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Full Research Article

Constructing a Knowledge Test to Measure the Knowledge Level of Farmers about Climate Change in Arid Ecosystem of India

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Abstract

Climate change has brought widespread misery and economic loss to farming community of India, adversely affecting agriculture, public health, food security, biodiversity and water resources. Climate change is a very complex issue and most of the farmers did not have any clear cut understanding about it. So it is very important to measure the knowledge level of farmers for successful adaptation. The present study is aimed to construct a knowledge test to measure the knowledge level of farmers in India. One pilot study was conducted to develop the test in Lechura village of Uttar Pradesh. The test was developed with reliability score of 0.709 and a sufficient degree of validity. The final study was conducted in Jodhpur and Jaisalmer district of Rajasthan. The study revealed that only 34% farmers knew about climate change and only 31% farmers knew that paddy cultivation also leads to emission of green house gasses. Cumulatively 45% respondents come under low level of knowledge category on climate change. The correlation analysis revealed that different social variables like education (0.800*), perception (0.638*), social participation (0.471*) and psychological variable like attitude (0.815*), value (0.820) and awareness (0.743*) were correlated positively with knowledge score of the respondents. However age (-0.257*), income (-0.003), area (-0.006), pessimism (-0.621*) and stress (-0.451) were correlated negatively. So policy maker should take into consideration these social and psychological dimensions of farmers' behavior for successful implementation of any adaptation strategy to climate change.

1. Introduction

The Intergovernmental Panel on Climate Change (IPPC, 2007) defined climate change as statistically significant variations in climate that persist for an extended period, typically decades or longer. Climate change has already become a major threat for the livelihood of farmer in developing countries and India is no exception. Though, climate change is a global phenomenon but people are affected by its local impacts. Climate change has brought widespread misery and huge economic losses to India, adversely affecting agriculture, food security, public health, water resources and biodiversity. Das and Tripathi (2014) reported that 40% farmers want to quit farming.

Climate change is a very complex issue and not only lay people but well educated people also have difficulties in differentiating among different environmental concepts like climate change, global warming, ozone depletion, weather change, climatic variability etc. People tend to confuse stratospheric ozone depletion with the greenhouse effect and weather with climate (Bostrom et al., 1994). Most of the farmers did not have a clear cut understanding on causes of climate change and what can be its consequence in future. Many of them react to climate change issues on the basis of their own everyday experience. It is acknowledged by the policy makers that at present there is little call from farmers to address the issue. In fact, some farmers, just like some of the general public, are skeptical that climate change is even real. Others are doubtful that whether it will affect agriculture. So, understanding the climate change dynamics is highly important from adaptation point of view.

Effective adaptation can only be achieved if farmers possess sufficient knowledge on climate change issues. But very few studies have been conducted so far in this direction. The most extensive measurement of knowledge was made by Sundblad et al in 2007 in Sweden but the measurement was extremely

difficult as they assess very precise climate change knowledge. However , Krosnick et al. , 2006 and Ashworth et al., 2011 measure self assessed knowledge. Still we lack a standardized knowledge test which can measure the knowledge. With this background, the present paper is aimed to develop a knowledge test to measure the knowledge level of farmers about climate change. Here knowledge on climate change has been defined as the understanding of the farmers about the causes of climate change, its impacts and procedural knowledge based on their experience. Moreover, in our study we highlighted the definition of knowledge of Bloom et al. 1956 which defined knowledge as those behaviours and test situations that emphasized the remembering either by recognition or recall of ideas, materials or phenomenon.

Such a knowledge test if constructed, by adopting scientific procedure, we will come to know the knowledge gap, and accordingly we can plan our future policy for better adaptation. Moreover adequate knowledge, in turn, will be instrumental in developing positive attitude, problem solving skill and positive value orientation toward climate change. With this intention in mind, present study endeavoured to develop a standardized knowledge test to measure knowledge of farmers about climate change. The farmers in the arid region are experiencing some extreme climatic changes which adversely are affecting their farming like increase in temperature, change in precipitation pattern, sand storm, heat wave, flooding etc. Hence, the present study was conducted in Arid ecosystem of India.

