resistant to Panama wilt:
a. Kunnan b. Palayankodan c. Karpooravally d. Njalipoovan

56. Infectious chlorosis in banana is caused by --------------------
a. Nitrogen deficiency b. Potash deficiency c. Aphids d. Nematodes

57. Which is the highly susceptible variety for *kokkan* disease in banana?
a. Robusta b. Koompillakannan c. Nendran d. Red banana

58. To control spindle leaf miner in banana what do you recommend?
a. Carbofuron -0.5g ai/plant b. Dimethoate- 0.05% c. Phorate-25g
d.Neem cake@1Kg/plant

59. To prevent the attack of nematode in banana, what do you suggest?
a) Neem cake-1kg/plant b) Phorate 10 G c) Bordeaux mixture-1 %
d) Tridemorph-0.05 %

60. Which of the following factors is the most important in the control of banana pseudostem weevil?
a) Regular irrigation b) Field sanitation c) Selection of resistant varieties
d) Sucker treatment with Carbofuron

Thank you very much

APPENDIX-VIII

Difficulty and Discrimination indices of identified items

Item no	Difficulty Index	Discrimination index	Point biserial correlation
1	0.73	0.30	0.0967^{NS}
2	0.40	-0.10	0.2484^{NS}
3	0.67	0.02	0.4095**
4	0.30	0.50	-0.0351^{NS}
5	0.73	0.03	0.1364^{NS}
6	0.57	0.60	0.5432**
7	0.23	0.00	0.0463^{NS}
8	0.50	-0.25	0.8114**
9	0.67	-0.25	0.6527*
10	0.73	0.00	0.4791**
11	0.57	-0.20	0.5075*
12	0.23	0.47	0.7542^{NS}
13	0.30	0.07	0.6274*
14	0.45	0.50	0.7617*
15	0.45	0.07	0.2860^{NS}
16	0.30	0.50	0.2614^{NS}
17	0.57	0.27	0.3418*
18	0.23	0.10	0.1841*
19	0.50	-0.21	0.7428**
20	0.75	-0.10	0.0913^{NS}
21	0.67	0.03	0.1746^{NS}
22	0.50	0.67	0.5075**
23	0.97	0.13	0.2401*
24	0.70	0.07	-0.0419^{NS}
25	0.70	0.03	0.0277^{NS}
26	0.24	0.23	0.5940*
27	0.63	-0.66	0.1253^{NS}
28	0.60	0.50	0.4505**
29	0.57	0.00	0.3733^{NS}
30	0.40	-0.21	0.0720^{NS}
31	0.63	-0.13	0.2766^{NS}
32	0.43	0.00	0.4627^{NS}
33	0.40	-0.20	0.6591*
34	0.56	0.10	0.4126**
35	0.60	0.23	0.4425^{NS}
36	0.37	0.57	0.3420**
37	0.33	0.00	0.0742^{NS}
38	0.67	-0.25	0.6440*
39	0.73	-0.13	0.6035*
40	0.50	0.57	0.3752*

Item no	Difficulty Index	Discrimination index	Point bi serial correlation
41	0.83	0.00	0.4725 ^{NS}
42	0.47	0.63	0.2782*
43	0.63	0.10	0.2294 ^{NS}
44	0.40	0.03	0.3265*
45	0.57	0.53	0.7384*
46	0.30	-0.02	0.4076 ^{NS}
47	0.60	0.70	0.6527**
48	0.55	0.53	0.6714**
49	0.50	0.47	0.5723*
50	0.47	0.00	0.7081*
51	0.23	-0.20	0.9130 ^{NS}
52	0.55	0.60	0.6719**
53	0.87	0.07	0.5604 ^{NS}
54	0.27	0.23	0.2861*
55	0.90	-0.21	0.7350*
56	0.80	0.07	0.7611*
57	0.47	-0.25	0.0655 ^{NS}
58	0.63	0.00	0.6241*
59	0.50	0.57	0.3840**
60	0.67	0.10	0.2763 ^{NS}

Bolded item numbers were selected for the test.

APPENDIX-IX

Phone: 0487 – 2370822 (Off.), 2370914 (Res.)
Telex : 0887–268–KAU–In; Fax: 91-487-2370019
Email: helenraj1@rediffmail.com

KERALA AGRICULTURAL UNIVERSITY
College of Horticulture
Department of Agri. Extension
Vellanikkara – 680 656, Thrissur, Kerala, India

Dr. F. M. H. Kaleel
Major Advisor

No: PhDQ-I/S.H/2006

Date: 10.03.06

Dear Sir/Madam,

Greetings!

This is in connection with the research study entitled "**Agricultural Expert System – A participatory assessment**" undertaken by Mrs. S. Helen (2003-21-09) doing her doctoral programme this department under my guidance. The main objective of her study is to explore the possibilities of functioning of Agricultural Expert System (AES) under the existing extension system. The study also aims to analyse the perception of the potential users on the information efficiency and problem solving capacity of the AES. In this context, she has constructed a questionnaire to assess the expectations of researchers who are involved in developing AES on the potential of the AES.

Considering your rich experience and expertise, you have been identified as one of the researchers to collect your responses in the enclosed questionnaire. You may please indicate your response by marking (√) against each item under the appropriate column. You are requested to add your opinion, which you may think are related and also rate them under appropriate column.

Amidst your busy schedule, I hope that you may kindly spare sometime for us. Your kind and early action in the matter would greatly help us to complete the study in time. Kindly return the duly filled annexure to the self addressed stamped envelope enclosed herewith. Your expertise will be greatly acknowledged.

Thanking you. With kind regards,

Yours sincerely,

(F. M. H. Kaleel)

Encl: Questionnaire.

A

KERALA AGRICULTURAL UNIVERSITY

FACULTY OF AGRICULTURE

COLLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

Date:

1. Name:
2. Designation:
3. Address of the institution:

4. Age:
5. Educational status: Post graduation/P G Diploma/ Doctorate/ Post doctorate
6. Subject of specialisation:

7. Total years of experience: ---- years. Research ------ Teaching ------- Extension-------

8. a) In your opinion, what is meant by an agricultural expert system?

b) Please name the Agricultural Expert Systems (AES) developed or assisted by you?

)	Name of the AES developed	On which subject	Name of the program used	Year of development	Whether it is released or not? (Yes or No)	Price if any. Rs

9. Please mention the trainings related to Information and Communication Technologies attended by you:

S.no	Name of the training	Name of training institution and place	Duration & year

10. a) Following items show the frequency of use of computers. In the five-point continuum '5' indicates that you 'always' use computers and '1' indicates that you 'never' use computers. The scores in between in the decreasing order show the degree of decrease in the level of your usage of computers. Please choose your response by marking tick (√) under the appropriate score:

S.no	Items	Scores				
		5	4	3	2	1
1.	I use computers for report preparation					
2.	I access information through internet					
3.	I attend formal trainings in computer usage					
4.	I make programming in computer					
5.	I develop softwares in agricultural technologies					
6.	I develop softwares in other areas					
7.	I assist to develop softwares in agricultural technologies					

b) How long you have been using computers? --------Years.

11. Following items show the performance of modern Information and Communication Technologies (ICT). In the five point continuum '5' indicates "Strongly agree" and '1' indicates "Strongly disagree" in relation to each given item. The scores in between in the decreasing order show the degree of decrease in the level of your agreement towards the performance of modern Information and Communication Technologies. Please choose your response by marking tick (√) in the appropriate column:

S.no	*Items*	Scores				
		5	4	3	2	1
1	ICT offers better opportunity for information access					
2	ICT helps its users for decision making					
3	Self learning is possible through ICT					
4	ICT creates interest to learn the subject delivered through it					
5	Information gathered through ICT has got reliability and credibility					
6	Information gathered through ICT is more updated than other sources					
7	ICT is useful in problem solving					

12. Following items show your rationality in decision making. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given item. The scores in between in the decreasing order show the degree of decrease in the level of taking time in decision making. Please choose your response by marking tick (√) under the suitable score:

S. no	Items	Scores				
		5	4	3	2	1
1.	I am quick in making decisions that are clear and rational					
2.	I am capable of looking at alternatives while taking decisions					
3.	I avoid decisions that seem unimportant					
4.	I recognise, analyse and evaluate problems on which decisions are to be taken					
5.	I take decisions independently without allowing others to influence					
6.	I put forth doubts and clarification even about minute aspects of field situation and potential users					

13. Following items show your source of information regarding technical aspects of your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given item. The scores in between in the decreasing order show the degree of decrease in the level of utilisation of information sources. Please choose your response by marking tick (√) under the suitable score:

S. no	Sources	Scores				
		5	4	3	2	1
1.	Own experience/ exposure					
2.	Research journals					
3.	Scientific Seminars/Symposia/ Conferences					
4.	News papers					
5.	Farm magazines					
6.	Television					
7.	Radio					
8.	Discussion with fellow officials/scientists					
9.	Trainings					
10.	Internet					
11.	Any other(Please specify)					

14. On getting information from various sources, do you make use of it in the following aspects:

a) For which crops you make use of the information? Please underline the crops given: Rice/ coconut/ banana/ other fruits/ vegetables/ spices/ medicinal plants/ others.

b) Following items show the level of utilisation of information regarding technical aspects of your subject area. In the five-point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of utilisation of information. Please choose your response by marking tick (√) under the suitable score:

S.no.	Items	Scores				
		5	4	3	2	1
1.	Characteristics of HYVs					
2.	Dose of manures and fertilizers					
3.	Weed management practices					
4.	Water management practices					
5.	Plant protection measures					
6.	Post harvest technologies					
7.	Market information					

15. How often do you communicate the technical information pertaining to the improved agricultural practices to the following personnel. Following items show the level of transfer of information regarding technical aspects of your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given item. The scores in between in the decreasing order show the degree of decrease in the level of transfer of information. Please choose your response by marking tick (√) under the appropriate score:

S.no.	Personnel	Scores				
		5	4	3	2	1
1.	Fellow scientists					
2.	Extension officers					
3.	Students					
4.	Subordinates					
5.	Farmers					
6.	Print media					
7.	Television					
8.	Radio					
9.	Entrepreneurs					
10.	NGOs					
11.	Any other(Please specify)					

16. How often do you provide feedback (response, opinions, feelings, doubts, ideas, thoughts and comments) on improved agrl. practices to others? Following items show the level of your information feedback regarding technical aspects of your subject area. In the five point continuum '5 indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of your information feedback. Please choose your response by marking tick (√) under the suitable score:

S.no.	Methods of information feed back	Scores				
		5	4	3	2	1
1.	Through publishing in farm magazines/dailies					
2.	Through personal /official letters					
3.	Through phone calls					
4.	Through workshops/seminars					
5.	Through internet / e-mail					

17. Following items show the infrastructure facilities provided by your institution to refresh yourself in your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of facilities provided by your institution. Please choose your response by marking tick (√) in the appropriate column:

S. no	Items	Scores				
		5	4	3	2	1
1.	Do you have adequate opportunities to undergo training on computer operations?					
2.	Whether your institution regularly arranges training to all of you?					
3.	Whether your office provides internet facilities to you to gather information on your subject area of interest?					
4.	Whether your institution arranges study tours, exhibitions, field visits to facilitate you to see and understand latest trend in scientific crop production & management?					
5.	Whether your organization conducts group discussions/seminars/workshops among scientists to provide information on latest developments in your subject area?					

18. It is known that Agricultural Expert System (AES) has got potential in transfer of technology. Considering your expertise in developing AES, please indicate the degree of potential as expected by you in the form of tick mark (√) against the statements given about Agricultural Expert System: In the five-point continuum, '5' indicates 'Highest potential' and '1' indicates 'Lowest potential' to the corresponding statement. The scores in between in the decreasing order show the degree of decrease in the level of your expectations on the potentials of agricultural expert system.

