Perceptions of Rubber Growers on Information Technology enabled Rubber Expert System

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ABSTRACT

The Expert system for plant protection of rubber was developed using Visual Basic 6.0. The computer based Rubber Expert System thus developed was abbreviated as RUBEX-04. Perceptions of Rubber Growers on Information Technology enabled Rubber Expert System was studied. It was evident that, majority of the respondents (60.83 per cent) were found to have high level of perception about modern information communication technologies, followed by 21.67 per cent with medium and remaining 17.50 per cent with low level of perception of modern information and communication technologies. It could be exonerated from the study that slightly less than three-fourth of the respondents reported that they were most satisfied with the diagnostic path which was sequential and logic in RUBEXS-04. A majority (81.67 per cent) of the respondents were most satisfied about the correct conclusion provided by the RUBEXS-04. More than half of the respondents were most satisfied that, photographs helped them to confirm the incidence of disease and pests. Most of the subjects preferred the Expert System for other technologies of rubber like, latex preservation and processing, tapping and yield stimulation and soil management, in addition to RUBEXS-04.

Key words: *Rubber Expert System; RUBEX-04;*

India is on the threshold of an Information revolution. Agricultural technology is constantly subjected to metamorphosis over years, and farmers are swamped with many new cultivars, pesticides, farm machines and farming techniques. Coping with this ever-growing complexity is overwhelming. It is at this juncture that the development of telecommunications and computer-based information technology in the era of globalization, poses the best alternative and means for a sea change in extension. ICTS can be exploited to design cost-effective systems to provide expert advice particularly to rural communities, helping to increase productivity and livelihoods. (Swaminathan, 2003).

Expert systems provide a frame work for presenting the latest scientific knowledge and decision –making tools. (Raju and Rao, 2005). The Expert system for plant protection of rubber was developed using Visual Basic 6.0. The computer based Rubber Expert System was abbreviated as RUBEX-04. The numerical value 04 indicates the year of designing ie 2004. The RUBEX-04 is a graphical user interface which uses graphics to organize work space. It also uses event-driven architecture. For the purpose of experimental study, the subject matter to test the effectiveness of the RUBEX-04 was confined to the pest and disease appearing on the stem portion of the rubber tree which is considered to be the most economical part of the crop.The present study was carried out to test its applicability among the end users of the farmers cultivating the rubber crop.

MTHODOLOGY

Perception is the process of understanding sensation or attaching meaning based on experience to signs. In this study, the perceptions of the subjects were studied on Expert system with regard to the technical and message components and other components of Expert system. To measure the perception level of subjects about the Expert system, a list of items seeking different contents namely technical aspects, message components, appearance and layout, voice and utility of Expert system were prepared. These items were administered to the subjects on a three point continuum, namely most satisfied, satisfied and not satisfied. Based on the scores the perception index was calculated using the formula:

$$\text{Perception Index (PI)} = \frac{\text{Individual subject's score}}{\text{Total score}} \times 100$$

The methodology for developing computer-based Expert system on rubber was divided in to 2 main parts: Knowledge engineering and software engineering. The Knowledge engineering methodology included acquiring the knowledge ,analyzing ,modeling the acquired knowledge and verifying the modeled knowledge. An exhaustive knowledge base for as many as 44 items on plant protection technology of rubber including leaf diseases, stem diseases, root disease non-microbial maladies and pests of rubber trees were acquired from various sources like literature, discussion with scientists from Rubber Research Institute of India and discussion with extension personnel of Rubber Board. The documented knowledge was analysed and grouped in a common knowledge base. The information generated from various sources for knowledge acquisition activities were analysed and it was represented in the form of flow chart, with the purpose of finding the domain knowledge which the experts were using to reach a conclusion from specific components in the domain layer. So, this inference analysis was aiming at modelling the acquired knowledge. The task analysis was done to find the sequence or the procedure, which the experts used to reach a final conclusion. The knowledge base was verified at the knowledge acquisition stage, analysis stage and implementation stage and got approved by the expert as a valid way for solving the problem.

Software engineering methodology: Different types of tools have demonstrated the enormous range of possible Expert System architectures that could be build around different representations and control regimes.