2. Materials and Methods

The whole paper is presented in two part-(2.1) First part deals with Knowledge Test development and (2.2) Second part deals with measurement of knowledge of farmers.

2.1. Knowledge test development

The different steps followed in knowledge test development are as follows-

2.1.1. Item collection

Items about climate change were collected from relevant literature, experts, panel discussion, personal experience and pilot studies were conducted in the area of investigation. Totally fourty items were selected covering most of the areas related to climate change. While selecting the items, necessary care was taken to see that they were based on the knowledge, which farmers possess. Here we emphasized on procedural knowledge and causal relationship than declarative knowledge due to its strong association with environmental behavior and positive correlation with risk perception (Renouf, C.R. et al, 2008; Bord et al., 2000).

2.1.2. Jury opinion

Total forty items were sent to hundred experts from different disciplines who are engaged in climate change research. The experts were asked to judge the relevancy of test items, their difficulty level and content validity of each test item. The relevancy of test items was judged on five point continuum from most relevant (5) to not at all relevant (0). Finally twenty seven items were selected whose mean relevancy score was above 2.5.

2.1.3. Sample size and item analysis

One pilot study has been conducted in Lehchura village of Bagpat district in Uttar Pradesh for item analysis and 60 respondents were selected randomly for present pilot study. An item analysis generally yields three kinds of information- item difficulty index, item discrimination index and item validity index. The twenty seven test items were administered to 60 respondents who were not included in the final test. Thus maximum possible score was 27 and minimum as 0. The score obtained by 60 respondents were summed up and arranged in descending order to divide them in 6 equal groups with 10 respondents in each group. The range of the score of 6 groups are presented in the Table 1 For the purpose of further item analysis we eliminate the middle two groups out of six groups.

2.1.3.1. Item difficulty index

The item difficulty index was defined as the proportion of the farmers giving correct answer to that particular item. Here underlying assumption was that difficulty was linearly related to the level of respondents' knowledge about climate change. The difficulty level was calculated using the following formula-

$Pi=n_i/N$;

Where, Pi=Difficulty index for i^{th} item, n_i=Number of respondents correctly answered the i^{th} item, N=Total number of respondents to which i^{th} item were administered.

Finally, the items with score between 0.30 to 0.95 were selected for final test based on the recommendation of Linda A. Atthouse and presented in Table 3

2.1.3.2. Discrimination index ($E^{1/3}$)

The following formula was employed to calculate item discrimination index-

$$E^{1/3} = \frac{(S1+S2)-(S5+S6)}{N/3}$$

Table 1: Range of scores obtained by the respondents (G1=Group 1…….G6=Group 6)

Group Number	G1	G2	G3	G4	G5	G6
Score Range	17-23	14-16	12-13	10-11	7-9	2-6
Number of Respondents	10	10	10	10	10	10

Where, S_1, S_2, S_5 and S_6 were the frequencies of correct answers in G_1, G_2, G_5 and G_6 groups respectively and N= Total number of farmers in the sample of the item analysis.

Finally, the item number 1, 4, 5, 6, 7, 8, 10, 12, 13, 14, 15, 17, 18 and 24 were selected based on their respective P value and discriminatory power (Table 3). Thus, total 14 items were selected in our final knowledge test. Then another pilot study was conducted to determine the reliability and validity of the test.

2.1.4. Reliability

Split-Half method was employed to calculate the reliability coefficient value as 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 (Garret, 2007). In this method, all the 14 items were first randomly arranged and then divided into two equal halves one containing the odd items and other one containing the even items. Then, co-efficient of correlation between two sets of scores was computed using and the "r" value of 0.709 was found to be significant at 1% level of significance which indicates that the knowledge test is highly reliable (Table 2).

2.1.5. Validity

Good item validity is in itself a guarantee of test validity and therefore the test was considered valid. Two methods employed to know the validity of the test – jury opinion and point bi-serial correlation. Content validity was ensured initially by administering every item to different experts for evaluating the representation of universe by the test, its relevance and appropriateness. Then we calculated the point bi-serial (r_{pbi}) correlation of every item to know the construct validity of the test. A point bi-serial value of atleast 0.15 is recommended though it is good to have point bi serial value of above 0.25. A large r_{pbi} value indicates that a farmer with high overall score also getting the item right and low r_{pbi} indicates that a farmer with low overall getting the item right. The results are displayed in Table 3. Finally, fourteen items were selected based on the items' difficulty level, discriminatory power and point bi-serial correlation score.