S. no	Items	Continuum				
		5	4	3	2	1
I	**AES strengthens TOT process**					
1.	It transfers knowledge from scientists to extension workers and farmers as and when necessary					
2.	Fills the knowledge gap between the expert and the user					
3.	Reduces the time gap of transferring technologies from scientists to farmers					
4.	Reduces distortion of message in TOT from researchers to users					
II	**AES provides information support**					
1.	Helps the extension personnel or researchers by providing recommendations					
2.	Supports the farm advisory services extended by extension personnel					
3.	Provides requisite expertise on site when human expertise is scarce					
4.	Helps for easy retrieval of relevant information					
5.	Captures and preserves the expertise of scientists who are about to retire					
6.	Assimilates the knowledge and experience of several human experts					
7.	Promotes sharing of knowledge					
8.	It clarifies and confirm doubtful information					
9.	Provides virtual visualization of field reality					
III	**AES promotes empowerment**					
1.	It builds the capacity of new human experts					
2.	Helps the farmer to remain competitive by providing need based information					
3.	Provision of information reduces dependence on subject matter specialists					
4.	Provision of need based information builds confidence among users					
5.	Empowering the users with adequate knowledge					
6.	Increases the professional efficiency of the users					
IV	**AES helps to solve field problems**					
1.	It helps to diagnose and solve field problems at the right time					
2.	It helps to choose appropriate technology					
3.	Provides adequate data base on specific technologies					
4.	In solving the problems, it considers basic needs and resources of the farmers					
V	**AES supports to increase farm income**					
1.	Increases food production & income by providing suitable timely information					
2.	Provides opportunity for better price by providing timely information					
VI	Any other (Please specify)					

Thank you very much.

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Email : helenraj1@rediffmail.com

KERALA AGRICULTURAL UNIVERSITY
College of Horticulture
Department of Agri. Extension
Vellanikkara – 680 656, Thrissur, Kerala, India

Dr. F. M. H. Kaleel
Major Advisor

No: PhDQ-II/S.H/2006

Date: 10.03.06

Dear Sir/Madam,

Greetings!

This is in connection with the research study entitled "**Agricultural Expert System – A participatory assessment**" undertaken by Mrs. S. Helen (2003-21-09) Ph D scholar of this department under my guidance. The main objective of her study is to explore the possibilities of functioning of Agricultural Expert System (AES) under the existing extension system. The study also aims to analyse the perception of the potential users on the information efficiency and problem solving capacity of the AES. In this context, she has constructed a questionnaire to assess the perception of agricultural researchers in the functioning of AES in Transfer of Technology.

Considering your rich experience and expertise, you have been identified as one of the researchers in Transfer of Technology to collect your responses in the enclosed questionnaire. You may please indicate your response by marking (√) against each item under the appropriate column. You are requested to add your opinion, which you may think are related and also rate them under appropriate column.

Amidst your busy schedule, I hope that you may kindly spare sometime for us. Your kind and early action in the matter would greatly help us to complete the study in time. Kindly return the duly filled annexure to the self addressed stamped envelope enclosed herewith. Your expertise will be greatly acknowledged.

Thanking you. With kind regards,

Yours sincerely,

(F. M. H. Kaleel)

Encl: Questionnaire.

B

KERALA AGRICULTURAL UNIVERSITY

FACULTY OF AGRICULTURE

COLLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

Date:

1. Name:
2. Designation:
3. Address of the institution:

4. Age:
5. Educational status: Post graduation/ P G Diploma / Doctorate/ Post doctorate
6. Subject of specialisation:
7. Years of experience: Research ------ Teaching ------- Extension-------
8. a) In your opinion, what is the meaning of agricultural expert systems?

   b) Please name the agricultural expert systems that you are aware?

9. Please mention the trainings related to Information and Communication Technologies attended by you during the past five years:

S.no	Name of the training	Name of training institution and place	Duration	Subject matter area

10. a) Following items show your proficiency in computer operations. In the five-point continuum '5' indicates your highest proficiency and '1' indicates lowest proficiency in computers. The scores in between in the decreasing order show the degree of decrease in the level of your proficiency. Please choose your response by marking tick (√) in the suitable score:

S.no	Items	Scores				
		5	4	3	2	1
1.	Working knowledge on computer usage					
2.	Working knowledge in accessing information through internet					
3.	Attended formal training in computer courses					
4.	Working knowledge on programming in computer					
5.	Developed softwares in agricultural technologies					

   b) Since how long you have been using computers? --------Years.

11. Following items show your rationality in decision making. In the five-point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in

between in the decreasing order show the degree of decrease in the level of time taken by you in decision making. Please choose your response by marking tick (√) in the suitable score:

S. no	Items	Scores				
		5	4	3	2	1
1.	I am quick in making decisions that are clear and rational					
2.	I am capable of looking at alternatives while taking decisions					
3.	I avoid decisions that seem unimportant					
4.	I recognise, analyse and evaluate problems on which decisions are to be taken					
5.	I take decisions independently without allowing others to influence					
6.	I put forth doubts and clarification even about minute aspects of schemes and extension programmes					

12. Following items show your source of information regarding technical aspects of your subject area. In the seven-point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given item. The scores in between in the decreasing order show the degree of decrease in the level of utilisation of information sources. Please choose your response by marking tick (√) in the suitable score:

S. no	Sources	Scores				
		5	4	3	2	1
1.	Own field experience					
2.	Research journals					
3.	Scientific Seminars/Symposia/ Conferences					
4.	News papers					
5.	Farm magazines					
6.	Television					
7.	Radio					
8.	Discussion with fellow officials/scientists					
9.	Trainings					
10.	Internet					
11.	Any other					

13. On getting information from various sources, do you make use of it in the following aspects:

a) For which crops you make use of the information? Please underline the crops given: Rice/ coconut/ banana/ other fruits/ vegetables/ spices/ medicinal plants/ others.

b) Following items show the level of utilisation of information regarding technical aspects of your subject area. In the five-point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of utilisation of information. Please choose your response by marking tick (√) in the suitable score:

S.no.	Items	Scores				
		5	4	3	2	1
1.	Characteristics of HYVs					
2.	Dose of manures and fertilizers					
3.	Weed management practices					
4.	Water management practices					
5.	Plant protection measures					
6.	Post harvest technologies					

14. How often do you communicate the technical information pertaining to the improved agricultural practices to the following personnel. Following items show the level of transfer of information regarding technical aspects of your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of transfer of information. Please choose your response by marking tick (√) in the suitable score:

S.no.	Personnel	Scores				
		5	4	3	2	1
1.	Fellow officials					
2.	Students					
3.	Subordinates					
4.	Farmers					
5.	Print					
6.	Television					
7.	Radio					
8.	Entrepreneurs					
9.	Any other					

15. How often do you provide the response, opinions, feelings, doubts, ideas, thoughts and comments on the improved agrl. practices to others? Following items show the level of your information feedback regarding technical aspects of your subject area. In the five point continuum '5 indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of your information feedback. Please choose your response by marking tick (√) in the suitable:

S.no.	Methods of information feed back	Scores				
		5	4	3	2	1
1.	Through publishing in farm magazines/dailies					
2.	Through personnel /official letters					
3.	Through phone calls					
4.	Through workshops/seminars					

16. Following items show the infrastructure facilities provided by your institution to refresh yourself in your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of facilities provided by your institution. Please choose your response by marking tick (√) in the appropriate column:

S.no	Items	Scores				
		5	4	3	2	1
1.	Do you have opportunities to undergo training on computer operations?					
2.	Whether your institution regularly arranges training to all of you?					
3.	Whether your office provides internet facilities to you to gather information on your subject area of interest?					
4.	Whether your institution arranges study tours, exhibitions, field visits to facilitate you to see and understand latest trend in scientific crop production & management?					
5.	Whether your organization conducts group discussions/seminars/workshops among scientists to provide information on latest developments in your subject area?					

17. Please tick the following based on your opinion on modern Information and Communication Technologies (ICT): Following items show the performance of modern Information and Communication Technologies. In the five point continuum '5' indicates "Strongly agree" and '1' indicates "Strongly disagree" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of your

agreement towards the performance of modern Information and Communication Technologies. Please choose your response by marking tick (√) in the appropriate column:

S.no	Items	Scores				
		5	4	3	2	1
1	ICT offers better opportunity for information access					
2	ICT has potential to store large volume of information					
3	ICT helps its users for decision making					
4	Self learning is possible through ICT					
5	ICT creates interest to learn the subject delivered through it					
6	Information gathered through ICT has got reliability and credibility					
7	ICT offers fast retrieval of information when compared to other sources					
8	Information gathered through ICT is more updated than other sources					

18. Please tick mark the columns given based on your opinion or preference for the following questions about the agricultural expert system you have come across. In the five-point continuum, '5' indicates 'I am most satisfied' and '1' indicates "I am not at all satisfied" to the corresponding statement. The scores in between in the decreasing order show the degree of decrease in your level of satisfaction.

S.no	Statements	Scores		
		5	4	3
1.	**Settings in the system:** a) The tutorial page provides complete guidance for the user to make use of the system.			
	b) The tutorial page can guide the user without any confusion			
	c) The tutorial page can retain the interest of the user in using the system further			
	d) The font size of the text is appropriate.			
	e) The pictures given in the system are appropriate to the subject given.			
	f) Colour combination of background, pictures and letters is appropriate.			
2.	**Retrievability:** a) The information provided in the system can be easily located by any user			
	b) The need based information can be received by the user with in less time			
	c) A common man can easily retrieve the needed information			
3.	**Servicability:** a) The system serves the needs of the users like researchers, teachers, students, extension personnel and farmers			
	b) The provided information is up to date			
	c) The provided information is need based			
	d) The system helps to find solutions to the specific problems related to the topic			
4.	**Relevancy:** a) The provided information is relevant to the user.			
	b) The system is able to provide information suitable to the users' resources.			
5.	**Practicability:** a) Provided information is practicable to the user.			
	b) Information provided in the system is feasible to the users' conditions.			
6.	**Information content:** a) Information is classified systematically			
	b) Supports easy learning			
	c) Provides complete information for decision making			
	d) Clarity of the messages given in the entire module			

	e) Message considers users resources			
	f) Attractive design and layout			
	g) Acceptable by the users			
	h) Provides reasons for the given solution			
	i) Sufficient and accurate information			
7.	**Information treatment:** a) Content coverage			
	b) Language used			
	c) Logical sequence of information			
	d) Use of scientific/technical terms			
	e) Time required to retrieve relevant information			
8.	**Mode of presentation:** a) Provides real time information			
	b) Emphasis of points with either bold or change of colour or font size of letters			
	c) Provides expert level recommendations understandable to the users			
	d) Provides an authentic learning situation similar to that is acquired directly from experimental data and real time examples			
	e) Icons in the home page are sufficient			
	f) Available features easily lead and direct the interaction effectively			
	g) Level of interactiveness of the system			
	h) Over all user friendliness of the system			
9.	**Provision for updating information:** a) Makes modification of knowledge base very conveniently			
	b) Has the ability to guide users to handle uncertain information			
	c) Can reach larger users			
10.	**Future Prospects:** a) AES will act as an efficient extension aid			
	b) It will be highly user friendly			
	c) It will strengthen the expertise of new human experts with minimum period because of the availability of combined effect of several human experts			
	d) It will provide greater support to take suitable decisions			
	e) Reduces the confusion and dilemma of taking decisions in farming			
	f) The system will be available at low cost			
	g) The cost of maintenance of the system will be nominal			
	h) It will be a supplementary and complementary extension tool for disseminating agricultural technologies			

19. Please give your over all assessment about the performance and potentials of the agricultural expert system. Please encircle the related score:

Highest Lowest

5 4 3 2 1

Thank you very much.

C

KERALA AGRICULTURAL UNIVERSITY
FACULTY OF AGRICULTURE
COLLEGE OF HORTICULTURE, VELLANIKKARA, THRISSUR

Title of the study: AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

Date:

1. Name:

2. Designation:

3. Address of the institution with e-mail and phone number:
4. Age:
5. Educational status: Graduation/Post graduation/PG Diploma/ Doctorate/ Post doctorate
6. Subject of specialisation if any:
7. Years of experience: -------- Research ------ Teaching ------- Extension-------
8. a) What is meant by an agricultural expert system?

   b) Please name the agricultural expert systems that you come across?

9. Please mention the trainings related to Information and Communication Technologies attended by you:

Sl.no	Name of the training	Name of training institution and place	Duration & year

10. a) Following items show your proficiency in computer operations. In the five-point continuum '5' indicates your highest proficiency and '1' indicates lowest proficiency in computers. The scores in between in the decreasing order show the degree of decrease in the level of your proficiency. Please choose your response by marking tick (✓) under the suitable score:

S.no	Items	Scores				
		5	4	3	2	1
1.	I have working knowledge on computer usage					
2.	I have working knowledge in accessing information through internet					
3.	I attend formal training in computer courses					
4.	I have working knowledge on programming in computer					
5.	I develop softwares in agricultural technologies					
6.	I assist to develop softwares in agricultural technologies					

b) How long you have been using computers? --------Years.

