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Development of scale for assessing farmers' attitude towards precision conservation agricultural practices

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ABSTRACT

Attitude is a behavioural construct that cannot be measured by a single variable, hence the need for developing a standardized instrument for its measurement. The present study has been conducted to develop a reliable and valid instrument for exploration of farmers' attitudinal orientation towards Precision Conservation Agricultural Practices (PCAPs). PCAPs are technologies and practices that are capable of helping farmers to apply right resources at the right place, at the right time, with a right method. The combination of these technologies and practices can help in achieving optimum resource stewardship and resource conservation at the farmers' field. However, the attitude of farmers' may influence the uptake of these practices at farmers' field. A step by step procedure of developing standardized attitude scale was followed using Likert's summated rating approach. The steps include item collection, relevancy test, item analysis, reliability test as well as validity test. Finally, thirty items were selected for the attitude scale which were found reliable at Spearman Brown coefficient of 0.75 and satisfied content validity. The attitude scale may be useful for researchers and extension functionaries in the field of Precision Conservation Agriculture (PCA) as well as climate smart agriculture (CSA).

Key words: Attitudes, Reliability, Resource conservation, Right practices, Standardized scale

With the current increasing demand for food globally due to increasing population growth as well as rising incomes in developing countries, the global farmers must take additional responsibility to increase crop production either by extensification or sustainable intensification (Maarten and Florian 2016). But how will farmers meet up with the rising food demand in face of the changing climate, land degradation due to the indiscriminate blanket application of fertilizer, fragmented land resources, declining underground water table, increasing scarcity and competing for resources such as water, land, and labour as well as socio-economical challenges? How will farmers be able to double their production sustainably by reducing their carbon footprint? Precision conservation agriculture practices (PCAPs), however, can help enhance productivity sustainably and ensure food security as well as reducing the environmental impact of Agricultural practices. Precision conservation agriculture (PCA) is one of the valuable options for Climate-Smart Agriculture (CSA) in the developing nations for cereal based system especially in rice, wheat, maize, millet, sorghum etc.

PCA is defined as a set of spatial technologies and procedures linked to mapped variables directed to implement conservation management practices that take into account spatial and temporal variability of natural and agricultural systems (Berry *et al*. 2003). PCA is the integration of Precision Agriculture (PA) which is a management strategy to increase productivity and economic returns with a reduced impact on the environment through application of production inputs as needed, in the amounts needed and where needed for the most economic production" (Searcy 2005) and Conservation Agriculture (CA) "a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment through minimum tillage, crop diversification as well permanent organic soil cover" (FAO 2015), is a holistic approach (Jat *et al*. 2009, Jat *et al*. 2011).

In the recent time, PCAPs is becoming of more important option for CSA in South Asia considering its prospect for sustaining farm profitability at low carbon footprint possible (Jat *et al*. 2009, Pathak *et al*. 2012, Kumar *et al*. 2013, Jat *et al*. 2014; Sapkota *et al*. 2014, Aryal *et al*. 2015, Shitu *et al*. 2015, Khatri-Chhetri *et al*. 2017). However, despite the series of completed and ongoing projects for the promotions of PCAPs alongside its prospect and benefit, the adoption of the practices at the farmers' field level has been reportedly low as farmers choose to revert back

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to their conventional practices after the project support is withdrawn (Shiferaw *et al*. 2009, Kuppannan *et al*. 2015, Khatri-Chhetri *et al*. 2017, Sadiku *et al*. 2017). The reason for this may be many socio-psychological factors among which attitudes are important factor. The adoption behavior of farmers has been reported to be affected by the attitude the farmer possess for a particular technology (Nikam *et al*. 2014, Kumar *et al*. 2015, Yadav *et al.* 2017). Holland *et al*. (2002) affirmed that strong attitudes have more impact on behavior, are less susceptible to self-perception effects and are more stable over time.

