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# A Standardized Scale to Measure Attitude of Agricultural Scientists towards ICT

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Advancement of Information Communication Technologies has become a crucial factor in improving decision making capacity of agricultural scientists, facilitating retrieval and sharing of agricultural information. This article aims at designing and validating a psychometric scale on basis of Likert's method of summated ratings to assess the attitude of agricultural scientist towards information communication technologies. Attitude is a developed feeling or emotion towards a psychological object which helps an individual to give a verdict on that psychological object. Commencing with initial set of 70 statements prepared/developed on the basis of insights from literature review of previous empirical research on attitude scales towards ICT, final scale constituted of 17 statements. The items were subjected to relevancy test and items having 't' value

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higher than 1.75 were selected in final scale. On the basis of and 't' value 17 statements constituted the final scale. The aggregate scale was verified for internal consistency and content validity. Cronbach's alpha value of 0.75 and whole test reliability value of 0.55 computed using the Spearman-Brown Prophecy formula established satisfactory level of internal consistency as reliability of the scale. Content validation of scale was ensured by administering the selected items to judges. The standardized scale allows quantitative assessment of agricultural scientist and would have practical applicability in discovering the intensity of attitude of agricultural scientist and thus facilitates to take right decisions by policy makers.

*Keywords: Psychometric scale; summated rating scale; Likert's scale construction; agricultural scientist; attitude scale; ICT.*

## 1. INTRODUCTION

"Access to information is a crucial factor in socio-economic transformation. The advancement of novel information and communication technologies (ICTs) has accelerated agricultural and rural development" [1]. "With the growth of smart phone and internet, traditional ICTs have evolved rapidly to include video, voice, SMS, apps, and internet-based services" [2]. "For international agriculture experts, there is a demonstrated need to evaluate capacity of ICT for development and fruitful implementation in agriculture" [3,4]. Smartphones have become widely used ICT devices across the globe [5] and mobile phones with internet connectivity have increased from 744 million users in 2020 from 930 million users by the year 2022 [6]. "ICTs refer to technology used for creation, acquisition, retrieval, storage, and dissemination of vocal, pictorial, textual, and numerical information for advancement of agriculture" [7]. "However, failure to link innovative and novel agricultural information with scientific community and related stakeholders can significantly affect overall agricultural development. Under Bharat Net Programme; internet-enabled devices in the rural market are believed to flourish rapidly as government plans to fiberize all villages by year 2025" [8]. "Conducting a needs assessment for ICT information and interventions in global agriculture may offer insights to effective extension-based information dissemination" [9]. A logical next step for ICT capacity building within international extension and agricultural scientist is to develop a scale for assessing existing attitude towards use of ICT in agriculture.

"Attitudes are individually attributed emotions, beliefs and behavioral tendencies an individual has towards a specific abstract or concrete object" [10]. "It is a hypothetical construct that represents an individual's degree of like or dislike for something" [11]. "Attitude scales attempt to determine what an individual believes, perceives or feels. Likert's summated rating method is a scale construction technique by which statements (items) that are favourable or unfavourable to the psychological object are standardized for the purpose of assessing attitude for a group of individuals about a particular object" [12]. "This method of scale construction is most popular form of attitude measurement and referred as attitude scale as they are derivation of a scaling procedure developed by Rensis Likert. It is a crude measuring device, consisting of a number of statements to which an individual must express his or her degree of agreement or disagreement" [13]. "Depending on the respondent's endorsement of each statement, a particular score is rendered. The total score which is calculated by adding up the scores for each item, places the respondent on a continuum from least favorable to most favorable. Attitude scale developed from Likert's scale construction technique comprised of a set of statements or items that scale an individual's level of agreement, favorability or other similar perception" [14]. Therefore, present study is focused on standardizing a scale to report the processes used to develop and validate a scale that focuses on the features of the ICT to be used by the agricultural scientist of the Punjab Agricultural University. All the procedural steps followed in developing a standardized attitude scale to measure the agricultural scientist attitude towards information and communication technologies are discussed in this paper.