11. Following items show the performance of modern Information and Communication Technologies (ICT). In the five point continuum '5' indicates "Strongly agree" and '1' indicates "Strongly disagree" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of your agreement towards the performance of modern Information and Communication Technologies. Please choose your response by marking tick (✓) in the appropriate column:

S.no	Items	Scores				
		5	4	3	2	1
1	ICT offers better opportunity for information access					
2	ICT helps its users for decision making					
3	Self learning is possible through ICT					
4	ICT creates interest to learn the subject delivered through it					
5	Information gathered through ICT has got reliability and credibility					
6	Information gathered through ICT is more updated than other sources					

12. Following items show your rationality in decision making. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of taking time in decision making. Please choose your response by marking tick (✓) under the suitable score:

S. no	Items	Scores				
		5	4	3	2	1
1.	I am quick in making decisions that are clear and rational					
2.	I am capable of looking at alternatives while taking decisions					
3.	I avoid decisions that seem unimportant					
4.	I recognise, analyse and evaluate problems on which decisions are to be taken					
5.	I take decisions independently without allowing others to influence					
6.	I put forth doubts and clarification even about minute aspects of projects, schemes and extension programmes					

13. Following items show your source of information regarding technical aspects of your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of utilisation of information sources. Please choose your response by marking tick (✓) under the suitable score:

S. no	Sources	Scores				
		5	4	3	2	1
1.	Own field experience					
2.	Research journals					
3.	Scientific Seminars/Symposia/ Conferences					
4.	News papers					
5.	Farm magazines					
6.	Television					
7.	Radio					
8.	Discussion with fellow officials/scientists					
9.	Trainings					
10.	Internet					
11.	e-mails					
12.	Any other					

a) On getting information from various sources, do you make use of it in the following aspects:
For which crops you make use of the information? Please underline the crops given: Rice/ coconut/ banana/ other fruits/ vegetables/ spices/ medicinal plants/ others.

b) Following items show the level of utilisation of information regarding technical aspects of your subject area. In the five-point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of utilisation of information. Please choose your response by marking tick (✓) under the suitable score:

S.no.	Items	Scores				
		5	4	3	2	1
1.	Characteristics of HYVs					
2.	Dose of manures and fertilizers					
3.	Weed management practices					
4.	Water management practices					
5.	Plant protection measures					
6.	Post harvest technologies					

14. How often do you communicate the technical information pertaining to the improved agricultural practices to the following personnel. Following items show the level of transfer of information regarding technical aspects of your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of transfer of information. Please choose your response by marking tick (✓) under the suitable score:

S.no.	Personnel	Scores				
		5	4	3	2	1
1.	Fellow officials					
2.	Students					
3.	Subordinates					
4.	Farmers					
5.	Entrepreneurs					
6.	Print					
7.	Television					
8.	Radio					
9.	e-mails					
10.	Personal letters					
11.	Any other					

15. How often do you provide the response, opinions, feelings, doubts, ideas, thoughts and comments on the improved agricultural practices to others? Following items show the level of your information feedback regarding technical aspects of your subject area. In the five point continuum '5 indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of your information feedback. Please choose your response by marking tick (✓) under the suitable score:

S.no.	Methods of information feed back	Scores				
		5	4	3	2	1
1.	Through publishing in farm magazines/dailies					
2.	Through personnel /official letters					
3.	Through phone calls					
4.	Through workshops/seminars					
5.	Through e-mails					

16. Following items show the infrastructure facilities provided by your institution to refresh yourself in your subject area. In the five point continuum '5' indicates "Always" and '1' indicates "Never" in relation to each given items. The scores in between in the decreasing order show the degree of decrease in the level of facilities provided by your institution. Please choose your response by marking tick (✓) in the appropriate column:

S.no	Items	Scores				
		5	4	3	2	1
1.	Do you have opportunities to undergo training on computer operations?					
2.	Whether your institution regularly arranges training to all of you?					
3.	Whether your office provides internet facilities to you to gather information on your subject area of interest?					
4.	Whether your institution arranges study tours, exhibitions, field visits to facilitate you to see and understand latest trend in scientific crop production & management?					
5.	Whether your organization conducts group discussions/seminars/workshops among scientists to provide information on latest developments in your subject area?					

17. Please choose your answer by marking tick (✓) for the following questions. This is to test the ability of the agricultural expert system to provide information to you and not to test your knowledge:

1. What is the main precaution you recommend when there was a widespread occurrence of gallmidge during the last season?
a. Spray Acephate b. Avoid early transplantation c. Avoid late transplantation
d. Carry out the cultural operations at the right time

2. What is the dosage of Carbaryl to control BPH in rice?
a. 400g of 85S/ha b. 250g of 85S/ha c. 625g of 85S/ha d. 725g of 85S/ha

3. What is the ETL of rice bug during flowering stage of the crop?
a) 5 bugs / hill (b) 10 bugs / hill (c) 8 bugs / hill (d) 2 bugs / hill

4. Please choose the tolerant rice variety for gall midge attack:
a) Deepthi (b) Kumbham (c) Neeraja (d) Uma

5. The ETL for Tungro virus in rice is:
a) 1 affected hill / m^2 b) 2 affected hills / m^2 c) 3 affected hills / m^2
d) 4 affected hills / m^2

6. Pesticide application should be completed how many days before harvest?
a) 15 days b) 20 days c) 25 days d) 30 days

7. The tender leaf base and soft tissues of the crown in coconut palm rot into a mass of decayed material emitting a foul smell. This is accompanied by drooping of successive leaves. Please identify the problem:
a. Leaf rot b. Mahali c. Root wilt d. Bud rot

8. Stem bleeding is the problem identified in coconut palm. What do you recommend to control the disease?
a. Neem cake @5Kg/palm b. Bordeaux mixture-1% c. Tridemorph-1%
d. Mancozeb-4%

9. As a prophylactic measure for leaf eating caterpillar in coconut, which are the parasites to be released?

a) *Stenobracon sp.* (b) *Cotesia sp.* (c) *Goniozus sp.* (d) *Charops sp.*

10. What is the percentage of moisture content you recommend to store the copra without infestation of beetles?
a) 12 % b) 10 % c) 8 % d) 4 %

11. Which of the following condition will aggravate stem bleeding in coconut?
a) Heavy rains b) Cyclone c) Cracks on the trunk d) Nutrient deficiency

12. Please choose the less susceptible variety of banana to bunchy top disease:
a. Nendran b. Njalipoovan c. Palayankodan d. Karpooravally

13. Please choose the following to manage pseudostem weevil in banana:
a. Quinalphos- 0.05% b. Phorate-12.5g c. Carbofuran- 10g d. None of these

14. What is the preventive measure for aphids infestation in banana?
a. Neem cake @1Kg/plant b. Chlorpyrifos-0.03% c. Carbaryl- 0.02% d. Phorate- 12.5g

15. To prevent the attack of nematode in banana, what do you suggest?
a) Neem cake-1kg/plant b) Phorate 10 G c) Bordeaux mixture-1 % d) Tridemorph-0.05 %

18. Please list out the technological problems faced by you in the plant protection aspects of rice, banana and coconut and tick mark (✓) against the problems given by you under the five-point continuum. '5' indicates 'Most experienced' and '1' indicates 'Least experienced' to the corresponding problems. The scores in between in the decreasing order show the degree of decrease in the level of the problems experienced:

S. no	Problems	Continuum				
		5	4	3	2	1
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

III After exposure

Title of the study: AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

1. Name:

2. Just now you have participated in a demonstration of a module of Agricultural Expert System. Please tick (✓) mark the columns given based on your opinion or preference for the following questions about this module. In the five-point continuum, '5' indicates 'I am most satisfied' and '1' indicates "Not at all satisfied" to the corresponding statement. The scores in between in the decreasing order show the degree of decrease in your level of satisfaction.

S.no	Statements	Scores				
		5	4	3	2	1
1. a)	**Settings in the system:** The tutorial page provides complete guidance for the user to make use of the system without any confusion.					
b)	The tutorial page can retain the interest of the user in using the system further.					
c)	The font size of the headings is appropriate.					
d)	The font size of the text is appropriate.					
e)	The pictures given in the system are appropriate to the subject given.					
f)	Colour combination of background, pictures and letters is appropriate.					
2. a)	**Retrievability:** The information provided in the system can be easily located by any user.					
b)	The need based information can be received by the user with in less time.					
c)	The received information is easily understandable by the user.					
d)	The necessary information can be taken as print out for further reference.					
3. a)	**Servicability:** The system serves the needs of the users like researchers, teachers, students, extension personnel and farmers.					
b)	The provided information is up to date.					
c)	The provided information is need based.					
d)	The system helps to find solutions to the specific problems related to the topic.					
4. a)	**Relevancy:** Relevance of information about the plant protection measures.					
b)	The system is able to provide information suitable to the users resources.					
c)	Information provided in the system is appropriate to the users needs.					
5. a)	**Practicability:** Practicability of information about the plant protection measures.					
b)	Information provided in the system is adoptable in the real situation.					
c)	Information provided in the system is feasible to the users' conditions.					
6. a)	**Information content:** Provides complete information systematically for decision making.					
b)	Message considers users resources.					
c)	Acceptable by the users.					
d)	Provides reasons for the given solution.					
7. a)	**Information treatment:** Supports easy learning.					
b)	Language used is simple.					
c)	Scientific terms are presented in understandable form.					
d)	Clarity of the messages given in the entire module.					
e)	Attractive design and layout.					

8. a)	**Mode of information delivery:** Provides real time information.					
b)	Emphasis of points with either bold or change of colour or font size of letters.					
c)	Provides expert level recommendations understandable to the users.					
d)	Provides an authentic learning situation similar to that is acquired directly from experimental data and real time examples.					
e)	Icons in the home page are sufficient.					
f)	Available features easily lead and direct the interaction effectively.					
g)	Level of interactive ness of the system.					
h)	Over all user friendliness of the system.					
9. a)	**Future Prospects:** AES will act as an efficient extension aid.					
b)	It will be highly user friendly.					
c)	It will strengthen the expertise of new human experts with minimum period because of the availability of combined effect of several human experts.					
d)	It will provide greater support to take suitable decisions.					
e)	It will reduce the confusion and dilemma of taking decisions in farming.					
f)	The system will be available at low cost.					
g)	The cost of maintenance of the system will be nominal.					
h)	It will be a complementary extension tool for disseminating agricultural technologies.					
i)	Information will reach wider audience with in no time.					
10	Any other.					

3. Please choose your answer by marking tick (✓) for the following questions. This is to test the ability of the agricultural expert system to provide information to you and not to test your knowledge:

1. What is the main precaution you recommend when there was a widespread occurrence of gallmidge during the last season?
a. Spray Acephate b. Avoid early transplantation c. Avoid late transplantation
d. Carry out the cultural operations at the right time

2. What is the dosage of Carbaryl to control BPH in rice?
a. 400g of 85S/ha b. 250g of 85S/ha c. 625g of 85S/ha d. 725g of 85S/ha

3. What is the ETL of rice bug during flowering stage of the crop?
a) 5 bugs / hill (b) 10 bugs / hill (c) 8 bugs / hill (d) 2 bugs / hill
4. Please choose the tolerant rice variety for gall midge attack:
b) Deepthi (b) Kumbham (c) Neeraja (d) Uma

5. The ETL for Tungro virus in rice is:
b) 1 affected hill / m^2 b) 2 affected hills / m^2 c) 3 affected hills / m^2
d) 4 affected hills / m^2

6. Pesticide application should be completed how many days before harvest?
a) 15 days b) 20 days c) 25 days d) 30 days

7. The tender leaf base and soft tissues of the crown in coconut palm rot into a mass of decayed material emitting a foul smell. This is accompanied by drooping of successive leaves. Please identify the problem:
a. Leaf rot b. Mahali c. Root wilt d. Bud rot

8. Stem bleeding is the problem identified in coconut palm. What do you recommend to control the disease?
a. Neem cake @5Kg/palm b. Bordeaux mixture-1% c. Tridemorph-1%
d. Mancozeb-4%

9. As a prophylactic measure for leaf eating caterpillar in coconut, which are the parasites to be released?
a) *Stenobracon sp.* *(b) Cotesia sp.* *(c) Goniozus sp.* *(d) Charops sp.*

10. What is the percentage of moisture content you recommend to store the copra without infestation of beetles?
a)12 % b) 10 % c) 8 % d) 4 %

11. Which of the following condition will aggravate stem bleeding in coconut?
a) Heavy rains b) Cyclone c) Cracks on the trunk d) Nutrient deficiency

12. Please choose the less susceptible variety of banana to bunchy top disease:
a. Nendran b. Njalipoovan c. Palayankodan d. Karpooravally

13. Please choose the following to manage pseudostem weevil in banana:
a. Quinalphos- 0.05% b. Phorate-12.5g c. Carbofuran- 10g d. None of these

14. What is the preventive measure for aphids infestation in banana?
a. Neem cake @1Kg/plant b. Chlorpyrifos-0.03% c. Carbaryl- 0.02% d. Phorate- 12.5g

15. To prevent the attack of nematode in banana, what do you suggest?
a) Neem cake-1kg/plant b) Phorate 10 G c) Bordeaux mixture-1 % d) Tridemorph-0.05 %

4. Please give your perception about the problem solving capacity of the demonstrated agricultural expert system by marking tick (√) against the problems experienced by you: In the five-point continuum, '5' indicates 'Most sufficient' and '1' indicates 'Least sufficient' to the corresponding statement. The scores in between in the decreasing order show the degree of decrease in the level of sufficiency of solutions provided by the system.

