Agriculture Update
Volume 7 | Issue 1 & 2 | February & May, 2012 | 113-118

Research Article

Scale to measure information efficiency of agricultural expert system

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Article Chronicle :
Received :
24.01.2012;
Revised :
22.02.2012;
Accepted :
28.03.2012

SUMMARY : A study was conducted to develop a scale for measuring the information efficiency of the agricultural expert system-'Diagnos-4', developed by Kerala Agricultural University. Forty researchers in Transfer of Technology and forty extension personnel formed the sample of the study. After a series of systematic procedures, Information Efficiency Scale was constructed including five dimensions with forty seven items. The information efficiency index was composite, reflecting the ability of the system to provide maximum information to the users at ease. The standardisation of the scale was done by establishing the reliability and validity of the scale.

How to cite this article : Helen, S. and Kaleel, F.M.H. (2012). Scale to measure information efficiency of agricultural expert system. *Agric. Update*, **7**(1&2): 113-118.

Key Words :
Agricultural expert system, Information efficiency scale, User friendliness

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BACKGROUND AND OBJECTIVES

The world is witnessing a revolution in Information and 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. Local information resource centres 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 Agricultural Expert System to satisfy the information needs of farmers. Hereafter Agricultural Expert System is referred as AES. The dissemination of the technologies could be enhanced by using expert systems and other artificial intelligence technologies (Hadi *et al.*, 2006).

In this context, Kerala Agricultural University developed an Agricultural Expert System (AES) for diagnosing pests and diseases of nine major crops of Kerala called 'DIAGNOS-4'. The modified version of it is likely to be released shortly for the benefit of all the stakeholders involved in agricultural development. User friendliness of the system needs special attention, which is mostly a forgotten area in any of the technology development process. Before releasing the software, it is appropriate to assess the information efficiency of the AES so as to make suitable modifications for making it more user friendly.

RESOURCES AND METHODS

'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. The research was conducted among the researchers from the Agricultural Research Institutes all over India, which are involved in developing AES and the Transfer of Technology (TOT). Forty researchers and forty extension personnel formed the sample of the study. The respondents were selected purposively who were either having an exposure or awareness about the performance of agricultural expert system.

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 the information efficiency of computer aided instruction tools. A review on various aspects of measurement of communication

efficiency, inter personal communication behavioural 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 calculated, reflecting the ability of the system to provide maximum information to the users at ease.

The present study tried to assess the AES by the users such as researchers, extension personnel and farmers in terms of its information efficiency. The first step in the development of the scale was to identify all possible dimensions for the scale were prepared after an elaborate review of pertinent literature available, consultation with experts and based on researcher's own conviction. Sixteen identified dimensions were screened to ten dimensions based on judges' opinion. From the ten dimensions, five dimensions were selected based on the stages of application and ranking of the mean relevancy indices (Table A).

Item generation:

The items related to information efficiency of AES under each dimension were identified. The primary source for item collection was literature, discussion with experts in related fields through critical incident technique. The collected items were screened by verifying its applicability in relation to the information efficiency of AES. Forty seven items were generated and theoretically classified under five major dimensions. The appropriateness of the items was pre-tested with a group of judges.

Preliminary screening of items:

The relevancy of the forty seven 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 forty judges were taken into account. The relevancy index for all the items were worked out and are presented in Table 1. The item having relevancy index of 70 and above were selected for the study.

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, correlation of items scores with total score were the most common indices used in item analysis (Guilford, 1971).

While developing managerial leadership scale by Mathew (1989) and managerial efficiency scale by Anantharaman (1991) conducted relevancy test and calculated item discrimination. 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.

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

Table A: Relevancy indices of identified dimensions for measuring the information efficiency the performance of AES

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

* Selected dimensions for assessing the information efficiency of AES.

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).

OBSERVATIONS AND ANALYSIS

The results obtained from the present investigation has been discussed below:

Selection of items for final scale:

Based on the stages of application and ranking of the mean relevancy indices, the dimensions such as Retrievability, Relevancy, Practicability, Information content, Knowledge gain by the respondents were selected 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 within less time. The received information should be easily understood by the user and could be printed as handout for future reference (Table 1).

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 (Table 1).

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 (Table 1).

Knowledge gain:

Knowledge gain was the quantity of information gained by the respondents before and after exposure of AES. 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, which would be a favourable niche to take right decision as well as extension of action in various functional areas of farming.

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. In order to measure the knowledge provided by AES on plant protection technologies of rice, coconut and banana, a knowledge test was developed using the steps as given under:

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. 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.

Administration of items:

Sixty items were administered among thirty extension personnel 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.

Difficulty index:

The difficulty value of an item refers to the proportion or percentage of individuals who answer the item correctly (Garrett, 1966; Guilford, 1971). 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.

Discrimination index:

Discrimination index referred to the extent to which an item discriminates well informed individual from the poorly

Table 1: Relevancy indices of identified items for measuring the perception of the respondents regarding the information efficiency of AES

Sr. No.	Identified items	Relevancy indices		
		Researchers	Extension personnel	Farmers
	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
	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
	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
	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

informed ones. Marshall and Hales (1972) defined discrimination index 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).

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

Table 2. Difficulty and discrimination indices of identified items under the dimension of knowledge gain from AES

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*
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}

Contd... Table 2

Contd.....Table 2

Bolded item numbers were selected for the knowledge test

of the item as recommended by Garrett (1966).

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). By computing point- biserial analysis, 5 more 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 assessing the knowledge gain from the 'Diagnos–4' and administered to the respondents. The value of discrimination index and difficulty index are presented in the Table 2.

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 the knowledge gain from the 'Diagnos–4' and able to provide information to the users based on their demand.

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

$$\textbf{Information efficiency index} = \frac{\textbf{Obtained total score}}{\textbf{Maximum possible score}} \textbf{ x 100}$$

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 efficient :	Above mean + 1 S.D
Medium efficient :	Between mean ± 1 S.D
Low efficient :	Below the mean – 1 S.D

Standardization of the scale:

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

Reliability of the scale:

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 administered 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 administered 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.

Validity of the scale:

Content validity 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, five dimensions were identified with different number of items under each dimension were selected carefully through scientific procedures to represent these dimensions. The items had been further subjected to item analysis to determine their relevancy to assess the Information Efficiency Index of AES. Such a way of meticulous and rigorous procedures followed in developing the scale automatically ensured it with high facing and sampling validity.

Conclusion:

Information Efficiency Scale was constructed to measure the information efficiency of the agricultural expert system developed by Kerala Agricultural University, 'Diagnos –4'. The scale included five dimensions with forty seven items. The information efficiency index was composite, reflecting the ability of the system to provide maximum information to the users at ease. The standardisation was done by establishing the reliability and validity of the scale.

Acknowledgement:

This study forms the part of the Ph.D. research programme of College of Horticulture, Vellanikkara. The authors wish to thank the Kerala Agricultural University for providing financial support for conducting the research programme and also thank all the respondents who responded promptly in completing the study with in the time frame.

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