## 2. METHODOLOGY

Likert's method of summated rating scale was used to develop the attitude scale. Attitude for the present study is operationalized as the degree of positive or negative feeling associated with ICT use and its features. All the systematic

steps were followed for the scale construction i.e. Item Collection, Relevancy Test and Selection of Items, Item Analysis and Computation of 't' value, Reliability Test and Validity Test. Possible statements concerning the psychological object attitude was collected based on review of literature, discussion with scientists and extensionists. In total a collection of 70 items were prepared initially which were organized and structured in form of an attitude items. The items were screened by following the fourteen (14) informal criteria suggested by Edwards (1969) [15] for editing and restructuring the statements at all stages of statement development. Based on the screening, 40 items which formed the universe of content were selected. The selected items include both positive and negative statements. To know the relevancy of each item towards the construct of study, the 40 items were then subjected to judge's opinion on a five-point continuum, ranging from, highly relevant to not relevant. The judges were also asked to make necessary modification, addition or deletion of the statement based on their judgments. The list of statements was sent to 100 judges who comprised of experts in agricultural extension from ICAR and scientists from Punjab Agricultural University and Govind Ballabh Pant University of Agriculture and Technology. Among the judges 60 responded back with their judgments. Based on their judgment relevancy scores individual items were screened for relevancies towards ICT using the following formula.

a) Relevancy Percentage (RP) It was obtained by using the following formula:

$$R.P.=\frac{MR\times5 +R\times4 + SWR\times3 + LR\times2+NR\times1}{\text{Maximum possible score}}\times100$$

b) Mean Relevancy Score (MRS) It was worked out using the following formula:

$$M.R.S.=\frac{MR\times5 +R\times4 + SWR\times3 + LR\times2+NR\times1}{\text{No.of judges responded}}$$

The final statements for scale were selected by calculating the t value for each item. The t-value method of summated rating scale was followed to compute individual score for each item of the scale. The 't' value is a measure of the extent to which a given item differentiates between the high and the low group. In method of summated ratings, the focus is to have set of items (20-25) which differentiate between the high and the low groups. The statements with the t-value equal to or more than 1.75 were selected for the final attitude scale, which indicates that average response of a high and low groups differs significantly. The scores obtained by the respondents were summed up and arranged in descending order. The 25 percent of the respondents with highest total score (the high group) and 25 percent of the respondents with the lowest total score (the low group) were selected for the analysis to calculate the t-value using the formula as given below.

$$t=\frac{XH-XL}{\sqrt{\sum(XH-XH)2+(XL-XL)2\ /n(n-1)}}$$

Where $X_H$= the mean score on a given statement for the high group, $X_L$= the mean score on a given statement for the low group, $\sum (X_H - \bar{x}_H)^2$ = the variance of the distribution of responses of the high group to the statement, $\sum (X_L - \bar{x}_L)^2$ = the variance of the distribution of responses of the low group and t = the extent to which a given statement differentiate between high and the low group.

Scale consistency was measured by employing Cronbach's alpha method which is called coefficient of reliability and to identify how closely set of items are related. It was measured to determine correlation among set of items in scale. Validity of scale was found using content validity to ascertain that the scale is a representative of all aspects of construct and to make conclusions about trustworthiness of scale and to know how accurately scale will test what it intends to measure.

## 3. RESULTS AND DISCUSSION

An objective methodology was devised in order to select the attitude items keeping in mind that the statements selected should adequately represent the respective domain of the universe of content with respect to ICT, as far as possible items with high t- values was selected and more or less equal number of items with agree and disagree attitudes be selected. Care was taken to ensure that the selected items represented the universe of content and covered the psychological, social and economical domains of ICT use in agriculture. Thereby, 17 items were selected with Cronbach's alpha method and with a uniform distribution along the psychological continuum. The procedure used in attitude scale thus constructed is described in detailed in this section.

### 3.1 Item Collection

Large number of items that describe about ICT and its features was studied and carefully edited. In order to frame the statements an item pool of 70 items was created initially by reviewing attitude scales related to study on use of ICT, as well as discussion with agricultural scientists and extension scientists. Some irrelevant statements were discarded from the list of raw statements and 40 statements were retained and selected from the 70 items collected initially. A conscious effort was taken to include approximately equal number of positive and negative statements, capable of differentiating the feeling of agricultural scientist towards use of ICT. The retained set of 70 statements were carefully analyzed by a panel of six experts in the field of scale construction techniques, senior extension education scientists and two experienced sociologists from Punjab Agricultural University. Finally after rigorous discussions with experts, a total of 40 items that are phrased specifically towards measure of construct were finalized for further analysis. Each statement was carefully checked, edited, revised and restructured in light of fourteen (14) criteria suggested by Edward [15].