S. no	Problems	Continuum				
		5	4	3	2	1
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

5. It is known that Agricultural Expert System (AES) has got potentials in transfer of technologies. Considering your experience in transfer of technology process, please indicate the degree of potentials as perceived by you in the form of tick mark (√) against the statements given about the agricultural expert system: In the five-point continuum, '5' indicates 'Most potential' and '1' indicates 'Least potential' to the corresponding statement. The scores in between in the decreasing order show the degree of decrease in the level of potential of agricultural expert system.

S. no	Items	Continuum				
		5	4	3	2	1
I	**AES strengthens TOT process**					
1.	It transfers knowledge from scientists to extension workers and farmers as and when necessary					
2.	Fills the knowledge gap between the expert and the user					
3.	Reduces the time gap of transferring technologies from scientists to farmers					
4.	Reduces the distortion of message in transfer of technologies from researchers to users					
II	**AES provides information support**					
1.	Helps the less experienced extension personnel or researchers by providing recommendations					
2.	Supports the farm advisory services extended by extension personnel					
3.	Provides requisite expertise on site when human expertise is scarce					
4.	Helps for easy retrieval of relevant information					
5.	Captures and preserves the expertise of retiring scientists					
6.	Assimilates the knowledge and experience of several human experts					
7.	Promotes sharing of knowledge					
8.	It clarifies and confirm doubtful information					
9.	Provides virtual visualization of field reality					
III	**AES promotes empowerment**					
1.	It builds the capacity of new human experts					
2.	Helps the farmer to remain competitive by providing need based information					
3.	Provision of need based information to extension personnel reduces dependence on subject matter specialists/ human experts					
4.	Provision of need based information builds confidence among users					
5.	Empowering the users with adequate knowledge					
6.	Increases the professional efficiency of the users					
IV	**AES helps to solve field problems**					
1.	It helps to diagnose and solve field problems at the right time					
2.	It helps to choose appropriate technology					
3.	Provides adequate data base on specific technologies					
4.	In solving the problems, it considers basic needs and resources of the farmers					
V	**AES supports to increase farm income**					
1.	Increases food production and farm income by providing suitable information at the right time					
2.	Provides better opportunity for better price by providing appropriate information at right time					
VI	Any other					

Thank you very much.

9. താഴെക്കൊടുത്തിട്ടുള്ള കാര്യങ്ങൾ നിങ്ങളുടെ കമ്പ്യൂട്ടർ പ്രവർത്തന പ്രാവീണ്യത്തെ കാണിക്കുന്നു. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എന്ന സംഖ്യ ഏറ്റവും പ്രാവീണ്യമുള്ളതിനെയും, '1' എന്നത് തീരെ പ്രാവീണ്യമില്ലാത്തതിനെയും കാണിക്കുന്നത്. കുറഞ്ഞുവരുന്ന സംഖ്യകൾ കമ്പ്യൂട്ടർ പ്രവർത്തന പ്രാവീണ്യം കുറഞ്ഞുവരുന്നതിനേയാണ് കാണിക്കുന്നത്. അനുയോജ്യമായ സ്കോറുകൾക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	കാര്യം	സ്കോറുകൾ				
		5	4	3	2	1
1.	കമ്പ്യൂട്ടർ ഉപയോഗത്തിൽ പ്രവർത്തന പരിജ്ഞാനമുണ്ട്					
2.	ഇന്റർനെറ്റിലൂടെ വിവരം ആർജ്ജിക്കന്നതിൽ പ്രവർത്തനപരിജ്ഞാനമുണ്ട്					
3.	കമ്പ്യൂട്ടർ കോഴ്സിൽ ഔദ്യോഗികമായി പരിശീലനം നേടിയിട്ടുണ്ട്					
4.	കമ്പ്യൂട്ടർ പ്രോഗ്രാമിങ്ങിൽ പ്രവർത്തന പരിജ്ഞാനമുണ്ട്					
5.	കാർഷിക സാങ്കേതികതയ്ക്കാവശ്യമായ സോഫ്റ്റ വെയറുകൾ ഞാൻ വികസിപ്പിച്ചിട്ടുണ്ട്					
6.	കാർഷിക സാങ്കേതിക സോഫ്റ്റ് വെയറുകൾ വികസിപ്പിക്കുന്നതിന് ഞാൻ സഹായിച്ചിട്ടുണ്ട്					

b) എത്രകാലമായി നിങ്ങൾ കമ്പ്യൂട്ടറുകൾ ഉപയോഗിക്കുന്നു?

________ വർഷങ്ങൾ

10. താഴെക്കൊടുത്തിട്ടുള്ള കാര്യങ്ങൾ ആധുനിക വിവര ആശയ വിനിമയ സാങ്കേതികതകളുടെ പ്രകടനങ്ങൾ കാണിക്കുന്നു. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എന്നത് ശക്തമായി അംഗീകരിക്കുന്നു എന്നും '1' എന്നത് ശക്തമായി വിയോജിക്കുന്നു എന്നതും കാണിക്കുന്നു. ഇടയ്ക്കുള്ള അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ ഇവയുടെ പ്രകടന ശേഷി കുറഞ്ഞുവരുന്നതിനോടുള്ള നിങ്ങളുടെ യോജിപ്പ് കാണിക്കുന്നു. അനുയോജ്യമായ കളങ്ങളിൽ '✓' രേഖപ്പെടുത്തുക.

D

കേരളകാർഷിക സർവ്വകലാശാല
കാർഷിക വിഭാഗം
ഹോർട്ടികൾച്ചർ കോളേജ്, വെള്ളാനിക്കര, തൃശ്ശൂർ

പഠനവിഷയം : കാർഷിക വിദഗ്ധ ശൃംഖല – ഒരു പങ്കാളിത്താവലോകനം

1. പേര് :
2. വയസ്സ്
3. മേൽവിലാസം :
4. വിദ്യാഭ്യാസ നിലവാരം : എസ്.എസ്.എൽ.സി/ബിരുദം/ ബിരുദാനന്തര ബിരുദം/ പി. ജി.ഡിപ്ലോമ
5. ഐഛിക വിഷയം (ഉണ്ടെങ്കിൽ) :
6. അനുഭവ പരിചയം : ഗവേഷണം :
   അധ്യാപനം :
   വിഞ്ജാപനവ്യാപനം :

7. a) കാർഷിക വിദഗ്ധ ശൃംഖല എന്നാലെന്താണുദ്ദേശിക്കുന്നത് ?

b) നിങ്ങൾക്ക് മുൻപരിചിതമായ കാർഷിക വിദ്ഗ്ധ ശൃംഖലകളുടെ പേരെഴുതുക :

8. കഴിഞ്ഞ വർഷങ്ങൾക്കുള്ളിൽ നിങ്ങൾ പങ്കെടുത്തിട്ടുള്ള വിവര ആശയ വിനിമയ സാങ്കേതിക സംബന്ധമായ പരിശീലനങ്ങൾ പരിപാടികൾ വിശദമാക്കുക.

ക്രമസംഖ്യ	പരിശീലനത്തിന്റെ പേര്	സ്ഥാപനത്തിന്റെ പേരും സ്ഥലവും	കാലാവധി

ക്രമനമ്പർ	കാര്യങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	വിവരമാർജ്ജിക്കാൻ ICT കൾ കൂടുതൽ അവസരങ്ങൾ നൽകുന്നു					
2.	ICT കൾ തീരുമാനങ്ങളെടുക്കുന്നതിന് ഉപഭോക്താക്കളെ സഹായിക്കുന്നു.					
3.	ICT മുഖേന സ്വയം പഠനം സാധ്യമാകും					
4.	ICT പകർന്നു തരുന്ന വിഷയങ്ങൾ പഠിക്കാൻ താത്പര്യമുളവാക്കുന്നു.					
5.	ICT മുഖേന ലഭിക്കുന്ന വിവരങ്ങൾ കൂടുതൽ വിശ്വസനീയവും ആശ്രയിക്കാൻ സാധിക്കുന്നതുമാണ്					
6.	ICT മുഖേന ലഭിക്കുന്ന വിവരങ്ങൾ മറ്റു സ്രോതസ്സുകളേക്കാൾ ആനുകാലികമാണ്					

11. താഴെക്കൊടുത്തിട്ടുള്ള കാര്യങ്ങൾ നിങ്ങളുടെ യുക്തിപൂർവ്വമായി തീരുമാനങ്ങളെടുക്കുന്ന കഴിവിനെ കാണിക്കുന്നു. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എപ്പോഴും എന്നും '1' ഒരിക്കലുമില്ല എന്നും സൂചിപ്പിക്കുന്നു. അവരോഹണക്രമ സംഖ്യകൾ തീരുമാനമെടുക്കുന്നതിനാവശ്യമായ സമയം കുറഞ്ഞുവരുന്നതിനെ കാണിക്കുന്നു. അനുയോജ്യമായ കളങ്ങളിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	കാര്യങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	നീതിയുക്തവും വ്യക്തവുമായ തീരുമാനങ്ങൾ ഞാൻ ദ്രുതഗതിയിൽ എടുക്കാറുണ്ട്					
2.	തീരുമാനങ്ങളെടുക്കുമ്പോൾ മറ്റുസാധ്യതകളെപ്പറ്റിയും ഞാൻ ആലോചിക്കാറുണ്ട്					
3.	അപ്രധാന തീരുമാനങ്ങൾ ഞാൻ ഒഴിവാക്കാറുണ്ട്					
4.	തീരുമാനമെടുക്കേണ്ട വിഷയങ്ങളെപ്പറ്റി ഞാൻ തിരിച്ചറിയുകയും വിശകലനം നടത്തുകയും വിലയിരുത്തുകയും ചെയ്യാറുണ്ട്					
5.	മറ്റുള്ളവരുടെ സ്വാധീനങ്ങളെ പരിഗണിക്കാതെ ഞാൻ സ്വതന്ത്രമായി തീരുമാനങ്ങൾ എടുക്കാറുണ്ട്					
6.	വിഷയങ്ങൾ, സ്കീമുകൾ, വിജ്ഞാനവ്യാപന പരിപാടികൾ തുടങ്ങിയവയിലെ നിസ്സാര സംശയങ്ങൾ പോലും ഞാൻ വ്യക്തമാക്കാറുണ്ട്					

12. താഴെക്കൊടുത്തിട്ടുള്ള കാര്യങ്ങൾ നിങ്ങളുടെ വിഷയമേഖലയുടെ സാങ്കേതിക വശങ്ങളെപ്പറ്റിയുള്ള വിവരസ്രോതസ്സുകളെ സംബന്ധിച്ചതാണ്. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എപ്പോഴും എന്നും '1' ഒരിക്കലുമില്ല എന്നും സൂചിപ്പിക്കുന്നു. അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ അത്തരത്തിലുള്ള വിവരസ്രോതസ്സുകളെ നിങ്ങൾ കുറച്ച് മാത്രം ആശ്രയിക്കുന്നതായി കാണിക്കുന്നു. അനുയോജ്യമായ കളങ്ങളിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	സ്രോതസ്സുകൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	സ്വന്തം അനുഭവങ്ങൾ					
2.	ഗവേഷണ ജേർണലുകൾ					
3.	ശാസ്ത്രീയ സെമിനാറുകൾ/ സിമ്പോസിയം/ കോൺഫറൻസുകൾ					
4.	പത്രങ്ങൾ (വർത്തമാനപത്രം)					
5.	കൃഷി മാഗസിനുകൾ					
6.	ടെലിവിഷൻ					
7.	റേഡിയോ					
8	പരിശീലനങ്ങൾ					
9.	ഇന്റർനെറ്റ്					
10	ഇമെയിൽ					
11	മറ്റെന്തെങ്കിലും					

a. വിവിധ സ്രോതസ്സുകളിൽ നിന്ന് വിവിധ വിവരങ്ങൾ ശേഖരിച്ച് അത് താഴെപ്പറഞ്ഞ ഏതെങ്കിലും വസ്തുക്കൾക്കായി ഉപയോഗിക്കാറുണ്ടോ? ഏതെല്ലാം വിളകൾക്കാണ് നിങ്ങൾ ഈ വിവരങ്ങൾ പ്രയോജനപ്പെടുത്തുന്നത്? നെല്ല്/ തെങ്ങ്/ വാഴ/മറ്റു പഴങ്ങൾ/ പച്ചക്കറികൾ/ സുഗന്ധവ്യഞ്ജനങ്ങൾ/ മരുന്നു ചെടികൾ/ മറ്റെന്തെങ്കിലും.

