Adopter categorization of extension professionals vis-à-vis agri-expert systems and factors influencing the adoption

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This communication focuses on adoption stages of extension professionals in terms of extent of use of expert systems and factors influencing the extent of adoption of such systems by them, with special reference to agri-expert systems 'KAU-Fertulator' and 'e-Crop doctor' developed by Kerala Agricultural University. A survey was conducted among three targeted segments of Kerala extension professionals with a total of 100 respondents who were actively involved in the field of agriculture, to evaluate questions about the adoption stage of respondents in using agri-expert systems and factors influencing the extent of adoption. Results showed that, extension professionals categorization based on the stage of agri-expert system adoption process. Based on the stage of adoption, respondents were categorized into different adopter categories, which led to comparison with Roger's adopter categorization. Also, innovation proneness was positively and significantly related with extent of adoption expert system among all three categories of respondents. Based on the results, it is imperative to boost the adoption of agri-expert systems by streamlining the basic expert system applications for ease of use.

Keywords: Adoption stages, agri-expert system, extension professionals.

IN the changing agricultural scenario, the agricultural field has not been computerized to the required extent. However, in the last decade, artificial intelligence-based computer programs, known as expert systems, have received a great deal of attention throughout the world, due to their impressive problem-solving capability in a variety of fields. To mention a few, they have immense potential in research, with the ability to solve complex problems by their dynamic and heuristic strategies. Expert system is a branch of artificial intelligence (AI) which deals with helping non-experts to find solutions to complex problems in a more expert-like fashion[1]. It performs many functions as an expert does, such as posing relevant questions and explaining its reasoning process. One of the most exciting features of the expert system development is the availability of this sophisticated computer technology for immediate practical use by the entire agricultural community. Expert systems are used mainly as extension tools in contrast to research activity. Their extension role presents several fundamental obstacles to their successful adoption in agriculture. An expert system must be judged by higher standards. It cannot be considered successful just because of correct mimicking of expert's knowledge, as it must also be employed by at least some of the potential users[2]. Adoption of expert systems appears to depend on the system attributes, the support of the system and user characteristics. However, a communication technology like agri-expert system achieves its full potential when adequate users in the communication network also adopt the technology[3]. The value of an expert system is limited if none of its customers/suppliers use or adopt it. If an expert system is intended for the benefit of the farming community through the guidance and support of extension personnel, the first to be aware and use the same should be the extension personnel. The extent of use of the expert system will have a direct bearing on the adoption of intended technologies among the farming community. Hence, a systematic appraisal of existing expert systems in agriculture vis-à-vis their adoption and factors influencing the extent of adoption of such systems among the extension personnel will be of great significance in terms of their practical utility.

A survey was conducted using pre-tested and structured questionnaire during 2012–2014 among three targeted segments of Kerala extension professionals to evaluate questions about the adoption stage of respondents in using agri-expert systems and factors influencing the extent of adoption of such systems by them. The method of data collection implemented was personal interview method in which each respondent was personally encountered and data collected using a questionnaire. Respondents were selected through simple random sampling from the whole of Kerala. The study sample constituted 100 respondents from Kerala state, comprising 40 agricultural officers (AOs) of the State Department of Agriculture (SDA), 30 frontline extension professionals of Krishi Vigyan Kendras (KVKs) and non-governmental organizations (NGOs) actively involved in the field of agriculture, and 30 scientists involved in the extension programmes of Kerala Agricultural University (KAU), ICAR (Indian Council of Agricultural Research) institutes and commodity boards.

The diffusion–adoption model was employed to categorize extension professionals by stage in the technology adoption process. Rogers has developed a sequence of stages to describe the adoption process. The adoption stages offer a logical progression of five sequential stages for the adoption of an expert system by extension professionals, viz. awareness, interest, evaluation, trial and adoption. Since the adoption of an agricultural innovation followed a normal curve, Rogers classified the adopters

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by calculating the mean for the curve and then, by adding or subtracting the standard deviation, divided the curve into five segments[4]. The segments assigned to these categories were: innovators, early adopters, early majority, late majority and laggards.