However, flexibility, simplicity, nature of problem and familiarity of the language to the researcher were considered for selecting the Expert System architecture. With that, the programming language Visual Basic 6.0 was chosen for designing and developing the Expert System on rubber. The main advantage of Visual Basic is that it is a rapid application development tool. This is the main reason for Visual Basic's extensive use as a prototyping language. Visual Basic applications insulate from having to deal with low-level message handling. Hence Visual Basic 6.0 was selected as a programming language for developing rubber Expert System. It has the following additional unique features.

Unique feature of the software : Visual Basic 6.0 has many powerful features (NIIT, 1999). Some of these features are:

- *It is based on the BASIC language* (Beginners All Purpose Symbolic Instruction Code).
- *It has programming objects and events:* The visual forms and objects like list boxes and radio buttons that are available on the forms, helps to interact with the application in order to find out the flow of the programme.
- *Advantage of common programming platform across all Microsoft office application:* Almost all Microsoft office applications support Visual Basic by sharing and reusing code across applications.
- *Facility of Native Code Compilation:* One of the most significant features of Visual Basic is the native code compilation. This compilation produces code almost 20 times faster than pseudocode compilation.
- *32-bit support:* Visual Basic supports 32-bit applications.
- *A quick and easy way to develop applications:* The tools provided by Visual Basic helps to reduce development time. It is faster to create applications using the tools available.
- *Wizards:* Visual Basic includes many wizards that can automate tasks or even automate coding. Visual Basic 6.0 has a new collection of wizards to perform some difficult and routine tasks. Some of these are:
  - The package and deployment wizard
  - The class builder utility
  - Data object generator wizard
  - The add-in designer
  - The application wizard
- *Object types:* New object types, called file system objects or FSO, have been added to Visual Basic 6.0. These objects enable to work faster and more easily with files and directories.
- *Additional functions:* There are fourteen additional functions in Visual Basic 6.0. All of them deal with striving data. Some of these are Call By Name, Filter, Format Currency, Format Date Time, Format Number, and Format Per cent.
- *Has an active X feature:* Visual Basic allow the designer to migrate applications to an active x document, which enables the application to install and run from web browser. Thus, the developer need not know languages like Java or HTML. Visual Basic also enables to create active x controls.
- *Database enhancements:* Data access features allow to create databases and front-end applications for most popular database formats, including Microsoft SQL Server and other enterprise-level database.
- *SDI/MDI/Explorer-style interface options:* Visual Basic has the functionality to create single, multiple, or Windows Explorer – style document interface applications.
- *An n-tier architecture:* The n-tier client/server, which includes more than two tiers. The applications using an n-tier architecture can be divided into a minimum of three parts, namely interface, business logic and

database functions.

- *Quick editing, testing, and debugging:* The Visual Basic development environment includes extensive editing and debugging tools.
- *Internet features:* The methods, properties and events of every element on a web page can be exposed using the Dynamic HTML technology.
- *Package and Deployment Wizard:* The package and Deployment Wizard, encompassed wide range of data access formats like ADO, DAO, ODBC, and RDO. A Visual Basic project is compressed into a cab file or an executable set up programme.

Procedure followed in designing RUBEXS-04 : The computer-based Rubber EXpert System was abbreviated as RUBEXS-04. The numerical value 04 indicates, the year of designing i.e.2004. The diagram given below represents the process of development of Computer-based Expert System RUBEXS-04 (Fig.2). The RUBEXS-04 was programmed using Visual Basic 6.0. It is a graphical user interface, which uses graphics to organise workspace. It also uses event-driven architecture. The interface comprises a form with controls. The step by step procedure followed in designing RUBEXS-04 is given below.