2.2. Sampling method for measurement of knowledge level in arid ecosystem

The state Rajasthan was selected purposively for the present study. Two districts namely Jodhpur and Jaisalmer from western part of Rajasthan were selected purposively as Western Rajasthan are more vulnerable to climate change. Two blocks namely Luni and Jaisalmer from each district again were selected purposively. From Luni block, Lonawaskhara and Porkkhawas village were selected purposively keeping the impact of climate change in mind. Similarly Bharamser and Pora village were selected purposively from Jaisalmer block. Finally 25 farmers from each village were selected randomly for the study.

3. Results and Discussion

3.1. Knowledge level

From the table number 4, it is clear that for most of the items mean score were above 0.5 which indicates a quite good degree of knowledge about climate change among the farmers. However, only 34% respondents knew about climate change and had an overall idea about climate change. Ashworth et al (2011) in a study also reported that majority public perceived science of climate change to be extremely complex and hard to understand (Mean=3.54). So people may have different explanation for same natural phenomenon. Such misconception can be a resistant to change (Posner et al, 1982). But, 75% respondents answered correctly to the question 'Which of the following is the human induced causes of climate change' with mean score of 0.75. Likewise, the mean score for question 'Which of the following gas is more responsible for climate change' was 0.57 just above the median value. These indicate farmers' knowledge was more on items related to the causes of climate change. However farmers had limited knowledge on items related to role of paddy cultivation and chemical fertilizer in GHG emission with mean score of 0.31 and 0.41. These finding imply that farmers knowledge level about contribution of faulty agricultural practices towards climate change were low. So, policy should be framed specifically focusing on role and potential of agricultural sector to address climate change issues. Necessary awareness campaign and training should be conducted to raise the knowledge level of farmers on climate change. 64% respondents heard about different climate resilient technologies like SRI, zero tillage, mulching etc. reflect their adaptive potential to climate change. Most of the respondents (73%) knew that maturity period of major crop is reducing due to climate change. Similarly majority of

Table2: Correlation value in split-half method

		Odd knowledge Item	Even knowledge items
Odd knowledge Item	Pearson correlation	1	0.709**
	Sign. (2- tailed)		0.001
	N	20	20
Even knowledge items	Pearson correlation	0.709**	1
	Sign. (2- tailed)	0.001	
	N	20	20

**Correlation is significant at the 0.01 level (2-tailed)

Table 3: Difficulty index, discrimination index and reliability value of different test items

