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Development of a Scale to Measure the Attitude towards Innovation Use in Rice Farming

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study elucidates the entire methodology adopted for the development of a scale to measure farmers' attitude towards innovation use (AIU) in rice farming. To measure the attitude of farmers towards innovation use in rice farming, a comprehensive list of 30 statements was developed by thoroughly reviewing the literature available and modifying some items from pre-existing scales. The items for this Likert-type scale were developed following the criteria put forward by Edwards and Kilpatrick (1948). These items were subjected to a thorough sorting process in consultation with domain experts and 19 statements were finally selected for the measuring instrument to be developed. These items were sent to judges for expert content evaluation. Based on the content validity index score for items and modified Kappa statistic, 15 statements were finally selected to constitute the proposed scale. The internal consistency check using Chronbach's alpha was used to ensure the reliability of the proposed scale, and a value of 0.88 was obtained, indicating higher reliability. The standardized scale has practical applicability in measuring the attitude of farmers towards innovation use in rice farming.

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1. INTRODUCTION

Innovation is a driving force which transforms the status quo of the food systems to a more food secure, sustainable, and employment-generating one. It is central to lift farmers out of agrarian distress and helping the world to attain food security and sustainable development goals (FAO, 2018). Innovation is much more than mere technology, and it ranges from institutional, organisational, and social processes spanning from access to credit, market and extension services delivery to marketing produce in a new way. It is a complex process in which multiple actors interact to play different roles. Speeding up and scaling up of innovation in agriculture sector can stimulate the remodelling which is crucial to the rapidly changing global marketing trends and climate change (FAO, 2018). To transform the agriculture sector, besides innovating, developing a positive attitude towards innovation use is very crucial.

Attitude, which is bipolar and a response to stimuli, has been traditionally structured with three dimensions: cognitive, affective, and behaviour [1]. It is how an individual responds to something or someone, i.e., a tendency to react positively or negatively to a certain object, idea, person, or situation. According to Fishbein and Ajzen [2] attitude derives from our beliefs, intension and action. It is considered as a psychological tendency which can be expressed by appraising a specific entity with a degree of favour or disfavour [3]. Persons with a positive or negative belief will express a favourable or unfavourable attitude [4]. Extensive evidence supports the notion that human attitudes play a crucial role in shaping intentions and influencing human behaviour [5]. Hence, development or formation of a positive attitude in one's life is crucial to face any challenge. Measurement of attitude of farmers is very important as it is presumed to have an impact on behaviours, decisions and judgements such as farm environmental management [6], welfare and health management [7] or adoption of new technologies and policies [8].

Rice being one of the staple foods, it is very essential to transform the farming sector through measuring the attitude of farmers towards innovation use in rice farming and thereby paving the way for speeding up and scaling up of innovation in the rice farming sector. Therefore, this study describes the development and standardization of a scale to measure the attitude of farmers towards innovation use in rice farming
.

2. METHODOLOGY

For this study, attitude towards innovation use is operationally defined as the degree of positive or negative feelings of farmers towards innovation use in rice farming. Among the various scale construction methods in psychometry, this study is based on summated rating approach which is an empirical, subject-centred, or individual difference strategy.

2.1 Domain Identification and Item Generation

Item generation is an important step in establishing sound measures [9]. Statements are items that make up an attitude scale and say about a psychological construct that will evoke a response in the subject under consideration. After an extensive review of available literature and following the criteria for statement editing by Edwards and Kilpatrick [10], a comprehensive list of 30 statements was prepared.

2.2 Expert Content Validation

Content validity indicates the degree to which an instrument is a representative of the construct being measured. A panel of experts considering the relevance of individual items within an instrument can be adopted as one of the approaches to examine content validity [11]. The panel of experts consisted of domain experts who have research and work experience in the concerned field. As per the reports, of quantitative content validity methods, the most widely reported approach for content validity i.e., the content validity index (CVI) [12,13,14] is adopted in the study. The domain experts were asked to rate the developed items in terms of its clarity and relevance to the construct to be measured on a 4-point ordinal scale as given below: -

List 1. Continuum for relevancy rating of developed items

Relevancy	Score
Not relevant	1
Somewhat relevant	2
Quite relevant	3
Highly relevant	4

Content validity index can be estimated both at item level (I-CVI) and content validity of the overall scale (S-CVI). The item level CVI was estimated as the number of experts providing a rating of either 3 or 4 to the relevancy of each item divided by the total number of experts. The I-CVI value ranges from 0 to 1 where, I-CVI > 0.79, then item is appropriate, between 0.70 and 0.79, then the item needs revisions, and if the value is below 0.70 the item is to be eliminated [15]. Even though I-CVI is widely used to estimate the content validity by researchers this index doesn't consider the inflated values due to chance agreements. Wynd et al. [14] proposed both content validity index and multi-rater kappa statistic in estimating content validity due to the kappa statistic's consensus of inter-rater agreement that adjusts for chance agreement and it provides information about the degree of agreement beyond chance.