Steps followed in designing RUBEXS-04

- The user interface was created by drawing controls such as text box, labels, option button, command button etc., on a form. Each form was carrying single question of a cause or about a situation coupled with dichotomous options of Yes or No. A form is one of the main building blocks in this application. Users interact with the controls on a form to obtain the desired result. The form becomes the first on-screen window a user sees while running a programme. In order to make the programme easier to read and debug, appropriate names were assigned to the objectives.
- The properties were set for the form and controls to specify values such as the caption, colour, size etc.
- Codes were written to bring the application to life or after setting the initial properties for the form and each object, codes were added that executes in response to events.
- HTML template – An Hypertext Markup Language (HTML) page is designed to act as a template; some parts of the page are replaced with dynamic content before the page is displayed especially, advice and more details of the cause are designed to act as a template.
- Describing symptoms in words is very difficult and sometimes is very confusing. Therefore, necessary images were inserted into relevant forms, with the main purpose of describing a disorder symptom, and confirming the diagnosis of the cause of a certain disorder by the user.
- The voice is recorded and edited using a soft ware sound forge. It is one of the best sound editing and recording software, and the background sound was given to add flavour to the multimedia presentation.
- After the project has been created, it has been saved using the 'Saved Project As' menu item on the 'File' menu option. Saving a project also saves its form and code modules.
- Debugging tools were used to check for errors and modified the code whenever necessary.

Functioning of RUBEXS-04 : The RUBEXS-04 will run form by form. Each form contains one question related to diagnosis of pest and diseases of rubber crop. Under each question, there will be two control buttons with the option of YES or NO User has an option to click either YES or NO command buttons based on their experience and prevailing situation about pest and disease in their rubber plantations. Based on their answers, RUBEXS-04 takes the users to next relevant questions. Likewise, it keeps on interact with the user and finally gives the diagnostic result. In the diagnostic result form two more additional control buttons are available with the caption of ADVICE and MORE DETAILS and Click on Advice button tells about the measure to control the problem diagnosed and click on more detail button, gives more information about the cause diagnosed by the RUBEXS-04.

Sampling procedure: The rubber plantation sector in India is dominated by smallholdings, which accounts for 88 per cent of the production and area of the rubber in the country. The small growers in the country number about a million. For the effective transfer of technology and for empowerment of the sector the Rubber Board has promoted formation of grass root level organisation/ institution building at the village level to be specifically known as Rubber Producer's Society (RPS). All small rubber growers having their holding located within the operational area of the concerned RPS can be members. The members in each RPS varied from 50 to 200. At the end of 2000-01 there were 2,100 RPSs registered in Kerala (Rubber Grower's Companion, 2004). There were 60 RPSs functioning under the Rubber Board, Regional Office, Mannarkkad. Since, RPSs were envisaged to function as extension arms of Rubber Board and to facilitate a meaningful devolution of extension functions to render effective service to the small growers, the RPSs were considered as opt and potential center for exposing the treatments. Out of 60 existing RPSs under Mannarkkad Regional Office, the three RPSs located in Ambalappara,

Ummanezhi and Machanthodu were randomly selected. These were also active, well functioning and representing the entire Regional Office.

Selection of respondents: RPSs were registered under charitable societies and formed based on a model by-law drawn by the Rubber Board, Kerala. Only rubber growers were permitted to become member in RPS. Hence, membership registers were maintained at each RPS. Based on the membership registers, wide publicity were given to all the members of the selected RPSs to participate in the "Special diagnosis campaign organised in the stipulated date, time and venue of the respective RPSs .

Accordingly from each RPS, rubber growers ranging between 60 and 75 had participated in the campaign. From these participants a sample of 20 rubber growers from each RPS concerned were selected randomly. Hence, a sample size of 60 rubber growers formed the total sample for the study of perception towards the modern information communication technology.

RESULTS AND DISCUSSION

Perception about the Modern Information Communication Technology (MICT): 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 categorised into low, medium and high using cumulative frequency method.

Table 1. Distribution of respondents according to their perception about modern information communication technology (MICT) (n=120)

S.No.	Category	No	Per cent
1.	Low	21	17.50
2.	Medium	26	21.67
3.	High	73	60.83

From the Table 1 it is evident that majority of the respondents (60.83 per cent) were found to have high level of perception about modern information communication technologies, followed by 21.67 per cent with medium and remaining 17.50 per cent with low level of perception of modern information and communication technologies. The reason may be due to the fact that though they had not undergone training on computer operations, thus possessing less familiarity in operating computer and other information communication technologies. But, they could sensitize and feel the pace of development on information technology taking place in their surrounding environment. Majority of the respondents also reported that, some of their children are studying computer courses and are capable of operating and accessing the information from computer and other information communication technologies.