However, due to the complexity of the attitude phenomenon, the researchers, as well as the psychologists, often find it difficult to clearly define and measure the attitude construct (Allport 1954, Dillard 1993). Many attitude based research do stay away from the long scale development procedures. In many cases, the researchers do employ alternative means of assessing attitude by modification of the existing standardized scale for their current research (Nikam *et al*. 2014, Meena and Singh 2013) or collect pool of statements from the literature review and administered them to the respondents in Likert form for their level of agreement (Fitzsimons and Wescott 2007, Siebert *et al*. 2010, Badola *et al*. 2012, Ashoori *et al*. 2016, Ward *et al*. 2016). The limitation to these types of research procedures is the question of reliability of the modified scale and its validity. This is the case observed when reviewing the literature available on the attitude of farmers towards Precision Conservation Agricultural practice. Most of the earlier work done in this area of research lack reliable data on the attitudinal orientation of farmers towards these technologies and practices, hence the need to fill the research gap by developing a standardized scale to explore attitudinal orientation of farmers towards PCAPs. Following the definition, given by Thurstone and Chave (1946), the attitudinal orientation of farmers has been operationalized as the degree of positive or negative affect that farmers associated with PCAPs. The dimension of the attitude scale has been derived from different component of practices involved in Precision Conservation Agriculture (PCA) based on the literature review and experts consultations.

MATERIALS AND METHODS

A step-by-step procedure of Likert's summated ratings was followed to develop a standardized attitude scale. Likert's is a scale construction technique by which statements (items) that are clearly a favourable or unfavourable to the psychological object are standardized for the purpose of assessing attitudinal orientation of group of individuals about a particular object (Likert 1932). Each respondent is asked to respond to each item according to their perceived attitude intensity towards the items usually on five point continuum (Strongly agree, Agree, Undecided, Disagree and Strongly disagree). The advantage of this technique above other methods of scale construction and standardization is the ease of scoring and ease of summarizing the information obtained. The step-by-step procedure includes Item Collections, Relevancy Test, Selection of Items, Item Analysis, Reliability Test and Validity Test.

Table 1 Domains of precision conservation agricultural practices in rice-wheat production system of IGP

Category of documentation	PCAPs
Crop improvement practices	Improved, Resilient, Recommended crop varieties
Water management practices	Precision laser and leveling, Alternate wetting and drying (AWD), Direct seeded rice (DSR), Crop diversification
Precision nutrient management practices	Leaf colour chart (LCC), Handheld green seeker (HGS), Nutrient expert decision support tools
Energy management practices	Conservation tillage/Zero tillage, Residue management, Precision planters, Indigenous precision planters
Risk management practices	Index based Insurance, ICT enabled Agromet services, CIMMYT Agriplex

Source: Authors' compilation from the Review of Literature

In item collection process, a pool of statements was collected from the review of literature as well as consultation with agricultural scientists, extension experts, farmers and personal experience. A total of 174 sets of statements were collected from the pool of scientific sources as well as information covering most of the area related to Precision Conservation Agriculture.The perspectives observed for the collection of statements from the six dimensions of PCA include the nature of the technology and practices, its utility as well as farmers' perspective towards the technology and practices. The source and information related to the identified six dimensions of PCA were exhausted during the item collection procedure. The sets of 174 statements collected were subjected to screening using the 14 criteria suggested by Edwards (1969) for attitude scale construction. Hence, the sets of 76 statements that satisfied the scaling criteria were finally selected from the pool of items collected.

Relevancy test is the procedure by which the selected items were sent to the experts in the field of PCA for their expert judgment on the relevancy of the statement selected. The set of 76 statements that satisfied the item collection procedure were sent to 120 judges. The judges were asked to judge the relevancy of the test items, their difficulty level and content validity on five point continuums, viz Most Relevant (MR), Relevant (R), Some What Relevant (SWR), Least Relevant (LR) and Not Relevant (NR) against each statement. The judges were also asked to make necessary modification, addition or deletion of the statement based on their judgments.

A pilot survey was conducted in two villages (Sonipat village and Bahu Akbarpur village) of Haryana state, India. An interview schedule was prepared consisting of the 66 statements and these were administered to 35 farmers during the survey. The data were collected through personal interview method. The respondents 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. Data were coded on an excel sheet which were later exported to SPSS for analysis. The analyses of data were done using relevant statistical tools and techniques such as Arithmetic mean, median, variance as well as t-test for item analysis.

The t-test analysis procedure was followed to calculate the t-value for the item analysis. 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.The mean score and variance of the high and the low group were calculated and t-value for each of the 30 statements was calculated using the formula for item analysis as given below.