### 3.2 Relevancy Test and Selection of Items

Relevancy test is the procedure by which the selected items were sent to the experts in the field of ICT for their expert judgment on the relevancy of the statements selected. To know relevancy of selected 40 items, it was administered to 100 judges through individual visits, e-mail as well as Google survey form. The selected judges were experts (Agricultural scientist) in the field related to scale construction techniques, Information and Communication Technology and Extension Education Expert. The responses were received from judges in a time span of 30 days and they were asked to check each of the statement carefully whether relevant or not using five point continnum as highly relevant (5), relevant (4), somewhat relevant (3), irrelevant (2) to highly irrelevant (1). Judges were also requested to make necessary modifications and additions or deletions of words, sentences, as desired. The results of mean relevancy test reveals that among 40 items that were subjected to relevancy test, 27 items made it to the cutoff point of relevancy test. Accordingly, statements having relevancy percentage of more than 64 per cent and mean relevancy score more than 3.47 were considered for further analysis of statements (Table 1). Hence, 27 attitude statements were selected after statistical analysis on basis of relevancy test. These statements were suitably modified and written as per the comments of the judges wherever applicable.

### 3.3 Item Analysis and Computation of 't' Values

Item analysis is an important step in constructing a valid and reliable scale. The purpose of item analysis is to determine how well each item is discriminating between persons having different attitude. For this, a pilot survey was conducted in non-sample area and 27 items that satisfied the criteria for relevancy test (i.e. above relevancy mean score) was administered on 60 agricultural scientists. They were asked to indicate their degree of agreement on a five point continuum namely; Strongly agree, Agree, Undecided, Disagree and Strongly disagree with scores of 5 to 1 for each positive statements and 1 to 5 for each negative statements respectively.

For the purpose of evaluating the statements the respondents were arranged in descending/ ascending order based on their individual scores. After that, criterion group was selected, i.e. 25 per cent of the respondents having the low score/group and 25 per cent having the high score/group were taken. The final scale was constructed by computing t-values as suggested in method of summated rating scale (Likert 1932). The score for their response was summed up and arranged in a descending order. Afterwards out of 27 statements, a set of 19 statements with the t-values equal to or higher than 1.75 were selected to include in final attitude scale. The results shown in Table 2 revealed t-value of the items that were able to differentiate between the high and the low group.

### 3.4 Reliability Test

A scale is reliable when it accurately measures what it intends to measure whenever it is applied into practical use. According to Guilford [16], reliability is the proportion of the true variance in obtained test scores. Kerlinger [17] refers reliability as the accuracy or precision of measuring score of an instrument. Kerlinger [17] opined that when a test gives consistently the same results when applied to the same sample, the test is said to be reliable. This is most crucial to attitude scale construction as it shows the strength of the attitude scale. The designed scale

**Table 1. Relevancy percentage (RP) and Mean relevancy score (MRS) of the statements based on the response of the judges**