Farmer's perception about RUBEXS-04: The farmers were exposed to Expert Systems for the first time through this research. This computer-based decision aid would be widely accepted only when the user develops a favourable attitude on this aid. It was felt necessary to assess the farmer's perception about RUBEXS-04. Farmer's extent of perception on different components of RUBEXS-04 as perceived by them is furnished in Table 2.

Table 2. Distribution of the respondents according to their perception about Expert System (n=60)

S. No.	Perception statement	MS No.	MS %	S No.	S %	NS No.	NS %
I.	*Technical and message components*						
1.	Diagnostic path is sequential and logic	42	72.00	14	23.33	4	6.67
2.	Diagnostic path leads to correct conclusion	49	81.67	9	15.00	2	3.33
3.	Questions are based on field reality	37	61.67	20	32.33	3	5.00
4.	Photographs helps for confirmation of disease and pest	33	55.00	18	30.00	9	15.00
5.	Adequacy of photographs	19	31.67	27	45.00	14	23.33
6.	Photo clarity	11	18.33	41	68.33	8	13.34
7.	Adequacy of message	24	40.00	29	48.33	7	11.67
8.	Clarity of message	31	51.67	18	30.00	11	18.33
9.	Words and sentences are simple	21	35.00	33	55.00	6	10.00
10.	Practical utility of message	21	35.00	36	60.00	3	5.00
11.	Facilitated adequate interaction	31	51.67	23	38.33	6	10.00
12.	Motivate to learn	23	38.33	34	56.67	3	5.00
II.	*Components and utility of Expert System*						
A.	*Appearance and layout*						
i)	Background colour	24	40.00	36	60.00	-	-
ii)	Size of the letter	18	30.00	34	56.67	8	13.33
iii)	Style of the letter	12	20.00	43	71.67	5	8.33
iv)	Colour of the letter	16	26.67	38	63.33	6	10.00
B.	*Voice'*						
i)	Voice clarity	42	70.00	18	30.00	-	-
ii)	Voice pace	40	66.67	20	33.33	-	-
iii)	Modulation in voice	42	70.00	18	30.00	-	-
C.	*Utility of Expert System*						
i)	Easily portable	12	20.00	48	80.00	-	-
ii)	Ease in use and functionality	22	36.67	31	51.67	7	11.66

MS=Most Satisfied S=satisfied NS=Notsatisfied

Technical and message components: Farmers perception with regard to technical and message components of RUBEXS-04 were collected on 12 items and the results are presented under the following sub headings.

Diagnostic path is sequential and logic : It could be exonerated from the Table 2 that slightly less than three-fourth of the respondents reported that they were most satisfied with the diagnostic path which was sequential and logic in RUBEXS-04. The reason might be that, the collected knowledge base was represented scientifically in decision tree with the help of scientists from Rubber Research Institute of India, who had the experience of more than twenty years in their respective field. This might have made them to feel satisfied.

Diagnostic path leads to correct conclusion: A majority (81.67 per cent) of the respondents were most satisfied about the correct conclusion provided by the RUBEXS-04. The sequential and logic in diagnostic path might be the appropriate reason for delivering the reliable / accurate diagnostic result.

Questions are based on field reality: Slightly less than two-third of the respondents were most satisfied about the questions exhibited in each forms in RUBEXS-04. Majority of the respondents selected for the study were having 11 – 20 years of experience in rubber cultivation. Because of their prime experience they could relate their field experience when they were exposed to questions while interacting with RUBEXS-04. This might be the reason for their most satisfaction.

Photographs helps for confirmation of disease and pest: Relevant photos related to major symptoms of selected disease and pests were scanned and embedded with the forms along with questions in RUBEXS-04. More than half of the respondents were most satisfied and that photographs helped them to confirm the disease and pests. The old adage "a picture is worth a thousand words" is crucially relevant. This might have increased their level of understanding of the problem.

Photo clarity: More than two-third of the respondents were satisfied about the clarity of the photo's provided in the RUBEXS-04. Less than one-sixth of the respondents (13.34) felt that, the clarity could be improved further.

Adequacy of photographs : Slightly less than one-third of the respondents expressed that they were most satisfied and less than half were satisfied with the adequacy of the photographs. But, a considerable percentage (23.33 per cent) of the respondents expressed that they need some more photographs which would help them for easy recognition and further confirmation of diseases and pests.