13. താഴെകൊടുത്തിരിക്കുന്ന കാര്യങ്ങൾ നിങ്ങളുടെ വിഷയത്തിനെക്കുറിച്ചുള്ള സാങ്കേതിക വിവരങ്ങൾ ലഭിക്കാൻ നിങ്ങൾ വിവരസ്രോതസ്സുകളെ എങ്ങനെ ഉപയോഗപ്പെടുത്തുന്നു എന്നറിയാനാണ്. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എപ്പോഴും എന്നും '1' ഒരിക്കലുമില്ല എന്നും സൂചിപ്പിക്കുന്നു. അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ വിവരം വളരെ കുറവായതോതിൽ മാത്രം ഉപയോഗപ്പെടുത്തുന്നു എന്ന് കാണിക്കുന്നു. അനുയോജ്യമായ കളങ്ങളിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	കാര്യങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	അത്യുല്പാദനശേഷിയുള്ള വിളകളുടെ സ്വഭാവഗുണങ്ങൾ					
2.	വളങ്ങളുടെ തോത്					
3.	കളനിയന്ത്രണ മാർഗ്ഗങ്ങൾ					
4.	ജലവിനിയോഗ മാർഗ്ഗങ്ങൾ					
5.	വിളസംരക്ഷണ മാർഗ്ഗങ്ങൾ					
6.	വിളവെടുപ്പിനുശേഷമുള്ള സാങ്കേതിക വശം					
7.	വിപണനം					

14. മെച്ചപ്പെട്ട കാർഷിക പണികളെപ്പറ്റിയുള്ള സാങ്കേതിക വിവരങ്ങളെക്കുറിച്ച് നിങ്ങൾ താഴെ കാണിച്ചിട്ടുള്ളവരുമായി എത്ര തവണ ബന്ധപ്പെടാറുണ്ട്? നിങ്ങളുടെ വിഷയത്തിന്റെ സാങ്കേതിക വശങ്ങളെപ്പറ്റി വിവരങ്ങൾ കൈമാറുന്നതാണ്. താഴെ പ്രതിപാദിച്ചിട്ടുള്ളവ. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എപ്പോഴും എന്നും '1' ഒരിക്കലുമില്ല എന്നും സൂചിപ്പിക്കുന്നു. അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ വിവരങ്ങൾ കൈമാറുന്ന തോത് കുറഞ്ഞുവരുന്നതിനെ കാണിക്കുന്നു. അനുയോജ്യമായ കളങ്ങളിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	വ്യക്തി/ മാധ്യമങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	പ്രമുഖ ഉദ്യോഗസ്ഥർ					
2.	ശാസ്ത്രജ്ഞർ					
3.	വിദ്യാർത്ഥികൾ					
4.	തൊഴിലാളികൾ					
5.	സംരഭകർ					
6.	പ്രിന്റ് മീഡിയ					
7.	ടെലിവിഷൻ					
8.	റേഡിയോ					
9.	ഇമെയിൽ					
10.	അനൗദ്യോഗിക/ സ്വകാര്യ കത്തുകൾ					
11.	എൻ. ജി. ഒ/ സന്നദ്ധസംഘടനകൾ/ സഹകരണസ്ഥാപനങ്ങൾ					
12.	മറ്റെന്തെങ്കിലും					

15. നിങ്ങൾ ഇടക്കിടെ മികച്ച കാർഷിക പ്രവൃത്തികളെപ്പറ്റി മറ്റുള്ളവർക്ക് അഭിപ്രായങ്ങൾ, മറുപടികൾ, അനുഭവങ്ങൾ, സംശയങ്ങൾ, ചിന്താഗതികൾ, ആശയങ്ങൾ, എന്നിവ നൽകാറുണ്ടോ? താഴെ കൊടുത്തിട്ടുള്ള കാര്യങ്ങൾ നിങ്ങളുടെ വിഷയസാങ്കേതിക വശങ്ങളെപ്പറ്റിയുള്ള പ്രതികരണം കാണിക്കുന്നു. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എപ്പോഴും എന്നും '1' ഒരിക്കലുമില്ല എന്നും സൂചിപ്പിക്കുന്നു. അനുയോജ്യമായ കളങ്ങളിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	വിവരങ്ങൾ പ്രതികരണം ചെയ്യുന്ന രീതി	സ്കോറുകൾ				
		5	4	3	2	1
1.	കൃഷി സംബന്ധ മാഗസിനുകളിലോ ദിനപ്പത്രങ്ങളിലോ പ്രസിദ്ധീകരിക്കും					
2.	കത്തുകൾ മുഖേന					
3.	ഫോൺകോൾ മുഖേന					
4.	ശില്പശാലകൾ, സെമിനാറുകൾ മുഖേന					
5.	ഇ മെയിൽ മുഖേന					

16. താഴെ കൊടുത്തിട്ടുള്ള കാര്യങ്ങൾ നിങ്ങളുടെ അറിവു പുതുക്കുന്നതിനായി നിങ്ങളുടെ കൃഷിഭവൻ/പഞ്ചായത്ത്എന്തെല്ലാം സൗകര്യങ്ങൾ ചെയ്തു തരുന്നു എന്നു കാണിക്കുന്നു. അഞ്ചക്കത്തുടർച്ചയിൽ '5' എപ്പോഴും എന്നും '1' ഒരിക്കലുമില്ല എന്നും സുചിപ്പിക്കുന്നു. അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ കാണിക്കുന്നത് സ്ഥാപനങ്ങൾ വളരെ കുറച്ചു മാത്രം സൗകര്യങ്ങളേ തരുന്നുള്ളു എന്നാണ്. അനുയോജ്യമായ കളങ്ങളിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക.

ക്രമനമ്പർ	കാര്യങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	കമ്പ്യൂട്ടർ പ്രവർത്തനങ്ങളെപ്പറ്റിയുള്ള പരിശീലനങ്ങളിൽ പങ്കെടുക്കാനുള്ള അവസരം ലഭിച്ചിട്ടുണ്ടോ?					
2.	നിങ്ങളുടെ കൃഷിഭവൻ/പഞ്ചായത്ത് തുടർച്ചയായി പരിശീലനങ്ങൾ സംഘടിപ്പിക്കാറുണ്ടോ?					
3.	നിങ്ങൾക്കാവശ്യമായ വിഷയങ്ങളെപ്പറ്റി കൂടുതൽ വിവരങ്ങൾ ലഭിക്കാനായി ഇന്റർനെറ്റ് സൗകര്യം ഓഫീസിൽ ലഭിക്കുന്നുണ്ടോ?					
4.	ശാസ്ത്രീയ കൃഷിരീതിയിലും നോക്കി നടത്തിപ്പിലും ഉള്ള പുതിയ കാര്യങ്ങൾ കാണാനും മനസ്സിലാക്കാനും പഠനയാത്രകളും, എക്സിബിഷനുകളും, കൃഷിയിട സന്ദർശനങ്ങളും മറ്റും നിങ്ങളുടെ സ്ഥാപനം സംഘടിപ്പിക്കാറുണ്ടോ?					
5.	നിങ്ങളുടെ വിഷയത്തിലെ നൂതന വികാസങ്ങളെപ്പറ്റി അറിയാൻ നിങ്ങളുടെ കൃഷിഭവൻ/പഞ്ചായത്ത് എന്തെങ്കിലും ഗ്രൂപ്പ് ചർച്ചകളോ സെമിനാറുകളോ, ശില്പശാലകളോ നിങ്ങൾക്കിടയിൽ നടത്താറുണ്ടോ?					

17. താഴെക്കൊടുത്തിട്ടുള്ള ചോദ്യങ്ങൾക്ക് ഉത്തരം തെരഞ്ഞെടുക്കുക. ഇത് നിങ്ങളുടെ അറിവ് പരിശോധിക്കാനല്ല മറിച്ച് കാർഷിക വിദഗ്ധ ശൃംഖലക്ക് നിങ്ങൾക്കാവശ്യമായ വിവരങ്ങൾ തരാനുള്ള കഴിവുണ്ടോ എന്ന് പരിശോധിക്കാനാണ്

ഗാളീച്ച സാധ്യത അതിവ്യാപകമായി ഉണ്ടാകുമ്പോൾ നിങ്ങൾ നിർദ്ദേശിക്കുന്ന പ്രധാന മുൻകരുതൽ എന്താണ്?

a) അസഫേറ്റ് തളിക്കുക b) മുപ്പെത്തും മുമ്പേയുള്ള പറിച്ചു നടൽ തടയുക
c) വൈകി പറിച്ചു നടാതിരിക്കുക d) ശരിയായ സമയത്ത് വേണ്ട കൃഷിപ്പണികൾ ചെയ്യുക.

നെല്ലിലെ മുഞ്ഞയെ തടയാൻ വേണ്ട കാർബാറിലിന്റെ അളവ് ?

a) 855 S/ha ന്റെ 450 ഗ്രാം, b) 855 S/ ha ന്റെ 250 ഗ്രാം,
c) 855 S/ ha ന്റെ 625 ഗ്രാം, d) 855 S/ ha ന്റെ 725 ഗ്രാം

നെല്ല് പൂവിടുന്ന സമയത്ത് നെൽച്ചാഴിയുടെ ETL എത്ര?

a) ഒരു നുരിയിൽ 5 ചാഴി, b) ഒരു നുരിയിൽ 10 ചാഴി,
c) ഒരു നുരിയിൽ 8 ചാഴി, d) ഒരു നുരിയിൽ 2 ചാഴി.

ഗാളീച്ചയുടെ ആക്രമണം ചെറുക്കുന്ന നെല്ലിനം.

a) ദീപ്തി b) കുംഭം c) നീരജ d) പവിത്ര

5. നെല്ലിൽ തുംഗ്രോവൈറസിന്റെ ETL എത്ര?

a) 1 ചതുരശ്രമീറ്ററിൽ 1 വൈറസ് ബാധയുള്ള നുരി

b) 1 ചതുരശ്രമീറ്ററിൽ 2 വൈറസ് ബാധയുള്ള നുരികൾ

c) 1 ചതുരശ്രമീറ്ററിൽ 3 വൈറസ് ബാധയുള്ള നുരികൾ

d) 1 ചതുരശ്രമീറ്ററിൽ 4 വൈറസ് ബാധയുള്ള നുരികൾ

6. നെല്ല് വിളവെടുക്കുന്നതിന് എത്ര ദിവസം മുൻപ് കീടനാശിനി തളിക്കുന്നത് അവസാനിപ്പിക്കണം?

a) 15 ദിവസങ്ങൾ b) 20 ദിവസങ്ങൾ c) 25 ദിവസങ്ങൾ d) 30 ദിവസങ്ങൾ

7. തെങ്ങിന്റെ തളിരോലയുടെ കടഭാഗവും, മുകൾഭാഗത്തെ മൃദുവായ ഭാഗങ്ങളും ചീഞ്ഞളിഞ്ഞ് ദുർഗന്ധം വരുന്നു. പുറമേയുള്ള ഓലകൾ ഒടിഞ്ഞു തൂങ്ങുന്നു. ഇതേത് രോഗമാണ്?

a) ഓലചീയൽ b) മഹാളി c) കാറ്റുവീഴ്ച d) കൂമ്പ് ചീയൽ.