Items	*p* value	E1/3	rpbi
Do you know about climate change? If yes, then kindly explain it.	0.53	0.7	0.53876
Do you agree with the statement that climate change and global warming is the same thing?	0.28 (×)	0.15 (×)	.12260 (×)
Do you agree with the statement that climate change and weather is the same thing?	0.30 (×)	0.2 (×)	.22537
Which of the following is the human induced cause of climate change?	0.53	0.55	.53548
Which of the following gas is more responsible for climate change?	0.72	0.4	.49899
Do you know that cultivation of paddy leads to emission of gasses responsible for global warming?	0.53	0.55	.52337
Which of the following gas i.e. responsible for climate change emitted due to application of chemical fertilizers in the field?	0.35	0.5	.54090
Do you know that cattle are also responsible for emitting GHGs?	0.53	0.30	-.15733
Do you know that application of carbon sequestration related practices can help in enhancing soil fertility and climate resilience?	0.13 (×)	0.05 (×)	.05478 (×)
Have you heard about different climate resilient technologies like zero tillage, mulching, SRI etc?	0.78	0.45	.50232
Do you know that rise in temperature affects the grain filling of wheat crop?	0.28 (×)	0.3	.37113
Do you know that maturity period of major crops is reducing due to climate change?	0.88	0.35	.50560
Are you informed that practices like burning of crop residues in field is also contributing toward climate change?	0.73	0.7	.62008
Are the gasses used in freeze and refrigerator responsible for climate change?	0.63	0.4	.33164
Which of the following will be the effect of global warming on sea level?	0.57	0.4	.37789
Do you know that climate change will lead to increased soil salinity level in coastal area?	0.30 (×)	0.65	.56436
What will happen to the rate of melting of snow glacier under changing climatic situation in Himalayan ecosystem?	0.78	0.6	.63481
What will be the major impact of climate change in arid ecosystem of India due to global warming?	0.53	0.5	.50021
Which of the following areas from agriculture contributes maximum to climate change?	0.2 (×)	0.6	.69997
The increased concentration of CO_2 will be beneficial for which type of crops?	0.17 (×)	0.45	.61602
Presently it is estimated that temperature is expected to rise over the 21st century by-?	0.07 (×)	0.2 (×)	.53291
Which of the following is an important GHG emitted through animal husbandry and livestock farming?	0.3 (×)	0.75	.59116
How agriculture can play a role to reduce Greenhouse gas concentration?	0.27 (×)	0.8	.69573
Which of the following will happen if there is an increase in atmospheric CO2 concentration?	0.58	0.85	.67906
Most of the carbon on earth is stored in which reservoir?	0.18 (×)	0.5	.64601
The seasonal decrease in atmospheric concentration occurs during which months?	0.23 (×)	0.20 (×)	.23110
Which of the following organization work on climate change related issues?	0.18 (×)	0.05 (×)	.14924 (×)

the farmers (61%) knew about the impact of global warming on sea level and 86% respondents had knowledge about the impacts of climate change in Arid ecosystem whereas 71% farmers possessed the knowledge about the impacts of melting glacier at increasing rate. But, Only 22% sample answered correctly to the question "Are the gases used in freeze and refrigerator responsible for climate change' reflecting their low level of knowledge. Gardner et al, 2008 in a previous study also reported that information relating to climate change may be poorly understood by respondents. So it is apparent that there is a more need on climate change education.

Farmers' score on the items related to impact of climate change were comparatively high to rest items. So, the study revealed that farmers had more knowledge on impact of climate change than its procedural or causal knowledge. The in-depth group discussion revealed that farmers answered correctly to the impacts of climate change based on their day to day farming experience. However some of them heard from TV, newspaper and from their school going children. Overall farmers' knowledge level was quite high in the area. This is

Table 4: Knowledge score of respondents

Items	%	Mean Score
Do you know about climate change? If yes, then kindly explain it.	34	0.34
Which of the following is the human induced cause of climate change?	75	0.75
Which of the following gas is more responsible for climate change?	57	0.57
Do you know that cultivation of paddy leads to emission of gasses responsible for global warming?	31	0.31
Which of the following gas i.e. responsible for climate change emitted due to application of chemical fertilizers in the field?	41	0.41
Do you know that cattle are also responsible for emitting GHGs?	33	0.33
Have you heard about different climate resilient technologies like zero tillage, mulching, SRI etc?	64	0.64
Do you know that maturity period of major crops is reducing due to climate change?	73	0.73
Are you informed that practices like burning of crop residues in field is also contributing toward climate change?	57	0.57
Are the gasses used in freeze and refrigerator responsible for climate change?	22	0.22
Which of the following will be the effect of global warming on sea level?	61	0.61
What will happen to the rate of melting of snow glacier under changing climatic situation in Himalayan ecosystem?	71	0.71
What will be the major impact of climate change in arid ecosystem of India due to global warming?	86	0.86
Which of the following will happen if there is an increase in atmospheric CO2 concentration?	72	0.72

due to the fact that in one of my sample area National Initiative on Climate Resilient Technologies project of ICAR is going on. They got different training, exposure and technology from NICRA (National Initiative on Climate Resilient Agriculture) project of ICAR (Indian Council of Agricultural Research) to adapt to climate change. This also helped them to raise their knowledge and understanding about climate change to a great extent. The primary observation also revealed that the knowledge level in NICRA project area was much higher as compare to non NICRA project area.

So, ICAR should take more initiative to expand such project in climatic vulnerable area to raise the knowledge level of farmers to draw and follow appropriate adaptive policy.