*Words and sentences are simple :*Majority of the respondents fell in the category of satisfied to most satisfied (55.00 to 35.00 per cent) and expressed that the words and sentences used were simple and easy to understand.

*Adequacy of message :*Slightly less than half of the respondents were satisfied and another 40.00 per cent were most satisfied with the information covered in RUBEXS-04 with regard to major pest and diseases of rubber crop, which are common in the study area. The information covered might have enlightened the farmers and as a result they expressed as satisfied to most satisfied.

Clarity of message: More than half (51.67 per cent) of respondents were most satisfied with the clarity of the message provided through RUBEXS-04. This was possible because of simple and brief sentences regarding the problems coupled with appropriate visuals and voice would have enhanced the clarity of the message.

*Practical utility of message :*Majority of the respondents (60.00 per cent) perceived that the message covered in the RUBEXS-04 would be of more practical value to them. This could be possible by the researcher through needs assessment. Before developing RUBEXS-04, the need was assessed among the different categories of stake holders like farmers, extension personnel of Rubber Board and scientists from Rubber Research Institute of India to select the important and most needed area of subject matter to be covered in RUBEXS-04. This might have been the reason for their satisfaction over the practical utility of message.

Facilitated adequate interaction : The messages were tailored in a logical sequence step by step. It was designed in such a way, it keep on posing the questions one by one to the user, the user has to interact and reply to each question which lead to the result part of diagnosis. This definitely would have made them to participate and interact actively along with the system. Hence, more than half of the respondents were most satisfied about the interactivity.

Motivation to learn: The simple words and sentences, sequential and logical presentation, the adequacy of messages coupled with photographs, voice and good interactivity of the RUBEXS-04 might have increased their inquisitiveness to learn more about the plant protection aspects of rubber crop. Hence the results indicated that, more than half of the respondents were in the category of satisfied and slightly more than one-third were in the category of most satisfied with regard to motivational aspects of RUBEXS-04 to learn the subject.

Components and utility of Expert System : The perception of the respondents with regard to components and utility of Expert System were categorised into three components namely (a) appearance and layout, (b) voice and (c) utility of Expert System.

The perception with regard to components and

utility of Expert System are furnished in Table 2 and discussed hereunder.

Appearance and layout : A detailed analysis of various components under appearance and layout of RUBEXS-04 indicated that, more than half of the respondents were satisfied with background colour, size, style and colour of the letters. A minimum percentage of the respondents emphasized still clear and bolder letters for better visibility even for the distant viewers.

Voice : The audio was provided for every page of the RUBEXS-04. It was recorded with the help of a girl who hailed from the adjacent district of study area. The accent was very much similar to the accent of people in the study area. Hence, slightly less than three-fourth of the respondents were most satisfied with voice clarity as well as modulation of voice. Two-third of the respondents were also most satisfied by the voice pace.

Utility of Expert System

Portability : The farmers were very much familiar about CD loaded with cine songs and film stories. Hence, 80.00 per cent of the respondents were satisfied with the ease in portability of CD loaded with Expert System.

Ease in use and functionality : Little higher than half (51.67 per cent) of the respondents satisfied and slightly more one-third of them were most satisfied in use and functionality of the Expert System. Though the farmers were new to a computer-based Expert System, after exposure to the treatments, with the user friendly navigation tools, they were much confident to successfully operate the package with little support and minimum orientation.

Farmers' opinion about feasibility of Expert System : Through their general acceptance of the Expert System the subjects inherently given their preference of using Expert System in various fields as a tool. The data with regard to their opinion is analysed using percentage and the results are furnished in Table 3.