For the estimation of modified kappa, each item's probability of chance agreement was first estimated by the formula as follows: -

$$Pc = \frac{N!}{A!(N-A)!}\ X\ 0.5^{N}$$

Where,

N= number of experts in a panel
A= number of panelists who agree that the item is relevant

Finally, kappa was estimated by the formula,

$$K = \frac{(ICVI - Pc)}{(1 - Pc)}$$

Where,

I-CVI = Item level content validity index
Pc= probability of chance agreement

List 2. Evaluation criteria for kappa statistic

Value	Interpretation
>0.74	Excellent
0.60 - 0.74	Good
0.40 – 0.59	Fair

There are two methods for estimating the scale level content validity index(S-CVI). One method needs the universal agreement among experts (S-CVI/UA) and is the proportion of items on an instrument that achieved a rating of 3 or 4 by all the experts. This method is more sensitive to number of experts. As the number of experts increases, the possibility of generating a low S-CVI also increases. The other method, which is a less conservative one is the average item-level CVIs (S-CVI/Ave). The S-CVI/Ave method is more liberal and is preferred [16]. The S-CVI/Ave is calculated by dividing the sum of I-CVIs by the total number of items. The S-CVI/Ave value ≥ 0.9 is estimated to be an acceptable standard [17] and have excellent content validity [18].

2.3 Reliability Testing

A pilot testing consisting of 50 surveys was carried out for statistical validation of reliability. Chronbach's alpha was used to estimate the consistency of the scale. It is a measure of internal consistency of the developed scale and the value ranges from 0 to 1. The closer Cronbach's alpha value is to 1.0, the greater will be the internal consistency of the items in the scale.

$$\alpha = \frac{N.\bar{c}}{\bar{v} + (N-1).\bar{c}}$$

N = number of items
$\bar{c}$ = average covariance between item pairs
$\bar{v}$ = average variance

List 3. Rule of thumb for interpreting Chronbach's alpha [19]

Chronbach's alpha	Internal consistency
α ≥ 0.9	Excellent
0.9> α ≥0.8	Good
0.8> α ≥0.7	Acceptable
0.7> α ≥0.6	Questionable
0.6> α ≥0.5	Poor
0.5 > α	Unacceptable

Finally, the standardized scale was administered for a sample of 30 for pilot testing. According to the scores obtained through summated rating approach, the farmers were categorized into different categories based on their attitude towards innovation use in rice farming using mean and standard deviation (SD).

List 4. Criteria for categorizing farmers into different categories

Sl. No.	Criteria	Category
1	<Mean - SD	Low
2	Mean – SD to Mean + SD	Medium
3	>Mean + SD	High

The item and other statistical analyses were conducted using R 4.2.2 and IBM SPSS version 22.0.

3. RESULTS AND DISCUSSION

3.1 Item Generation

A thorough sorting process was conducted with the help of domain experts to refine the 30 identified statements to avoid duplication and to have clarity about the construct to be measured. Following the sorting process, only 19 statements were selected for the instrument to be developed.

3.2 Standardization of the Scale

The consistency or precision of a scale to give similar scores on repeated measurement and the notion that the instrument measures what is intended to measure i.e., reliability and validity are two requisite for scale construction. They are two indispensable concepts for the scientific research.

3.3 Testing the Validity

For estimating the validity of the measuring instrument developed content validity index was calculated both at the item and scale level. The identified 19 statements after sorting in consultation with experts were arranged in a 4-point continuum. It was administered to a panel of experts consisted of 50 domain experts who have research and work experience in the concerned field. Out of 50 a total of 36 experts responded back.

The number of experts who judged the item as relevant was divided by number of content experts to estimate the CVI for each item. The results of the I-CVI analysis are shown in Table 1.

Among the 19 identified items, four items with I-CVI value less than 0.70 were eliminated. Fifteen items with I-CVI value greater than 0.79 were found to be appropriate for the scale to be developed. The items 1, 9, 10 and 19 had I-CVI value 1 which indicates the complete agreement of all the experts towards the content validity of these items. The S-CVI was estimated using the average approach (S-CVI/Ave). The S-CVI/Ave value was found to be 0.91 which lies in the acceptable range value and indicates good content validity of the scale developed.