In the present study, we apply the diffusion–adoption model on the use of agri-expert system (with special reference to KAU-Fertulator and e-Crop Doctor) by extension professionals and to determine the extent of their adoption of such systems for decision-making. Subsequent analysis helps identify extension professionals at each adoption stage. The test consisted of five questions which were provided with 'Yes' or 'No' choices. The respondents were asked to tick mark the correct answer.

The study also depicts factors influencing the extent of adoption of agri-expert systems by respondents with correlation analysis. The main factors influencing the extent of adoption of agri-expert systems were as follows.

Age: It was operationalized by considering the chronological age of the extension personnel in completed years at the time of investigation.

Education: This was operationalized as the number of years of formal schooling obtained by the extension personnel.

Training: This refers to the number of times training was received by the respondents on Information Communication Technology (ICT) tools.

Innovation proneness: This refers to the behavioural pattern of an individual who has interest and desire to seek changes in ICT tools, and is ready to introduce such changes which are practical and feasible.

Availability: This was operationalized as the ICT offered with reasonable proximity and appropriate hardware and software.

Accessibility: This refers to the ability to access the expert system.

Retrievability: This was operationalized as the extent to which information provided in the system can be easily located and received by any user.

Relevancy: This was operationalized as the opinion of the respondents about the suitability of the information provided by agricultural expert system to the users' situation. It was assessed whether the system was able to provide information suitable and appropriate to the users' needs.

Format clarity: This was operationalized as the extent to which information given is in clear format, which helps the receiver to arrive at a decision.

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

Timeliness: This was operationalized as the information provided when it is needed.

Accuracy: This was operationalized as the quality of information being near the true value.

The completed and returned questionnaires from our sample of respondents revealed that 10% of them were at awareness stage (had just come to know about the expert system), 19% at interest stage, 32% at evaluation stage, 24% at trial stage and 15% were at adoption stage in using agri-expert systems for decision making (Table 1).

Based on the stage of adoption, respondents were categorized into innovators, early adopters, early majority, late majority and laggards for adopter categorization using percentiles, as measure of check (Table 2).

Table 2 reveals the respondent's stage in the different adopter categories. It is evident from the table that 10% of the sampled respondents belonged to the 'innovators' category; followed by early adopters (19%), early majority (32%), late majority (24%) and laggards (15%). A detailed perusal of Table 2 and Figure 1 further reveals that the frontline extension personnel (FLEP) of KVKs and NGOs belong to the 'innovators' category with the highest percentage (13.33), when compared to scientists of ICAR institutes and AOs of SDA. A similar pattern was observed in case of early adopter and early majority categories.

Observing the 'AOs' stage in the diffusion–adoption process, 7.5% of the sampled respondents belonged to the 'innovators' category, followed by 15% to the early adopters, 27.5% to early majority, 30% to late majority and 20% to laggards. In case of 'FLEP' stage in the diffusion–adoption process, 13.33% of the sampled respondents belonged to the 'innovators' category, followed by 16.66% to early adopters, 36.66% to early majority, 20% to late majority and 13.33% to laggards. In case of 'scientists' stage in the diffusion–adoption process, 10% of the sampled respondents belonged to the 'innovators' category, followed by 26.66% to early adopters, 33.33% to early majority, 20% to late majority category and 10% to laggards.

Table 2 and Figure 1 further reveal that in all the three categories, the innovators, early adopters and early majority showed high percentage, and the late majority and laggards showed were low percentage when compared to the Roger's standard adopter categorization, except AOs wherein laggards showed high percentage. This might be because respondents were more interested in using e-agricultural extension technology for solving farmer's problems and they perceived that relatively less proficiency is essential for using agri-expert systems. Based on studies of characteristics that determine the success of this Kerala Agricultural University agri-expert system innovation, it has been identified that it is convenient to emphasize the following information for communication through expert systems to enable adoption with special reference to innovators, early adopters and early majority.