Item Analysis Formula for calculating t-value

$$t = \frac{\bar{X}_H - \bar{X}_L}{\sqrt{\frac{S_H^2}{n_H} + \frac{S_L^2}{n_H}}}$$

where $\bar{X}_H$ = the mean score on a given statement for the high group, $\bar{X}_L$ = the mean score on a given statement for the low group, $S_H{}^2$= the variance of the distribution of responses of the high group to the statement, $S_L{}^2$ = the variance of the distribution of responses of the low group to the statement, n_H= the number of the subject in the high group, n_L= the number of the subject in the low group, t = the extent to which a given statement differentiate between high and the low group.

The value of t is a measure to which each item differentiate 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 final statements were selected by calculating the t value for each item and rearranging the items in rank order according to their t-value. The statements with the highest t-value were selected for the attitude scale.

Anastasi (1968) defines test reliability as the consistency of scores obtained by the same individuals when re-examined with test on different occasions or with different set of equivalent items, under variable examining conditions. For this study, split half method of Reliability test was employed to calculate the reliability coefficient (r) value of the developed attitude scale. According to Garret (2007), split-half method is conceived as best of the methods for measuring test reliability and the main advantage is that all data for computing reliability are obtained upon one occasion which helped to eliminate the variations brought about by differences between the two testing situations. Thirty five respondents were selected for the reliability test. The respondents 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. The scores for each respondent were coded into excel sheet. The respondents' scores were divided in into two equal halves based on the odd and even numbers of the respondents. The two halves were further exported into SPSS for the scale reliability analysis. For the reliability test analysis on the SPSS screen, the split half model was selected for the scale reliability.

Lindquist (1951) defined validity of a test as the accuracy with which it measures that which is intended to measure. The content validity test procedure was followed for assessing the validity of the developed attitude scale. This was done by administering the developed reliable attitude scale to 20 experts in the field of agricultural extension for their suggestions and opinion on the developed scale. According to Anastasi (1968), content validity involves essentially the systematic examination of the test content to determine whether it covers a representative sample of the behaviour domain to be measured.

RESULTS AND DISCUSSION

Item collection

The result of the item collection procedure reveals that 76 statements that satisfied the 14 criteria for attitude scale construction suggested by Edwards (1969) were selected from the 174 statements collected, hence 98 statements that did not satisfy the condition were deleted.A conscious effort was taken to include approximately equal number of positive and negative statements.The item collection was done by pooling statements on five main components of practices involved in precision conservation agriculture in rice-wheat production system of South Asia as revealed by the review of literature as well as discussion with agricultural scientists, extension experts, farmers and personal experience. The practices selected for development of the attitude scale includes laser guided land levelling, zero tillage, residue management/mulching, precision nutrient management practices (PNM), crop diversification and alternative wet and drying (AWD) as shown in Table 1.

Relevancy test

The set of 76 selected items was administered to 120 judges through individual visits, e-mail as well as Google survey form. The selected judges were experts (Agricultural scientist) in the field related to Precision Conservation Agriculture. The responses were received from 40 judges and were subjected to further analysis. The judges' responses were scored from most relevant (5) to not at all relevant (1). The results of mean relevancy test analysis reveals that among 76 items that were subjected to relevancy test, 66 statements made it to the cutoff point of 2.5 mean relevancy score (Table 2). However, 10 statements below the cutoff point relevancy mean score were deleted from the scale.

Item analysis

The results of the item analysis procedure as shown in Table 2 revealed t-value of the items for the attitude