| S.No. | Statements | RP | MRS |
|---|---|---|---|
| 1. | ICT enhances agricultural scientist's professionalism* | 92 | 4.6 |
| 2. | I like to access internet and share information through internet* | 67 | 3.4 |
| 3. | The information on ICT is not credible* | 88 | 4.4 |
| 4. | I find it difficult to manage the volume of information | 51.66 | 2.5 |
| 5. | Statistical analysis of the research data become have been eased through the use of ICT* | 91 | 4.55 |
| 6. | Continuous responses on ICT cause tiredness. * | 72.66 | 3.633 |
| 7. | ICT facilitates me to be updated in my field of knowledge | 60 | 3 |
| 8. | I believe that use of electronic media will reduce use of print media | 39 | 1.95 |
| 9. | My way of interacting with farmers is enhanced by my use of ICT | 31 | 1.55 |
| 10. | The security breach concerns limits the reliability on ICT* | 84.33 | 4.21 |
| 11. | Overall use of computer is affecting my health* | 85.66 | 4.28 |
| 12. | I believe that Internet access favors the interconnection between the scientific community | 42.33 | 2.11 |
| 13. | It bothers me to update my academic profile on social media* | 82.33 | 4.11 |
| 14. | ICT based technologies assists teachers in timely decisions* | 89.66 | 4.48 |
| 15. | ICT can be accessed beyond geographical barriers* | 76 | 3.8 |
| 16. | ICT cannot cater emotional aspect while communication | 51.66 | 2.58 |
| 17. | The access of databases and web browsers are facilitating the research work* | 87 | 4.35 |
| 18. | ICT can increase confidence level* | 63.66 | 3.18 |
| 19. | ICT based research tools enhances quality of research* | 63.33 | 3.16 |
| 20. | ICT can increase agriculture and rural development* | 62.66 | 3.13 |
| 21. | One wastes precious time by browsing unnecessary sites on internet* | 87 | 4.35 |
| 22. | Online teaching causes stress* | 65.66 | 3.28 |
| 23. | ICT based teaching system is alternative to traditional teaching system | 40.33 | 2.01 |
| 24. | ICT enhances standard of living* | 65 | 3.25 |
| 25. | I lack e-tools that can support my research* | 95 | 4.75 |
| 26. | ICT cannot deliver personalized information | 59.66 | 2.98 |
| 27. | I believe that use of electronic media will reduce use of print media | 61.33 | 3.06 |
| 28. | E-journals are the fastest way to disseminate the results of research* | 87 | 4.35 |
| 29. | ICT help in improving research-extension-farmer-market linkage* | 75 | 3.75 |
| 30. | Training on ICT improves skills* | 65.66 | 3.28 |
| 31. | ICT creates addiction | 56 | 2.8 |
| 32. | ICT reduces manual capacity to work | 50 | 2.5 |
| 33. | ICT are low cost information exchange platform* | 65.66 | 3.28 |
| 34. | I am interested in learning new ICT tools that I can use in the classroom* | 87.33 | 4.36 |
| 35. | Existing ICT infrastructure of PAU is enough to meet needs of scientists* | 100 | 5 |
| 36. | The technical skills proficiency is a pre-requisite for usage of ICT tools* | 89.33 | 4.46 |
| 37. | The use of ICT creates work-life imbalance* | 88.66 | 4.43 |
| 38. | I encourage use of ICT among farming community | 30.66 | 1.53 |
| 39. | ICT is a complete source of information* | 62 | 3.1 |
| 40. | ICT application in agriculture has created employment opportunities | 48.66 | 2.43 |

**selected items on basis of relevancy test*

**Table 2. Item analysis of statements administered to the agricultural scientist**

| S.No. | Statements | t-value |
|---|---|---|
| 1. | ICT help in improving research-extension-farmer-market linkage | 1.10 |
| 2. | ICT can increase confidence level | 1.23 |
| 3. | The use of ICT creates work-life imbalance* | -1.87 |
| 4. | The information on ICT is not credible* | 2.44 |
| 5. | Continuous responses on ICT cause tiredness* | 3.01 |
| 6. | Online teaching causes stress | -1.47 |
| 7. | The security breach concerns limits the reliability on ICT* | 2.64 |
| 8. | Overall use of computer is affecting my health* | 1.76 |
| 9. | ICT based research tools enhances quality of research | 1.26 |
| 10. | I like to access internet and share information through internet | 1.70 |
| 11. | ICT based technologies assists teachers in timely decisions | -1.45 |
| 12. | It bothers me to update my academic profile on social media* | 4.49 |
| 13. | ICT can increase agriculture and rural development | 1.39 |
| 14. | ICT enhances agricultural scientist's professionalism* | 2.46 |
| 15. | ICT can be accessed beyond geographical barriers* | 1.88 |
| 16. | Training on ICT improves skills | 1.55 |
| 17. | Statistical analysis of the research data become have been eased through the use of ICT* | 2.30 |
| 18. | The access of databases and web browsers are facilitating the research work* | 3.60 |
| 19. | ICT enhances standard of living | 1.65 |
| 20. | One wastes precious time by browsing unnecessary sites on internet* | 3.46 |
| 21. | The technical skills proficiency is a pre-requisite for usage of ICT tools* | 2.35 |
| 22. | I lack e-tools that can support my research* | 5.42 |
| 23. | E-journals are the fastest way to disseminate the results of research* | 2.46 |
| 24. | I am interested in learning new ICT tools that I can use in the classroom* | 3.55 |
| 25. | Existing ICT infrastructure of PAU is enough to meet needs of scientists* | 4.26 |
| 26. | ICT are low cost information exchange platform* | 1.80 |
| 27. | ICT is a complete source of information | 1.58 |