- Agri-expert systems are more relatively advantageous.
- Compatibility of the agri-expert system with the end-users wishes and needs.

Table 1. Categorization of respondents based on the stage of adoption

Statements on stages of adoption	Agricultural officers (n = 40)	Frontline extension personnel (n = 30)	Scientists (n = 30)	Total
Name any expert systems you know or you have used (awareness stage)	3	4	3	10
Do you have interest to get training on the use of expert systems? (interest stage)	6	5	8	19
Are you aware about the advantages and disadvantages of expert systems? (evaluation stage)	11	11	10	32
Have you used expert system to determine the usefulness for further adoption? (trial stage)	12	6	6	24
Are you solving farmer's problems mainly through the use of expert systems? (adoption stage)	8	4	3	15

Table 2. Adopter categorization of respondents with reference to usage of Kerala Agricultural University expert systems

	Agricultural officers (n = 40)		Frontline extension personnel (n = 30)		Scientists (n = 30)		Total	
Category	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Innovators ($>P_{80}$)	3	7.5	4	13.33	3	10	10	10
Early adopters (P_{80}–P_{60})	6	15	5	16.66	8	26.66	19	19
Early majority (P_{60}–P_{40})	11	27.5	11	36.66	10	33.33	32	32
Late majority (P_{40}–P_{20})	12	30	6	20	6	20	24	24
Laggards ($<P_{20}$)	8	20	4	13.33	3	10	15	15
Percentile under each class of respondents	P_{20}–9.33, P_{40}–20, P_{60}–40, P_{80}–66.66		P_{20}–6.66, P_{40}–20, P_{60}–40, P_{80}–66.66		P_{20}–20, P_{40}–40, P_{60}–40, P_{80}–66.66			

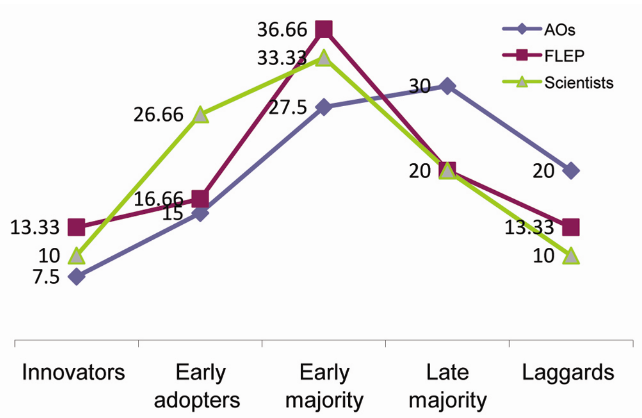

Figure 1. Adoption curves indicating the distribution of three categories of respondents.

- Overall impact created by the agri-expert system.
- Exclusiveness and value of exclusiveness of the innovation.
- Economy, affordability and durability of the innovation.
- Complexity or the degree of ease of use of the innovation.

The traditional way of advising recommendations was time-consuming as it had to consider many variables such as varieties, spacing, area and package of practice recommendations for giving specific fertilizer or pesticide/ fungicidal or herbicidal recommendations. With the advent of KAU expert system, these recommendations could be made within seconds through confirmative option selections. Also, with system being available offline, net connectivity was not a problem for its use when compared to many crop-specific and on-line expert systems. These qualities reaffirmed the innovation characteristics with special reference to KAU expert systems. The diffusion curves for breakthrough communication technologies have historically taken a decade or more to grow after their first introduction[5]. However, in this study, diffusion and adoption of KAU expert systems, viz. 'KAU-Fertulator and e-Crop Doctor' took place relatively faster than other communication technologies, which is slightly different from the findings of Ortt and Schoormans[5], and is actually a positive aspect of this expert system. However, the expert system needs to be further popularized through an 'awareness/hands-on training' to further scale up its use for the assistance of the farming community.