3.1. Distribution of respondents according to their knowledge level

The respondents were classified into different groups using cumulative cube root frequency method. The formulae used

$L\ i=Yi-1+[(Sk/L-Si-1)/\sqrt{fi}]^{*}[Yi-Yi-1]$

in this method was-

Where, L=Number of strata, L_i=i^{th} strata, Y_{i-1}=Lower limit of the class in which L_i lies

S_k=Cumulative $\sqrt{f_i}$, f_i=Square root of the frequency of the i^{th} class in which L_i (S_k/L) lies

S_{i-1}=Cumulative square root of the frequency of preceding class in which L_i (S_k/L) lies

Y_i=Upper limit of the class, Y_i-Y_{i-1}=Width of the class in which L_i (S_k/L) lies

From the Table 5 it is clear that 16% respondents had very low level knowledge and 29% had low level knowledge about climate change. 18% respondents come under medium level knowledge category. However to our surprise 12% respondents had very high knowledge level and 7% had only high level knowledge. Again the reason is attributed to ICAR NICRA project in one of my sampling area. However still 45% of the respondents cumulatively fall below mean score. So, a lot of efforts are needed to address this issue.

3.2. Correlation analysis

The Pearson correlation analysis was done using bivariate method in SPSS16. The major output of analysis is displayed in the Table 6. From the Table 6 it is inferred that age was negatively correlated with the knowledge level of the respondents and correlation was significant at 0.01 levels. Aaron M. McCright (2009) also reported that some study found that younger adult express greater global warming concern than do older adults. This implies that younger age respondents had higher level knowledge on climate change than the old age people. Whereas in India now most of the farmers belonged to old age category whose knowledge level found to be lower. So special effort should be taken to raise the knowledge level of old age category. The role of communication behind the knowledge level is clear from the correlation between social

Table 5: Categorization according to the knowledge level of respondents

Category	Very Low (<4.76)	Low (4.76-6.61)	Medium (6.61-8.75)	High (8.75-11.07)	Very High (>11.07)
Frequency	16	29	18	13	24
%	16	29	18	13	24

Table 6: Correlation between knowledge score and different socio-psychological variable

Variable	Pearson correlation	Sig 2 tailed	N	Variable	Pearson Correlation	Sig 2 tailed	N
Age	-.257*	.010	100	Attitude	.815*	.000	100
Income	-.003	.973	100	Value	.820	.000	100
Area	-.006	.955	100	Awareness	.743*	.000	100
Education	.800*	.000	100	Pessimism	-.621*	.000	100
Social participation	.471*	.000	100	Openness	.679*	.000	100
Perception	.638*	.000	100	Stress	-.451	.000	100
Risk perception	.606*	.000	100				

Correlation is significant at the 0.01 level (2-tailed)

participation and knowledge of individual which was positively correlated (0.471) and significant at 0.01 level. Similarly the variable perception (0.638) and risk perception (0.606) also positively correlated with the knowledge level significantly at 0.01 level. The study also revealed the role of individual's attitude upon his knowledge level. The individual with positive attitude scored high in knowledge test and negative attitude accompanied by low score. The positive correlation between awareness and knowledge level (0.743, significant at 0.01 level) highlighted the need of more awareness campaign of farmers. The negative correlation between the variable pessimism and knowledge level (-0.621, significant at 0.01 level) again highlights the importance of psychological dimension of human behavior upon his knowledge level. Another psychological variable stress was also found to be negatively related with the knowledge level of farmers. These all indicate the importance of socio-psychological factors that shape the knowledge level of individual. So, policy maker should take into account a holistic overview to frame a future policy to raise the knowledge level including economic, political, sociological and psychological factors.

4. Conclusion

Low level of knowledge base has been realized, however better knowledge on impacts of climate change was mainly due to experience. So, if we can supplement experiential knowledge with scientific evidence, the knowledge acquisition will be more sustaining. The knowledge level of the farmers was more in operational area of NICRA project. The policy maker should expand the coverage under NICRA and formulating adaptive strategies need socio-psychological factors into account to mitigate the adverse impacts of climate change.

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