8. തെങ്ങിൽ സാധാരണയായി കാണുന്ന ചെന്നീരൊലിപ്പിന് നിങ്ങൾ ഏത് മരുന്ന് ഉപയോഗിക്കും?

a) തെങ്ങൊന്നിന് 5 കി. ഗ്രാം വേപ്പിൻ പിണ്ണാക്ക് b) 1% ബോർഡോ മിശ്രിതം

c) 1% ട്രൈഡിമോർഫ് d) 4% മാൻഗോസെബ്.

9. തെങ്ങിൽ ഇലതീനിപ്പുഴുക്കൾ വരാതിരിക്കാനായി ഏതു പരാദങ്ങളെയാണ് ഉപയോഗിക്കേണ്ടത്?

a) സ്റ്റിനോബ്രാക്കോൺ b) കോട്ടീസിയ c) ഗോണിയോസസ് d) ചാരോപ്സ്

10. വണ്ടാക്രമണം ഇല്ലാതെ കൊപ്രസംരക്ഷിക്കാൻ വേണ്ട ഈർപ്പം എത്രയെന്നാണ് നിങ്ങളുടെ നിർദ്ദേശം?

a) 12% b) 10% c) 8% d) 4%

11. തെങ്ങിലെ ചെന്നീരൊലിപ്പ് കൂട്ടുന്ന സ്ഥിതി ഏതാണ്?

a) കടുത്ത മഴ b) ചുഴലിക്കാറ്റ് c) തടിയിലെ വിള്ളലുകൾ d) മൂലകക്കുറവ്

12. വാഴയിലെ ഏതിനത്തെയാണ് കുമ്പടപ്പ് രോഗം അധികം ബാധിക്കാത്തത്?

a) നേന്ത്രൻ b) ഞാലിപ്പൂവൻ c)പാളയം കോടൻ d) കർപ്പൂരവള്ളി.

13. വാഴപ്പിണ്ടിപ്പുഴുവിനെ നിയന്ത്രിക്കാൻ അനുയോജ്യമായ കീടനാശിനി?

a) 0.05% ക്വിനാൽഫോസ് b) 12.5 ഗ്രാം ഫോറേറ്റ്

c) 10 ഗ്രാം കാർബോഫുറാൻ d) ഇവയൊന്നുമല്ല.

14. വാഴയിലെ നീരൂറ്റിക്കുടിക്കുന്ന പേനുകളെ നിയന്ത്രിക്കാനുള്ള മാർഗ്ഗം

a) 1 കിലോ വേപ്പിൻ പിണ്ണാക്ക് ഓരോ ചെടിക്കും b) 0.03% ക്ലോർപൈറിഫോസ്

c) 0.02% കാർബാറിൽ d) 12.5 ഗ്രാം ഫോറേറ്റ്

15. വാഴയിലെ നിമാ വിരകളുടെ ആക്രമണം തടയാനായി നിങ്ങൾ എന്തു നിർദ്ദേശിക്കും?

a) 1 ചെടിക്ക് 1 കിലോ വേപ്പിൻപിണ്ണാക്ക് b) 10 G ഫോറേറ്റ്

c) 1% ബോർഡോമിശ്രിതം d) 0.05% ട്രൈഡിമോർഫ്.

18 വാഴ, തെങ്ങ് എന്നിവയിലെ വിളസംരക്ഷണ മാർഗ്ഗങ്ങളിൽ നിങ്ങൾ നേരിടുന്ന സാങ്കേതിക പ്രശ്നങ്ങളുടെ പേരെഴുതുക. അഞ്ചക്കത്തുടർച്ചാ സ്കെയിലിൽ '✓'മാർക്ക് രേഖപ്പെടുത്തുക. '5' അധികം അനുഭവപ്പെടുന്നു എന്നും '1 'വളരെക്കുറച്ച് അനുഭവപ്പെടുന്നു എന്നും കാണിക്കുന്നു. അവരോഹണക്രമം കുറവായി അനുഭവപ്പെട്ടു വരുന്ന തോതിനെ കാണിക്കുന്നു.

ക്രമനമ്പർ	പ്രശ്നങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.						
2.						
3						
4						
5						
6						
7						
8						
9						
10						

II. പരിചയപ്പെടുത്തലിനുശേഷം

പഠന വിഷയം : കാർഷിക ശൃംഖല – ഒരു പങ്കാളിത്താവലോകനം

1. പേര് :

2. കാർഷിക വിദഗ്ധശൃംഖലയുടെ ഈയൊരു പ്രദർശന മൊഡ്യൂളിൽ നിങ്ങൾ പങ്കെടുത്തല്ലോ. ഈ മൊഡ്യൂളിനെപ്പറ്റി താഴെകൊടുത്തിട്ടുള്ള ചോദ്യങ്ങളിൽ നിങ്ങളുടെ അഭിപ്രായം / താത്പര്യം അനുസരിച്ച് '✓' മാർക്ക് രേഖപ്പെടുത്തുക. ഈ അഞ്ചക്കത്തുടർച്ചയിൽ 5 ഞാൻ വളരെ തൃപ്തനാണ് എന്നും 1 തീരെ തൃപ്തിയില്ല എന്നും കാണിക്കുന്നു. അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ തൃപ്തി കുറഞ്ഞു വരുന്നതിനെ കാണിക്കുന്നു.

ക്രമം	സ്വഭാവഗുണങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	ക്രമീകരണം:					
a)	പരിശീലന പേജ് ഉപഭോക്താവിന് ഒരു പരിഭ്രമവും കൂടാതെ ഉപയോഗിക്കാൻ വേണ്ട മുഴുവൻ നിർദ്ദേശങ്ങളും നൽകുന്നു.					
b)	പരിശീലന പേജ് ഉപഭോക്താവിന് വീണ്ടും ഉപയോഗിക്കാനുള്ള താത്പര്യം നിലനിർത്താൻ സഹായിക്കുന്നു					
c)	തലവാചകങ്ങളുടെ അക്ഷരങ്ങളുടെ വലുപ്പം തികച്ചും അനുയോജ്യമാണ്					
d)	ബോഡിയിലുള്ള അക്ഷരങ്ങളും അനുയോജ്യമായ വലുപ്പത്തിലാണ്					
e)	വിഷയത്തിനനുയോജ്യമായ ചിത്രങ്ങളാണ് / ദൃശ്യങ്ങളാണ് ഇതിൽ കൊടുത്തിരിക്കുന്നത്					
f)	അക്ഷരങ്ങളുടേയും, ദൃശ്യങ്ങളുടെയും, പശ്ചാത്തലത്തിന്റേയും നിറവിന്യാസം വളരെ അനുയോജ്യമാണ്					
2.	കണ്ടെത്താനുള്ള സൗകര്യം					
a)	ഈ സമ്പ്രദായത്തിൽ കൊടുത്തിട്ടുള്ള വിവരങ്ങൾ ഉപഭോക്താവിന് എളുപ്പത്തിൽ കണ്ടെത്താം					
b)	ആവശ്യാനുസൃത വിവരങ്ങൾ ഉപഭോക്താവിന് ചുരുങ്ങിയ സമയത്തിൽ ലഭിക്കും					
3.	ഉപയോഗക്ഷമത					
a)	ഗവേഷകർ, അധ്യാപകർ, വിദ്യാർത്ഥികൾ, വിജ്ഞാനവ്യാപന ഉദ്യോഗസ്ഥർ, കർഷകർ, തുടങ്ങിയ എല്ലാ ഉപഭോക്താക്കളുടേയും ആവശ്യങ്ങൾ ഈ സമ്പ്രദായം കൊണ്ട് നിറവേറ്റാനാകും					
b)	ഈ സമ്പ്രദായം മുഖേന ആനുകാലിമായ വിവരങ്ങൾ ലഭിക്കുന്നു.					
c)	ആവശ്യാനുസൃതമായ വിവരങ്ങൾ ഇവ നൽകുന്നു					
d)	വിഷയത്തെക്കുറിച്ചുള്ള പ്രത്യേക പ്രശ്നങ്ങൾക്കു പോലുള്ള പരിഹാരങ്ങൾ ഇതു വഴി കണ്ടെത്താവുന്നതാണ്.					
4.	പ്രസക്തി					
	വിളസംരക്ഷണ മാർഗ്ഗങ്ങൾ വളരെ പ്രസക്തമാണ്					
5.	പ്രായോഗികത					
	വിള സംരക്ഷണ മാർഗ്ഗങ്ങളെപ്പറ്റിയുള്ള വിവരങ്ങൾ വളരെ പ്രാവർത്തികമാണ്					
6.	ഉള്ളടക്കം					
a)	തീരുമാനങ്ങളെടുക്കാനാവശ്യമായ വിവരങ്ങൾ മുഴുവനായും വളരെ ക്രമമായും ലഭിക്കുന്നു.					
b)	ഉപഭോക്താക്കളുടെ വിവര ലഭ്യതയ്ക്കനുസൃതമായ വിവരങ്ങൾ നൽകുന്നു.					
c)	ഉപഭോക്താക്കൾക്ക് വളരെ സ്വീകാര്യമാണീ വിവരങ്ങൾ					
d)	പ്രശ്ന പരിഹാരത്തിന് വേണ്ട കാരണങ്ങളും വ്യക്തമാക്കുന്നു.					
7.	വിവര പരിചരണം					
a)	എളുപ്പത്തിലുള്ള പഠനത്തിന് സഹായിക്കുന്നു.					
b)	വളരെ ലളിതമായ ഭാഷ ഉപയോഗിച്ചിരിക്കുന്നു					
c)	ശാസ്ത്രീയ പദങ്ങൾ മനസ്സിലാക്കാവുന്ന രീതിയിൽ അവതരിപ്പിച്ചിരിക്കുന്നു.					
d)	മൊഡ്യൂളിലുള്ള സന്ദേശങ്ങൾ വളരെ വ്യക്തമായി കൊടുത്തിരിക്കുന്നു.					
e)	വളരെ ആകർഷകമായി രൂപകൽപന ചെയ്തിരിക്കുന്നു					
8.	വിവരങ്ങൾ കൈമാറുന്ന രീതി					
a)	യഥാർത്ഥ / കാലത്തിനനുസൃതമായ വിവരങ്ങൾ നൽകുന്നു					

3. സാങ്കേതിക പരിജ്ഞാനം കൈമാറ്റം ചെയ്യുന്നതിൽ കാർഷിക വിദഗ്ധ ശൃംഖലയ്ക്ക് കഴിവുണ്ടെന്ന് അറിവുള്ളതാണ്. നിങ്ങളുടെ ഈ വിഷയത്തിലുള്ള അനുഭവം വെച്ച് ഈ ശൃംഖലയുടെ കഴിവിനെ ✓ മാർക്ക് നൽകി രേഖപ്പെടുത്തുക. അഞ്ചക്ക തുടർച്ചയിൽ 5 ഏറ്റവും കഴിവുള്ളത് എന്നും 1 തീരെ കഴിവില്ലാത്തത് എന്നും കാണിക്കുന്നു. ഇടയിലുള്ള സ്കോറുകൾ അവരോഹണക്രമത്തിൽ ഈ ശൃംഖലയുടെ കഴിവുകേടിനെ സൂചിപ്പിക്കുന്നു.