The results of correlation analysis (Table 3) were taken into consideration for analysing the influence of factors on the extent of adoption of the expert system by the respondents. Correlation analysis revealed that out of 12 factors, only one, namely innovation proneness was positively and significantly related with the extent of adoption of the expert system among all three categories of respondents, viz. AOs of SDA, FLEP of KVKs and NGOs, and scientists at 1% level of probability.

However, a detailed analysis showed that 2 out of 12 factors were positively and significantly correlated to the extent of adoption of the expert system AOs of SDA; 6

Table 3. Factors influencing the extent of adoption of agri-expert systems

Factors	Correlation coefficient '*r*' value		
	Agricultural officers (n = 40)	Frontline extension personnel (n = 30)	Scientists (n = 30)
Age	–0.126	0.339	0.130
Education	0.052	0.157	0.199
Training	0.065	0.593**	0.317
Innovation proneness	0.327**	0.589**	0.615**
Availability	0.062	0.601**	0.535**
Accessibility	0.221	0.150	0.435
Retrievability	0.298	0.241	0.327
Relevancy	0.116	0.491**	0.483**
Format clarity	0.451**	0.144	0.144
Information content	0.253	0.467**	0.662**
Timeliness	0.105	0.460*	0.337*
Accuracy	0.301	0.472**	0.469**

*Significant at 0.05 level of probability; **Significant at 0.01 level of probability.

out of 12 factors were positively and significantly correlated to the extent of adoption by FLEP at 1% level of probability. While, availability, innovation proneness, training, information content, accuracy and relevancy were the factors influencing the extent of adoption by FLEP, availability, innovative proneness, information content, accuracy and relevancy were the influencing factors for scientists. In case of FLEP and scientists, timeliness was positively and significantly related to the extent of adoption at 5% level of probability. Accessibility was positively and significantly related to the extent of adoption by scientists at 5% level of probability.

Table 3 reveals that the coefficient of correlation between the 'extent of adoption of the expert system' and factors such as innovation proneness among all categories of respondents is greater than the table value of r at 0.01 level of probability. Hence, null hypothesis was rejected and empirical hypothesis was accepted. It could, therefore, be inferred that there is a positive and significant relationship between innovation proneness and extent of adoption of the expert system. In case of FLEP and scientists, availability, relevancy, information content and accuracy are the factors which when increased might have resulted in greater adoption of agri-expert systems. The similar trend of increased training of respondents will increase the adoption of agri-expert systems by FLEP at 0.01 level of probability. Timeliness is the factor which influences the rate of agri-expert system adoption by FLEP and scientists at 0.05 level of probability. It could, therefore, be inferred that there is a positive and significant relationship between the stated factors and extent of adoption of agri-expert systems.

Training on ICTs would enhance the usage of agri-expert systems. FLEP from KVK and NGOs perceived that training programmes on ICT tools would make them aware about new agri-expert systems, and could impart knowledge and skill to adopt such systems. Innovation proneness directly influenced the extent of adoption among all categories of respondents. This might be because AOs from SDA were more to know about new ICT aspects. FLEP and scientists were directly involved in developing new ICT tools, which motivated them to adopt agri-expert systems. Availability of agri-expert systems among FLEP and scientists directly influenced the extent of adoption of the expert system. This might be because most of the respondents felt that availability of hardware and software products to operate expert systems was ease in use, which prompts them to adopt the expert system. Relevancy of agri-expert systems among FLEP and scientists directly influenced the extent of adoption of such systems. This might be because most of the respondents felt that the expert system was able to provide information suitable to the users' resources and appropriate to the users' needs, which would enhance the usage of such systems. Format clarity of agri-expert systems among AOs of SDA directly influenced the extent of adoption of the systems. This might be because most of the AOs felt that it was effective for the trainers to post messages to the learners to stimulate discussion and encourage interaction, if the format is clear enough to enhance the adoption of agri-expert systems. Information content of agri-expert systems among FLEP and scientists directly influenced the extent of adoption of such system. This might be because most of the respondents felt that the information content from expert systems was clear, easily understandable and adequate to adopt them. Timeliness of the information from agri-expert systems among FLEP and scientists directly influenced the extent adoption of such systems. This might be because most of the respondents felt that information was being provided at the right time. FLEP and scientists were also involved in development of expert systems, and hence they were good enough to quickly retrieve information. Accuracy of information from agri-expert systems among FLEP and scientists directly influenced the extent of adoption of such systems. This might be because most of the respondents from these two categories perceived that information from the agri-expert system is near to true value with greater accuracy which can be enhanced the decision making ability of end users for the betterment of farming community.