Besides item level and scale level content validity index, modified kappa statistic was estimated to check the issue of inflated values due to chance agreements. Kappa statistic's has a greater

Table 1. I-CVI analysis for the items developed

Items	Relevant (Rating 3 or 4)	Not relevant (Rating 1 or 2)	I-CVI*	Interpretation
1	36	0	1.00	Appropriate
2	34	2	0.94	Appropriate
3	35	1	0.97	Appropriate
4	24	12	0.67	Eliminated
5	25	11	0.69	Eliminated
6	24	12	0.67	Eliminated
7	34	2	0.94	Appropriate
8	35	1	0.97	Appropriate
9	36	0	1.00	Appropriate
10	36	0	1.00	Appropriate
11	34	2	0.94	Appropriate
12	34	2	0.94	Appropriate
13	33	3	0.92	Appropriate
14	35	1	0.97	Appropriate
15	34	2	0.94	Appropriate
16	25	11	0.69	Eliminated
17	35	1	0.97	Appropriate
18	35	1	0.97	Appropriate
19	36	0	1.00	Appropriate
	S-CVI/Ave**		**0.91**	

**Item content validity index **Scale level average content validity index*

consensus of inter-rater agreement that adjusts for chance agreement and it provides information about degree of agreement beyond chance. The results of modified kappa statistics is shown in Table 2.

As per the criteria for interpreting modified kappa given by Cicchetti and Sparrow (1981), K value greater than 0.74 is interpreted as excellent, 0.60 to 0.74 as good, 0.40 to 0.59 as fair respectively. According to Polit et al. [20] by calculating adjusted Kappa and controlling the items accordingly, items with I-CVI value equal to or higher than 0.78 would be considered as excellent. It is very important to consider that as the number of experts increases the probability for chance agreement decreases and hence the values of I-CVI and Kappa tend to converge. Similar findings can be observed here too. Those items with I-CVI value higher were found to have higher K value too and which reduces the probabilities for chance agreement.

3.4 Reliability of the Scale

For the statistical validation of reliability, the selected 15 items were administered for a pilot testing consisting of 50 surveys. The attitude towards innovation use in rice farming is measured with 15 statements in a five-point continuum ranging from 'Strongly agree', 'Agree', 'Undecided', 'Disagree' to 'Strongly disagree' with scores of 5,4,3,2 and 1 for positive statements and the score is reversed for negative statements. The method of Chronbach's alpha was used for checking reliability and is a measure of internal consistency of the scale. Table 3 shows the results of Chronbach's alpha for each item and the overall scale.

Chonbach's alpha value of 0.884 was obtained, which is acceptable and reliable as it is approaching the end to 1 [21]. An arbitrary Chronbach's alpha value of 0.70 is considered to be a sufficient measure for reliability or internal consistency of an instrument developed [22]. From the table 3 the corrected item-total correlation indicates the correlation between each item and the total score of the scale developed. All items should correlate with the total score in a reliable scale. As per the recommendations given by Field (2009) check for items with a score less than 0.30 was conducted to identify the items which don't correlate well with the overall scale and it was found that item-total correlation score was more than 0.30 for all the items in the scale. The result also showed that deleting of any items won't improve the total Chronbach's alpha score for the scale, hence all the 15 items were retained in the scale.

Table 2. Modified Kappa statistic for the developed items

Item	Relevant (Rating 3 or 4)	I-CVI*	Pc**	K***	Interpretation
1	36	1.00	0.0000	1.00	Excellent
2	34	0.94	0.0000	0.94	Excellent
3	35	0.97	0.0000	0.97	Excellent
4	24	0.67	0.0182	0.66	**Eliminated**
5	25	0.69	0.0087	0.69	**Eliminated**
6	24	0.67	0.0182	0.66	**Eliminated**
7	34	0.94	0.0000	0.94	Excellent
8	35	0.97	0.0000	0.97	Excellent
9	36	1.00	0.0000	1.00	Excellent
10	36	1.00	0.0000	1.00	Excellent
11	34	0.94	0.0000	0.94	Excellent
12	34	0.94	0.0000	0.94	Excellent
13	33	0.92	0.0000	0.92	Excellent
14	35	0.97	0.0000	0.97	Excellent
15	34	0.94	0.0000	0.94	Excellent
16	25	0.69	0.0087	0.69	**Eliminated**
17	35	0.97	0.0000	0.97	Excellent
18	35	0.97	0.0000	0.97	Excellent
19	36	1.00	0.0000	1.00	Excellent