Table 3. Farmers opinion regarding the feasibility of using Expert System in Agriculture (n=60)

S.No.	Items	No	Per cent
1.	As diagnostic tool	58	96.67
2.	As training / education tool	55	91.67
3.	As extension tool	53	88.33
4.	As decision support system	51	85.00
5.	As management tool	49	81.67

* Multiple responses

It is explicit from Table 3 that, 96.67 per cent of subjects opined that, the Expert System could be used as a diagnostic tool. This may be due to the fact that, the RUBEXS-04 was reliable in diagnosis, the data seemed to be adequate in reaching a well-accepted diagnosis. This result is in agreement with Batchelor et al. (1991) who reported that, pest management recommendations from extension bulletins and the Expert System are compared with an expert's recommendations. Results indicate the potential improvement in decision-making process with the adoption of Expert Systems. A majority of the subjects felt that the Expert System could also be used as training / education tool. This may be due to the fact that the subjects might have had a favourable experience with RUBEXS-04 which was augmented with multimedia capabilities which would have enhanced the understanding of the subjects. More than three-fourth of the subjects expressed that there is a feasibility to use the Expert System extension, decision-making and management tool in agriculture. This is because, the hyper text may be incorporated into Expert System which has been proved to be a useful method of providing additional educational information to the Expert System user and also helps the field extension officers to disseminate technology with confidence.

The results clearly indicates that, there is an ample scope for Expert System to be widely developed and used. The application of Expert System had already demonstrated the value of this programme. These programmes do not replace people, but serve as intelligent assistants, improving the quality and productivity of decision-making in farmer's field.

Farmers' suggestions for effective utilization of Expert System : The suggestions from subjects were elicited for effective utilization of Expert System. The results are furnished in Table 4.

Need Expert System for other technologies in rubber: The findings of the study have very clearly indicated that the subjects required Expert Systems on other technologies of rubber in addition to the RUBEXS-04.

From Table 4, it could be inferred that slightly less than three-fourth of the subjects (70.00 per cent) expressed that they need Expert System on latex preservation and processing. Rubber growers are gradually shifting from quantity to quality production in the changing liberalized era to meet the global market. This might have made them to know more about quality production. Almost equal number of the respondents (68.33 per cent) expressed to have Expert System on tapping and yield simulation. This may be due to the fact that nowadays the rubber growers are getting reasonably good price for their crop which might have influenced them to know more about scientific exploitation of latex to make profitable farming. Slightly more than half of the subjects (55.00 per cent) stated that they need Expert System on nursery and plant propagation techniques. This is mainly because, still considerable number of rubber

growers are relying upon the local nurseries to get seedlings for their plantations and hence the result to become self reliant and get good quality seedlings.

Less than half of the subjects liked to have Expert System in other technologies like, climate and planting requirement, land preparation and field establishment, field upkeep, intercropping and bee-keeping in rubber plantation.

Table 4. Farmers suggestions for effective utilization of Expert System (n=60)

S.No.	Strategies	No	Per cent
1.	*Need Expert System for other technologies in rubber*		
i.	Latex preservation and processing	42	70.00
ii	Tapping and yield stimulation	41	68.33
iii	Soil management	38	63.33
iv	Nursery and plant propagation techniques	33	55.00
v	Climate and planting requirement	27	45.00
vi	Land preparation and field establishment	26	43.33
vii	Field upkeep	18	30.00
viii	Intercropping	13	26.67
ix	Beekeeping in rubber plantation	6	10.00
2.	*Need training on the operation of Expert System*		
i	Necessary	60	100.00
ii	Not necessary	-	-
3.	*Duration of training required to operate Expert System*		
i	One day	53	88.33
ii	Two days	7	11.67
4.	*Place to keep the CD with Expert System package*		
i	Rubber Producer's Society (RPs)	60	100.00
ii	With field officers of Rubber Board	52	86.67
iii	Krishi club	41	68.33
iv	With input dealers	8	13.33
5.	*Affordability of Expert System packages and computer*		
i	By individual farmer	2	3.33
ii	By group of farmers	58	96.67
6.	Assistance to purchase computer and CD loaded with Expert System		
i	Needed	60	100.00
ii	Not needed	-	-

* *Multiple responses obtained*

Need training on the operation of Expert System: It was observed from the result that cent per cent of the subjects fell in the category of necessary to have training on the operation of Expert System. This might be due to the fact that cent per cent of the subjects have not attended any training on computer so far and a great majority (90.83 per cent) of them had low level of familiarity in using computers. Anandaraja (2002) who reported the similar findings and revealed that all the non-computer owning respondents needed training on the operations of computer and IMCD.