The findings of the present study confirm that more respondents belonged to 'innovators' category with special reference to the use of KAU expert system when compared to Roger's standard. Innovation proneness was positively and significantly related with the extent of adoption of the expert system among all three categories of respondents. Even though a fair percentage of respondents belonged to the 'innovators/early adopters/early majority' category, there was a gap between laggards and innovators. This gap should be reduced by imparting proper training for augmenting the usage of agri-expert systems for effective decision-making with precise, correct and timely information.

1. Waterman, D. A., *A Guide to Expert Systems*, Pearson Education, Delhi, 2004, p. 419.
2. Plant, R. E. and Stone, N. D., *Knowledge-Based Systems in Agriculture*, McGraw-Hill, NY, USA, 1991, p. 364.
3. Chetsumon, S., Attitudes of extension agents towards expert systems as decision support tools in Thailand. Ph D thesis, Lincoln University, Thailand, 2005.
4. Rogers, E., Categorizing the adopters of agricultural practices. *Rural Sociol.*, 1958, **23**, 345–354.
5. Ortt, J. and Schoormans, J. P. L., The pattern of development and diffusion of breakthrough communication technologies. *Eur. J. Innov. Manage.*, 2004, **7**(4), 292.

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Comparative analysis of spectral characteristics of EO-1 ALI and Landsat 8 OLI imagery

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Landsat 8 (L8) is the only normally operating Landsat satellite at present, and the Earth Observing One (EO-1) Advanced Land Imager (ALI) was the prototype for operational land imager (OLI) on-board the L8 satellite. To comprehend well the differences in spectral characteristics between the two sensors, six nearly simultaneous image pairs were selected, which included five land-cover categories: water, bare soil, vegetation, manmade and rock. Moreover, comparisons of spectral characteristics were made through orbital parameters, imaging parameters, spectral response characteristics and spectral characteristics. Finally, the mutual quantitative relations were built up among these image pairs. The results demonstrate that Landsat 8 OLI and EO-1 ALI have similar orbital parameters. With regard to the imaging and spectral response characteristics, the top-of-atmosphere (TOA) reflectance and normalized difference vegetation index (NDVI) of EO-1 ALI are slightly different from those of L8 OLI, but there is a high correlation between EO-1 ALI and L8 OLI of TOA reflectance and NDVI, with the coefficients of determination ranging from 0.962 to 0.994. Therefore, the TOA reflectance and NDVI images from the two sensors are complementary.

Keywords: Top-of-atmosphere reflectance, spectral characteristics, image pairs, vegetation index.

To probe and quantify long-term changes in the earth's environment using satellites, one usually relies on multi-sensors and multi-date datasets. However, the quality of remote-sensing images varies as a result of atmospheric attenuation, sun-looking geometry parameters, orbital and imaging parameters, etc.[1]. Consequently, to monitor changes over time, it is crucial to comprehend the discrepancies between different remote sensors.

Landsat-8 (L8) launched on 11 February 2013, is the only normally operating Landsat satellite at present. It carries two sensors, Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). Earth Observing One (EO-1), launched on 21 November 2000, has three sensors on-board, including the Atmospheric Corrector

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