ക്രമ നമ്പർ	കഴിവുകൾ	സ്കോറുകൾ				
		5	4	3	2	1
1.	കാർഷിക വിദഗ്ധ ശൃംഖല വിവരസാങ്കേതികത കൈമാറുന്നതിനെ ത്വരിതപ്പെടുത്തുന്നു					
a)	ഇത് ശാസ്ത്രജ്ഞരുടെ അറിവിനെ വിജ്ഞാന വ്യാപകരിലേയ്ക്കും തുടർന്ന് കർഷകരിലേയ്ക്കും ആവശ്യാനുസരണം കൈമാറുന്നതിന് സഹായിക്കുന്നു					
b)	വിദഗ്ധർക്കും ഉപഭോക്താക്കൾക്കുമിടയിലുള്ള അറിവിന്റെ അകലം നികത്തുന്നു					
c)	ശാസ്ത്രജ്ഞരിൽ നിന്ന് കർഷകരിലേയ്ക്ക് സാങ്കേതിക വിദ്യ കൈമാറ്റം ചെയ്യുന്നതിലുള്ള സമയം കുറയ്ക്കുന്നു					
d)	ഗവേഷകരിൽ നിന്നും ഉപഭോക്താക്കളിലേക്ക് സാങ്കേതിക വിദ്യ കൈമാറ്റം ചെയ്യുമ്പോൾ സംഭവിച്ചേക്കാവുന്ന സന്ദേശ വൈകൃതങ്ങൾ കുറയ്ക്കുന്നു.					
2.	കാർഷിക വിദഗ്ധ ശൃംഖല അവശ്യ വിവരങ്ങൾ നൽകുന്നതിന് സഹായിക്കുന്നു					
a)	ഇത് അനുഭവ സമ്പത്ത് കുറഞ്ഞ വിജ്ഞാനവ്യാപന പ്രവർത്തകരേയും, ഗവേഷകരേയും, നിർദ്ദേശങ്ങൾ നൽകി സഹായിക്കുന്നു					

b)	ചില കാര്യങ്ങൾ ഉറപ്പിക്കുന്നതിനു വേണ്ടി നിറം കടുപ്പിച്ചോ, നിറം മാറ്റിയോ, അഥവാ അക്ഷരങ്ങളുടെ വലുപ്പം മാറ്റിയോ പ്രതിപാദിപ്പിച്ചിരിക്കുന്നു.					
c)	ഉപഭോക്താക്കൾക്ക് മനസ്സിലാക്കാവുന്ന രീതിയൽ വിദഗ്ധ നിർദ്ദേശങ്ങൾ കൊടുത്തിരിക്കുന്നു.					
d)	നേരിട്ടു നടത്തിയ പരീക്ഷണ വിശദാംശങ്ങളിൽ നിന്നും, കൃത്യ സമയത്ത് എടുത്ത സാമ്പിളുകളിൽ നിന്നും ആധികാരികമായി നേരിട്ടു ലഭിക്കുന്ന ഒരു പഠന സാഹചര്യം കിട്ടുന്നു.					
e)	ഹോം പേജിലുള്ള ഐക്കൺ ആവശ്യാനുസൃതമാണ്					
f)	ലഭ്യമായ ദൃശ്യങ്ങൾ ഉപഭോക്താക്കളെ എളുപ്പത്തിൽ നയിക്കാനും, ആശയവിനിമയം ഫലവത്താക്കാനും സഹായിക്കുന്നു					
g)	ഉപഭോക്താക്കളോട് ഇടപഴകുന്ന രീതി					
h)	ഉപഭോക്താക്കളേട് വളരെ സൗഹൃദപൂർവ്വം സഹകരിക്കുന്ന സമ്പ്രദായമാണിത്					
9.	ഭാവി പരിപാടികൾ					
a)	കാർഷിക ഗവേഷണ ശൃംഖലയ്ക്ക് വളരെ കാര്യക്ഷമമായ ഒരു വിജ്ഞാനവ്യാപന സഹായിയാവാൻ സാധിക്കും					
b)	ഇത് വളരെ ഉപഭോക്തൃസഹായിയായിരിക്കും					
c)	അനേകം മനുഷ്യ വിദഗ്ധരുടെ കൂട്ടായ്മയുടെ ഫലമായുണ്ടായ ഇതിന് ചുരുങ്ങിയ സമയത്തിനുള്ളിൽ പുതിയ മനുഷ്യ വിദഗ്ധരുടെ വൈദഗ്ധ്യത്തെ ശക്തമാക്കാൻ കഴിവുണ്ട്					
d)	അനുയോജ്യമായ തീരുമാനങ്ങളെടുക്കുന്നതിന് ഇത് വലിയ താങ്ങ് നൽകുന്നു					
e)	കൃഷിയ്ക്കാവശ്യമായ തീരുമാനങ്ങളെടുക്കുന്നതിനുള്ള പരിഭ്രാന്തിയും അങ്കലാപ്പും കുറയ്ക്കുന്നു.					
f)	ചുരുങ്ങിയ ചെലവിൽ ഈ ശൃംഖല ലഭ്യമാണ്					
g)	ഇതിന്റെ നിലനിൽപിനാവശ്യമായ ചെലവ് വളരെ കുറവാണ്					
h)	കാർഷിക സാങ്കേതിക വിവരങ്ങൾ എല്ലാവരിലേയ്ക്കും എത്തിക്കുന്നതിനുള്ള സൗജന്യ / അനുബന്ധ വിജ്ഞാന ഉപാധിയാണ് ഇത്					
i)	ധാരാളം കാണികളിലേയ്ക്ക് ചുരുങ്ങിയ സമയത്തിനുള്ളിൽ വിവരങ്ങൾ എത്തിക്കുന്നതിന് ഇതിന് കഴിവുണ്ട്					
10.	മറ്റെന്തെങ്കിലും					

b)	വിജ്ഞാനവ്യാപന പ്രവർത്തകരുടെ കാർഷീകോപദേശ സഹായ ങ്ങൾക്ക് കാർഷിക വിദഗ്ധ ശൃംഖല സഹായിക്കുന്നു					
c)	മനുഷ്യ വിദഗ്ധരുടെ കുറവനുഭവപ്പെടുമ്പോൾ ഇവ ആവശ്യാനുസ രണം വിദഗ്ധ മാർഗ്ഗനിർദ്ദേശം നൽകുന്നു					
d)	വിവരങ്ങൾ എളുപ്പം കണ്ടെത്താൻ സഹായിക്കുന്നു					
e)	ജോലിയിൽ നിന്നും വിരമിച്ച ശാസ്ത്രജ്ഞരുടെ നൈപുണ്യം കണ്ടെത്തി സംരക്ഷിക്കുന്നു					
f)	അനേകം വിദഗ്ധരുടെ അറിവും അനുഭവ പരിചയവും സ്വായത്തമാ ക്കുന്നു.					
g)	അറിവ് കൈമാറ്റം ചെയ്യാൻ സഹായിക്കുന്നു					
h)	സംശയാസ്പദമായ വിവരങ്ങൾ പരിശോധിച്ച് ഉറപ്പിക്കുന്നു					
i)	കൃഷിയിടത്തിലെ യാഥാർത്ഥ്യങ്ങളെ പച്ചയായി ദൃശ്യാവിഷ്കരണം ചെയ്യുന്നു					
3.	കാർഷിക വിദഗ്ധ ശൃംഖല ശാക്തീകരിക്കുന്നു					
a)	പുതിയ വിദഗ്ധരുടെ കഴിവുകൾ ഉറപ്പിക്കുന്നു.					
b)	ആവശ്യാനുസൃതമായ വിവരങ്ങൾ നൽകി കർഷകനെ മത്സരിക്കാൻ പ്രാപ്തനാക്കുന്നു					
c)	ആവശ്യാനുസൃതമായ വിവരങ്ങൾ വിജ്ഞാനവ്യാപന പ്രവർത്ത കർക്ക് നൽകി മറ്റു വിഷയവിചക്ഷണൻമാരോടും, വിദഗ്ധരോടുമുള്ള ആശ്രയത്വം കുറയ്ക്കുന്നു					
d)	ഉപഭോക്താക്കൾക്കിടയിൽ ആത്മ വിശ്വാസം വളർത്തുന്നു					
e)	ആവശ്യമായ പരിജ്ഞാനം നൽകി ഉപഭോക്താക്കളെ ശക്തിപ്പെടു ത്തുന്നു					
f)	ഉപഭോക്താക്കളുടെ തൊഴിൽക്ഷമത വർദ്ധിപ്പിക്കുന്നു					
4.	കാർഷിക വിദഗ്ധ ശൃംഖല കൃഷിയിട പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നു					
a)	ശരിയായ സമയത്ത് കൃഷിയിട പ്രശ്നങ്ങൾ പരിശോധിക്കാനും, പരി ഹരിക്കാനും ഇത് കൊണ്ട് സാധിക്കുന്നു					
b)	അനുയോജ്യമായ സാങ്കേതികവിദ്യ തെരഞ്ഞെടുക്കാൻ സഹായി ക്കുന്നു					
c)	പ്രത്യേക സാങ്കേതികവിദ്യക്കാവശ്യമായ വിവരങ്ങൾ നൽകുന്നു					
d)	പ്രശ്നപരിഹാരം ചെയ്യുമ്പോൾ കർഷകരുടെ അടിസ്ഥാന ആവശ്യ ങ്ങളും, വിഭവശേഷിയും കണക്കിലെടുക്കുന്നു.					
5.	കാർഷിക വിദഗ്ധ ശൃംഖല കാർഷിക വരുമാനം കൂട്ടാൻ സഹായി ക്കുന്നു					
a)	അവശ്യ സമയത്ത് ആവശ്യമായ വിവരങ്ങൾ നൽകി നല്ല വില കിട്ടാൻ അവസരം നൽകുന്നു					
6.	മറ്റെന്തെങ്കിലുമുണ്ടെങ്കിൽ വ്യക്തമാക്കുക.					

4. താഴെക്കൊടുത്തിട്ടുള്ള ചോദ്യങ്ങൾക്ക് ഉത്തരം തെരഞ്ഞെടുക്കുക. ഇത് നിങ്ങളുടെ അറിവ് പരിശോധിക്കാനല്ല മറിച്ച് കാർഷിക വിദഗ്ധ ശൃംഖലക്ക് നിങ്ങൾക്കാവശ്യമായ വിവരങ്ങൾ തരാനുള്ള കഴിവുണ്ടോ എന്ന് പരിശോധിക്കാനാണ്

1. ഗാളീച്ച സാധ്യത അതിവ്യാപകമായി ഉണ്ടാകുമ്പോൾ നിങ്ങൾ നിർദ്ദേശിക്കുന്ന പ്രധാന മുൻകരുതൽ എന്താണ്?

a) അസഫേറ്റ് തളിക്കുക b) മൂപ്പെത്തും മുമ്പേയുള്ള പറിച്ചു നടൽ തടയുക

c) വൈകി പറിച്ചു നടാതിരിക്കുക d) ശരിയായ സമയത്ത് വേണ്ട കൃഷിപ്പണികൾ ചെയ്യുക.

2. നെല്ലിലെ മുഞ്ഞയെ തടയാൻ വേണ്ട കാർബാറിലിന്റെ അളവ് ?

a) 855 S/ha ന്റെ 450 ഗ്രാം, b) 855 S/ ha ന്റെ 250 ഗ്രാം,

c) 855 S/ ha ന്റെ 625 ഗ്രാം, d) 855 S/ ha ന്റെ 725 ഗ്രാം

3. നെല്ല് പൂവിടുന്ന സമയത്ത് നെൽച്ചാഴിയുടെ ETL എത്ര?

a) ഒരു നുരിയിൽ 5 ചാഴി, b) ഒരു നുരിയിൽ 10 ചാഴി,

c) ഒരു നുരിയിൽ 8 ചാഴി, d) ഒരു നുരിയിൽ 2 ചാഴി.