Duration of training required to operate Expert System: It is seen from the table that 88.33 per cent of the subjects felt that they need a training for a period of one day to become familiar with operation of Expert System. They stated that one day is enough to understand the functions of all the navigation tools and learn to open, run and get a diagnostic result from the Expert System.

Place to keep the CD with Expert System :It is evident from the Table that cent per cent of the subjects opined that the CD with Expert System package should be kept in Rubber Producer's Societies (RPSs). This may be due to reason that all the subjects selected for the study are members in Rubber Producer's Societies. The RPSs are envisaged to function as extension arms of Board and to facilitate a meaningful devolution of extension function to render effective service to the small growers and hence the result.

A majority (86.67 per cent) of the subjects were also suggested to keep the Expert System package with field officers of Rubber Board. The reason might be the availability of extension officers at all zonal / regional offices and field stations posted by Rubber Board and they frequently visit the rubber plantation for advisory purpose. Growers could also meet these officers at their offices for interaction. Slightly more than two-third (68.33 per cent) of the subjects suggested to keep the Expert System with Krishi clubs (KHDP) and very minimum percentage (13.33 per cent) of the subjects were in opinion to keep it with input dealers.

Affordability of Expert System packages and computer: A great majority of the subjects (96.67 per cent) expressed that, individual farmer would not afford to bear the high cost of computer and Expert System packages. The reason might be that majority of the subjects had small holdings of rubber. On the other hand they felt that through groups (RPSs) they could afford it.

Assistance to purchase computer and CD loaded with Expert System: Cent per cent of the subjects reported that they needed assistance to purchase computer and other accessories. They required financial assistance such as long term loan, subsidy from Rubber Board and insurance etc. This finding is in agreement with the findings of Anandaraja (2002).

Suggested stages for designing and effective utilization of Expert System : Based on the experiences and empirical evidence evinced in this experimental study the following stages are proposed for design and effective use of Expert System in Agriculture.

Stage I: Identify the major and location specific problems in agriculture with its stakeholders through participative approaches.

Stage II: Collect the practical experience of the experts in the concerned field and available literature on the particular subject under study.

Stage III: Represent the collected knowledge base appropriately according to the various branches of subject matter.

Stage IV: Choose the simple and user friendly software from the bundle of available softwares.

Stage V: Consider the technical components of expert system such as sequential and logical diagnostic path, field reality of the problems, use of local language and simple words, use of adequate and appropriate photographs and animation, insertion of audio etc.

Stage VI: Validate the developed Expert System with its clients for its refinement.

Stage VII: Use the developed Expert System in an interactive mode with its clients with preliminary orientation about the Expert System.

Stage VIII: Place the Expert System in a common venue like office of the block level agricultural offices / Krishi clubs. This Expert System may be put to operation and execution by the self help groups / commodity groups / farmers organisations.

Stage IX: Identify and train local diploma / graduates in agriculture / Extension officers.

Stage X: Dissemination of farm technologies using Expert System by the Officers trained individuals to achieve effective TOT in terms of better knowledge gain, retention, knowledge related skill, symbolic adoption and thereby adoption.

Stage XI: Based on the feedback and emerging problems in the agro-ecological system the stages may be reconsider to design new Expert System to suit the need.

CONCLUSION

A majority of the subjects were most satisfied and expressed that the diagnostic path leads to correct conclusion, diagnostic path is sequential and logic questions were based on field reality. But, few of them were not satisfied with the adequacy of the message.

To conclude, farmers recognised RUBEXS-04 as user-friendly, invaluable and a very useful tool for the identification and management of pest and disease of rubber crop. It can be used by (a) farmers, especially who are unfamiliar with all the variations and combinations of crop diseases and disorders, (b) extension officers who may not be specialised in pests and disease of rubber, but who because of the varied nature of their work, are required to make diagnosis and solve such problems on the spot and (c) moreover, this could also be used by trainers and students concerned with rubber crop for whom the RUBEXS-04 provides a satisfactory teaching / learning aid. It will not be a substitute for extension officers and will be a complementary to the field extension officers, which would allow him to recommend appropriate control measures with confidence though it could be used as an effective extension teaching tool in future.

Most of the subjects preferred the Expert System for other technologies of rubber like, latex preservation and processing, tapping and yield stimulation and soil management, in addition to RUBEXS-04.

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