**selected items on basis of 't' value higher than 1.75*

**Table 3. The Final Attitude scale with 17 statements for measuring attitude of agricultural scientists towards ICT**

| S.No. | Final Statements | t-value |
|---|---|---|
| 1. | The use of ICT creates work-life imbalance | -1.87 |
| 2. | The information on ICT is not credible | 2.44 |
| 3. | Continuous responses on ICT cause tiredness. | 3.01 |
| 4. | The security breach concerns limits the reliability on ICT | 2.64 |
| 5. | Overall use of computer is affecting my health | 1.76 |
| 6. | It bothers me to update my academic profile on social media | 4.49 |
| 7. | ICT enhances agricultural scientist's professionalism | 2.46 |
| 8. | ICT can be accessed beyond geographical barriers | 1.88 |
| 9. | Statistical analysis of the research data become have been eased through the use of ICT | 2.30 |
| 10. | The access of databases and web browsers are facilitating the research work | 3.60 |
| 11. | One wastes precious time by browsing unnecessary sites on internet | 3.46 |
| 12. | The technical skills proficiency is a pre-requisite for usage of ICT tools | 2.35 |
| 13. | I lack e-tools that can support my research | 5.42 |
| 14. | E-journals are the fastest way to disseminate the results of research | 2.46 |
| 15. | I am interested in learning new ICT tools that I can use in the classroom | 3.55 |
| 16. | Existing ICT infrastructure of PAU is enough to meet needs of scientists | 4.26 |
| 17. | ICT are low cost information exchange platform | 1.70 |

was tested for its reliability using Cronbach's alpha method. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. The value of Cronbach's alpha was found to be 0.75 showing that the scale has good internal consistency and thus, the scale was reliable.

### 3.5 Content Validity Test

To establish content validity, a thorough review of the literature was conducted prior to and during the development of the individual scales. According to Chovatia et al. [18], the validity of the scale was examined for its content validity to determine how well the content of the scale represented the construct of study. Once a final list of proposed items was developed, a panel of experts reviewed the scale to establish content validity. The 17 final statements were given to 20 judges for their expert guidance in the scale construction. The suggestions given by the experts were included in the scale and therefore the scale satisfied content validity. Also intrinsic validity was found to be 0.55. Hence, 17 items which satisfied procedural conditions of Likert's summated ratings were selected for the final attitude scale. The't' values were significant for all the 17 statements which reflect high discriminating values. It indicated that the scores obtained by utilizing the present scale would measure the intended item. Thus the scale is considered as valid based on the content validity criterion.

### 3.6 Description of the Final Attitude Scale

The final standardized version of the scale (Table 3) would measure attitude of agricultural scientist towards ICT which contains 17 items consisting of both positive (8) and negative statements (9). Those statements will be placed randomly in the scale in order to obtain most honest responses. All the items are framed on a five point continnum. In case of positive statements, strongly agree, agree, neutral, disagree and strongly disagree were scored as 5, 4, 3, 2, 1, while reverse coding was done for negative statements respectively. The score obtained for each statement would be summed up to arrive at the attitude score for the respondents. The score will range from maximum to minimum on a particular value. Maximum score would indicate a favourable attitude and minimum score indicated an unfavourable attitude towards ICT. The respondents would be categorized as 'less favourable', 'moderately favourable' and 'highly favourable' after getting the total attitude score based on the range values of the attitude score possible.

## 4. CONCLUSION

This paper elaborates development of a psychometric scale for quantification of attitude towards ICT use by agricultural scientists. Total 17 items were included in the final scale out of which 8 were positive statements while 9 were negative statements. The purpose was accomplished by verifying the scale's content validity and internal consistency which was found to be 0.75. The reliability and validity analysis revealed that selected items were highly reliable, valid and statistically significant. The standardized scale would have practical applicability in discovering the intensity of attitude of agricultural scientist and thus it facilitates to take right decisions by policy makers. Like any other tool it has certain limitations like prior standardization that need to be considered before its use outside India. The standardized attitude scale will fill gap in the literature related to assessment of attitude towards Information and Communication Technologies uptake by scientific communities for agricultural purposes. It will also serve as a valuable tool for further attitude studies by academicians, extension workers and social organizations involved in promoting ICTs at scientist's level. Hence, the psychometric analysis of the scale has indicated that this tool is reliable and valid, and can prove valuable in assessing the attitude of agricultural scientist towards ICT.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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