**I-CVI Item level content validity index **Pc Probability of a chance occurrence ***K modified Kappa*

Table 3. Chronbach's alpha values for each item and the overall scale

Item	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Item 1	60.6000	27.837	.728	.673	.869
Item 2	61.0600	29.568	.487	.475	.879
Item 3	60.8600	29.062	.567	.618	.876
Item 4	61.2200	25.644	.685	.623	.872
Item 5	61.0200	30.959	.362	.567	.884
Item 6	60.5000	30.949	.379	.283	.883
Item 7	60.4600	29.723	.585	.549	.876
Item 8	61.5200	26.540	.654	.663	.873
Item 9	60.6800	30.426	.452	.594	.881
Item 10	60.8200	29.538	.600	.751	.875
Item 11	60.7800	29.808	.537	.570	.878
Item 12	60.5000	30.663	.435	.686	.881
Item 13	60.7200	28.532	.584	.594	.875
Item 14	60.9600	27.835	.695	.805	.870
Item 15	60.5400	30.294	.449	.639	.881
Chronbach's alpha for the scale					**0.884**

3.5 Administration of the Scale

The final scale which would measure the attitude towards innovation use (AIU) in rice farming consisted of 15 statements (two negative statements and 13 positive statements). The scale can be administered on a five-point continuum ranging from, "Strongly agree, Agree, Undecided, Disagree and Strongly disagree" with scores 5 to 1 for positive statements and vice versa for negative statements.

4. CONCLUSION

The results obtained indicate that the developed scale meets the requirements of reliability and validity and it can be administered on a five-point continuum ranging from 'strongly agree' to 'strongly disagree' to measure the attitude of farmers towards innovation use in rice farming. It is suggested to validate the scale in other populations to enhance its use and applicability.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX I

Comprehensive list of statements adopted

Sl. No.	Statements	Nature of item
1	Without technological innovations there is no progress in rice farming	Adopted from Zrakic et al. [23] with appropriate modification
2	Innovations in rice farming reduce production costs	Adopted from Zrakic et al. [23] with appropriate modification
3	Innovations have a positive effect on quality of production	Adopted from Zrakic [23] with appropriate modification
4	As a progressive rice farmer, I feel myself as a key player in transforming wetland agricultural innovation systems	Developed for the study
5	Role of scientific and educational institutions on spread of innovations in rice farming is often overlooked	Developed for the study
6	Rice farmers are not inclined towards innovations	Developed for the study
7	Only rich farmers can afford to take advantage of rice farming-based innovations	Developed for the study
8	Adopting rice-based innovations is often viewed as a chance to contribute to food security	Developed for the study
9	Searching for new ideas related to rice farming is enjoyable to me	Developed for the study
10	I am motivated to figure out innovative ways to make existing rice farming better	Developed for the study
11	I am seldom inclined to adopt an innovation that no one has ever tried	Developed for the study
12	Positive socio-ecological changes associated with innovations are the triggers for trying new ones	Developed for the study
13	Innovations in rice farming increase the interest of farmers in rice crop	Developed for the study
14	Rice-based innovations inspire farmers to participate in demonstration and training of improved technologies	Developed for the study
15	Increasing uncertainties in rice farming leads to innovations	Developed for the study
16	Changing market demands of rice farmers are seldom addressed by the farm innovations	Developed for the study
17	The use of any new farming practices makes me popular among my peers	Developed for the study
18	My farmer friends who use new rice farming innovations influence me to do the same	Developed for the study
19	I receive personal satisfaction from applying modern rice farming production practices	Developed for the study

APPENDIX II

Final AIU scale in rice farming

Please indicate your response regarding the attitude towards innovation use in rice farming by putting a tick mark (✓) in the most suitable column.

Sl. No.	Statements	Strongly agree	Agree	Undecided	Disagree	Strongly disagree
1	I feel without technological innovations there is no progress in rice farming					
2	In my opinion innovations in rice farming mostly reduce production costs					
3	Innovations have a positive effect on the quality of production					
4	Only rich farmers can afford to take advantage of rice farming-based innovations					
5	Adopting rice-based innovations is often viewed as a chance to contribute to food security					
6	Searching for new ideas related to rice farming is enjoyable to me					
7	I am motivated to figure out innovative ways to make existing rice farming better					
8	I am seldom inclined to adopt an innovation that no one has ever tried					
9	Positive changes associated with innovations are the triggers for trying new ones					
10	Innovations in rice farming increase the interest of farmers in rice crop					
11	Rice-based innovations inspire farmers to participate in demonstration and training of improved technologies					
12	Increasing uncertainties in rice farming leads to innovations					
13	The use of any new farming practices makes me popular among my peers					
14	My farmer friends who use rice farming innovations influence me to do the same					
15	I receive personal satisfaction by adopting innovations in rice farming					

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