Table. 2 Results of relevancy test and item analysis

Statements	Relevancy test (Mean) n_1= 40	Item analysis (t) n_2=35
Laser guided land levelling		
I think run-off will occur when my field is not properly levelled	3.78	1.82
I am satisfied with my field production using traditional levelling method and no need of taking up new levelling technology	2.88	1.00
Low level of groundwater has become a problem these days so I will do anything to save water to irrigate my field	3.83	3.03
In my opinion, land levelling is difficult to use compared to traditional levelling method	2.65	1.60
Zero tillage		
I believe in using innovative tillage technology for land preparation that will improve the usage of water in my field	3.63	1.00
I think conventional/traditional tillage does not lead to degradation of soil resources	3.03	1.00
I believe my cost of production will be reduced when I sow my seed without my field being ploughed.	4.00	7.50
One should promote zero-tillage as climate change adaptation technology as it reduces agricultural-related green house gas emission	3.90	7.96
I think looking for technology to achieve early sowing of wheat is not necessary since yield loss due to late sowing of wheat is small	2.65	1.56
Residue management/mulching		
I believe leaving residue on the field compete with fodder availability for livestock	2.925	8.06
Through mulching, a farmer can reduce the cost of production by reducing weed emergence	3.25	1.00
I believe mulching helps to maintain a protective vegetation on the soil surface	3.40	1.00
I think mulching increases my cost of cultivation	2.67	1.00
Precision nutrient management (PNM)		
Too much use of fertilizer add to the cost of the production	3.65	1.00
Cost of PNM technologies discourages one to adopt it	2.73	1.57
Economical use of input through PNM helps maximize productivity and income	3.74	1.53
Being literate is important to handle precision nutrient management technologies such as Green Seeker	2.97	8.00
Adopting PNM will help me mitigate climate change	3.55	7.96
Crop diversification		
The stagnancy in yield experienced in growing single crop demands farmers to grow more than one crop to increase yield and income today	3.18	1.09
It is better for farmers to try different crops considering the level of risk and uncertainty in today's agriculture	3.48	1.47
Adopting multiple crops do not assure increase in productivity and income for farmers	2.55	1.47
It is true that there is yield stagnancy in single crop therefore the need to grow different crops	3.50	1.09
Adopting crop diversification is a big challenge for farmers because of technical knowledge required to change from single mono cropping system to multiple cropping	3.35	1.51
I believe that there is a nutrient depletion through one type of crop	3.62	1.60
AWD-Alternate wet and drying		
I will adopt any innovative technology to save water in my field as making most efficient use of irrigation water in paddy field is my priority	3.70	1.60
I will prefer any technology that can help my decision making on when to flood and dry my field	3.48	1.47
Alternate flooding and drying of paddy field decrease cost of pumping water in paddy farming	3.33	1.47
Maximizing yield is important to me than maximizing water use efficiency in my paddy field	3.08	1.00
AWD may promote unmanageable weeds affecting the grain yield	2.83	1.00
Extra moisture/water in paddy field may be responsible for diseases and pests affecting paddy at the terminal stage of rice crop, e.g rice blast	3.38	8.35

Table 3 Results of Reliability Test (Split Half Method)

	Number of items	18[a]
	Number of items	18[b]
	Total number of items	36
Correlation between forms		0.601
Spearman-Brown coefficient	Equal length	0.751
	Unequal length	0.751

scale. The set of 66 statements that satisfied the criteria for relevancy test (i.e. above relevancy mean score) were administered to 35 respondents. The respondents 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 4 to 0 for each positive statements and 0 to 4 for each negative statements respectively. The score for their response was summed up and arranged in a descending order. The high and low group was selected which were the 25 percent of the respondents with highest total score and the 25 percent respondents with lowest total score respectively. The means and the variance of each group were calculated. These were used to calculate the t-value for each of the 66 statements.

Among the 66 statements for the item analysis, the 30 statements with the highest t-values were selected for the final attitude scale while the other 36 statements were rejected from the scale. The results of the item analysis shows that the statements were able to differentiate between the high and the low group as the range of the item selected was between 8.06 and 0.00 t-value.

Reliability test

According to Ray and Mondal (1999), Reliability refers to the precision or accuracy of measurement or score. Kumar (2016) opined that when a test gives consistently the same results when applied to the same sample, the test is said to be reliable. The results of the reliability statistics for the constructed attitude scale show that the split half model reliability coefficient was 0.75 (Spearman brown coefficient). The reliability coefficient thus obtained indicated high internal consistency of attitude scale constructed for the study.

This is most crucial to attitude scale development as it shows the strength of the attitude scale.

Validity test

The 30 final items were given to 20 judges for their expert guidance in the scale development. The suggestions given by the experts were included in the scale and therefore the scale satisfied content validity. Hence, 36 items which satisfied procedural conditions of Likert's summated ratings were selected for the final attitude scale.

The Attitude scale developed is a contribution to the body of knowledge in the field of social sciences and behavioural science. The standardized attitude scale will fill the gap in the literature related to assessment of Precision Conservation Agricultural practices uptake among farming communities. It will also serve as a valuable tool for further attitude studies by researchers, extension functionaries and social societies involved in promoting PCAPs at farmers' level.

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