4. ഗാളീച്ചയുടെ ആക്രമണം ചെറുക്കുന്ന നെല്ലിനം.

a) ദീപ്തി b) കുംഭം c) നീരജ d) പവിത്ര

5. നെല്ലിൽ തുംഗ്രോവൈറസിന്റെ ETL എത്ര?

a) 1 ചതുരശ്രമീറ്ററിൽ 1 വൈറസ് ബാധയുള്ള നുരി

b) 1 ചതുരശ്രമീറ്ററിൽ 2 വൈറസ് ബാധയുള്ള നുരികൾ

c) 1 ചതുരശ്രമീറ്ററിൽ 3 വൈറസ് ബാധയുള്ള നുരികൾ

d) 1 ചതുരശ്രമീറ്ററിൽ 4 വൈറസ് ബാധയുള്ള നുരികൾ

6. നെല്ല് വിളവെടുക്കുന്നതിന് എത്ര ദിവസം മുൻപ് കീടനാശിനി തളിക്കുന്നത് അവസാനിപ്പിക്കണം?

a) 15 ദിവസങ്ങൾ b) 20 ദിവസങ്ങൾ c) 25 ദിവസങ്ങൾ d) 30 ദിവസങ്ങൾ

7. തെങ്ങിന്റെ തളിരോലയുടെ കടഭാഗവും, മുകൾഭാഗത്തെ മൃദുവായ ഭാഗങ്ങളും ചീഞ്ഞളിഞ്ഞ് ദുർഗന്ധം വരുന്നു. പുറമേയുള്ള ഓലകൾ ഒടിഞ്ഞു തൂങ്ങുന്നു. ഇതേത് രോഗമാണ്?

a) ഓലചീയൽ b) മഹാളി c) കാറ്റുവീഴ്ച d) കൂമ്പ് ചീയൽ.

8. തെങ്ങിൽ സാധാരണയായി കാണുന്ന ചെന്നീരൊലിപ്പിന് നിങ്ങൾ ഏത് മരുന്ന് ഉപയോഗിക്കും?

a) തെങ്ങൊന്നിന് 5 കി. ഗ്രാം വേപ്പിൻ പിണ്ണാക്ക് b) 1% ബോർഡോ മിശ്രിതം

c) 1% ട്രൈഡിമോർഫ് d) 4% മാൻഗോസെബ്.

9. തെങ്ങിൽ ഇലതീനിപ്പുഴുക്കൾ വരാതിരിക്കാനായി ഏതു പരാദങ്ങളെയാണ് ഉപയോഗിക്കേണ്ടത്?

a) സ്റ്റിനോബ്രാക്കോൺ b) കോട്ടീസിയ c) ഗോണിയോസസ് d) ചാരോപ്സ്

10. വണ്ടാക്രമണം ഇല്ലാതെ കൊപ്രസംരക്ഷിക്കാൻ വേണ്ട ഈർപ്പം എത്രയെന്നാണ് നിങ്ങളുടെ നിർദ്ദേശം?

a) 12% b) 10% c) 8% d) 4%

11. തെങ്ങിലെ ചെന്നീരൊലിപ്പ് കൂട്ടുന്ന സ്ഥിതി ഏതാണ്?

a) കടുത്ത മഴ b) ചുഴലിക്കാറ്റ് c) തടിയിലെ വിള്ളലുകൾ d) മൂലകക്കുറവ്

12. വാഴയിലെ ഏതിനത്തെയാണ് കുമ്പടപ്പ് രോഗം അധികം ബാധിക്കാത്തത്?

a) നേന്ത്രൻ b) ഞാലിപ്പൂവൻ c)പാളയം കോടൻ d) കർപ്പൂരവള്ളി.

13. വാഴപ്പിണ്ടിപ്പുഴുവിനെ നിയന്ത്രിക്കാൻ അനുയോജ്യമായ കീടനാശിനി?

a) 0.05% ക്വിനാൽഫോസ് b) 12.5 ഗ്രാം ഫോറേറ്റ്

c) 10 ഗ്രാം കാർബോഫുറാൻ d) ഇവയൊന്നുമല്ല.

14. വാഴയിലെ നീരൂറ്റിക്കുടിക്കുന്ന പേനുകളെ നിയന്ത്രിക്കാനുള്ള മാർഗ്ഗം

a) 1 കിലോ വേപ്പിൻ പിണ്ണാക്ക് ഓരോ ചെടിക്കും b) 0.03% ക്ലോർപൈറിഫോസ്

c) 0.02% കാർബാറിൽ d) 12.5 ഗ്രാം ഫോറേറ്റ്

15. വാഴയിലെ നിമാ വിരകളുടെ ആക്രമണം തടയാനായി നിങ്ങൾ എന്തു നിർദ്ദേശിക്കും?

a) 1 ചെടിക്ക് 1 കിലോ വേപ്പിൻപിണ്ണാക്ക് b) 10 G ഫോറേറ്റ്

c) 1% ബോർഡോമിശ്രിതം d) 0.05% ട്രൈഡിമോർഫ്.

5. ഇവിടെ പ്രദർശിപ്പിച്ച കാർഷിക വിദഗ്ധ ശൃംഖലയുടെ പ്രശ്ന പരിഹാരക്ഷമതയെപ്പറ്റി നിങ്ങൾ നേരത്തെ എണ്ണപ്പെടുത്തിയ പ്രകാരം എങ്ങനെ വിലയിരുത്തുന്നു എന്നത് ✓ മാർക്ക് നൽകി രേഖപ്പെടുത്തുക. അഞ്ചക്കത്തുടർച്ചയിൽ 5 എന്നത് ഏറ്റവും ആവശ്യം എന്നും 1 എന്നത് തീരെ ആവശ്യമില്ല എന്നതും കാണിക്കുന്നു. ഇടയിലുള്ള അവരോഹണക്രമത്തിലുള്ള സ്കോറുകൾ സമ്പ്രദായത്തിന് പ്രശ്നപരിഹാരം നൽകുന്നതിന്റെ കഴിവു കുറഞ്ഞു വരുന്നതിനെ കാണിക്കുന്നു.

ക്രമസംഖ്യ	പ്രശ്നങ്ങൾ	സ്കോറുകൾ				
		5	4	3	2	1
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

Plates

Plate 1. Farmers responding after the exposure of AES alone

Plate 2. Participating extension personnel responding after the exposure of AES alone

Plate 3. Farmers in groups assessing the problem solving capacity of AES

Plate 4. A session on plant protection aspects of rice, coconut and banana by a human expert

Plate 5. Farmers exposed to AES+ HES

Plate 6. Participants discussing with human experts

Plate 7. Farmers in groups assessing the information efficiency of AES

മാതൃഭൂമി • 2007 ഫിബ്രവരി 10 • ശനിയാഴ്ച

കീടനിയന്ത്രണത്തിന് കമ്പ്യൂട്ടർ നിയന്ത്രിത സംവിധാനമൊരുങ്ങുന്നു

തത്തമംഗലം: സംയോജിത കീടരോഗ നിയന്ത്രണ മാർഗ്ഗങ്ങൾ സോഫ്റ്റ്‌വെയർ സിസ്റ്റത്തിലൂടെ കർഷകരിലെത്തിക്കുന്ന പദ്ധതിക്ക് കാർഷിക സർവകലാശാല രൂപം നൽകുന്നു. ഇതിന്റെ ഭാഗമായി പാടശേഖര സമിതികളിലെ കർഷകർക്ക് കൃഷി ശാസ്ത്രജ്ഞരായ ചാന്ദിനി, ഹൈലൻ എന്നിവരുടെ നേതൃത്വത്തിൽ പരിശീലനം നൽകി.

കാലാവസ്ഥയിൽ വരുന്ന മാറ്റം മൂലം അനുഭവപ്പെടുന്ന കീടബാധ, അമിത രാസവള പ്രയോഗത്തിന്റെ ദൂഷ്യഫലങ്ങൾ, ക്ഷുദ്രജീവികളുടെ ആക്രമണം എന്നിവയ്ക്കുള്ള പരിഹാരമാർഗ്ഗങ്ങൾ കമ്പ്യൂട്ടർവഴി കർഷകന് ലഭ്യമാക്കാനാണ് പദ്ധതി. തെങ്ങ്, നെല്ല്, വാഴ, വെണ്ട, പയർ, തക്കാളി, വഴുതിന തുടങ്ങി 9 ഇനം വിളകളെ ബാധിക്കുന്ന രോഗങ്ങൾക്കുള്ള നിവാരണ മാർഗ്ഗങ്ങളാണ് ഇപ്പോൾ ലഭിക്കുക. ഈ പദ്ധതി നിലവിൽവന്നാൽ കർഷകർ വിളകളുടെ രോഗബാധയെക്കുറിച്ച് കൃഷിഭവനിൽ അറിയിക്കണം. കൃഷിഭവനിൽനിന്ന് സോഫ്റ്റ്‌വെയർ വഴി കാർഷിക സർവകലാശാലയിൽ അറിയിക്കും. കർഷകർക്ക് ഉടൻതന്നെ നിവാരണത്തിനുള്ള മാർഗ്ഗം ലഭിക്കും. ഓരോ കൃഷിഭവനിലും കമ്പ്യൂട്ടർ സംവിധാനം ഏർപ്പെടുത്തും. കീടബാധമൂലം വൻ കൃഷിനാശം സംഭവിക്കുന്ന അവസ്ഥയ്ക്ക് ഇതോടെ മാറ്റമുണ്ടാകുമെന്ന് ശാസ്ത്രജ്ഞർ പറഞ്ഞു. ചടങ്ങിൽ ടി.എ. വിശ്വനാഥൻ അധ്യക്ഷനായി.

Plate: 8 A copy of the report of local daily about a session on plant protection technologies in rice, coconut and banana using AES

Abstract

AGRICULTURAL EXPERT SYSTEM – A PARTICIPATORY ASSESSMENT

By

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ABSTRACT OF THE THESIS

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ABSTRACT

Cyber Extension includes effective use of Information and Communication Technology, national and international information networks, Internet, Expert Systems, Multimedia Learning Systems and Computer based training systems to improve information access to the farmers, extension personnel and scientists. The dissemination of the technologies could be enhanced by using expert systems and other artificial intelligence technologies (Hadi *et al.*, 2006).

An expert system is a computer-based program that uses knowledge, facts and different reasoning techniques to solve problems that normally require the abilities of human experts. The expert systems are based on the concept of artificial intelligence in which the experience and knowledge of human experts are captured in the form of IF-THEN rules and facts, to solve the field problems (Rao, 2003).

'Diagnos-4', was a computer-assisted software developed by Kerala Agricultural University during 2004. This package would support the agricultural extension workers and literate farmers for decision-making and help them in suggesting suitable control measures of the major pests and diseases of important nine crops of Kerala (Ganesan, 2002). It will be modified and released shortly for the benefit of all the stakeholders involved in agricultural development. Before introducing the system among users, it is appropriate to explore the possibilities of functioning of AES under the existing extension system so that suitable modifications can be made to make it more user friendly.

Development of AES, 'Diagnos-4' was the pioneering and ambitious programme of Kerala Agricultural University. The personnel involved in technology dissemination and technology users need much information on plant protection measures. Hence 'Diagnos-4' was selected purposively.

The research was conducted among the prospective users in two phases viz; exploratory design among researchers who were in the research institutes engaged in AES development and in TOT, all over India and experimental design among extension personnel and farmers from Palakkad District of Kerala. Mean scores, percentage analysis, Kendall's Coefficient of Concordance, t-test for two samples assuming equal variances and Binary Logistic Regression were the statistical tools used in this study.

Twenty AES were identified during this study, developed by various agricultural research institutions in India. Many of the systems were restricted only to limited groups of users and they were yet to be popularized among the ultimate users. It was found that extension personnel and farmers possessed low level of knowledge especially in the areas of plant protection aspects of crops and they were in need of information on the same. Hence there is a lot of scope for the application of AES among extension personnel and farmers on plant protection aspects of crops that help the users to clarify their doubts, confirm their knowledge and provide real time information to the technology users.

Prospective users in the transfer of technology stream were very much satisfied about the future prospects of AES based on its better performance, settings in the AES, mode of presentation, practicability and serviceability of the system. The areas that needed modifications were: retrievability of information, relevancy of information and information content. Release of Malayalam Version with more emphasis on easy retrievability of information, needs the immediate attention of the researchers. All the categories of respondents perceived that AES had got 'more potential' in the transfer of technology in terms of disseminating information to the users.

The combination of AES and human expertise showed better performance and higher Information Efficiency Index (IEI) among the extension personnel and farmers. Majority of the extension personnel rated AES with high IEI. Whereas majority of the farmers rated AES with low IEI. Extension personnel and farmers assessed that the overall percentage of solution offered by AES in the plant protection of rice, coconut and banana was almost on par with the solutions given by human experts and in combination, it served better. It is better to introduce the AES designed separately for extension personnel and farmers. It is also necessary to release the software among the prospective users after a comprehensive orientation in using the AES. Maximum potential of AES can be explored by making the users as the partners in the AES development process to ensure user friendliness of Agricultural Expert System.