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A Comparative Study on Knowledge Level of Climate Smart Agricultural Practices (CSAP) among Paddy Farmers in Eastern Haryana

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HIGHLIGHTS

- Considerable difference was observed in knowledge level of CSAP among CSV and N-CSV respondents.
- Knowledge index of CSV respondents was higher in comparison to N-CSV respondents.
- Social and extension mobility of respondents were highly correlated with the knowledge index of respondents.

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ABSTRACT

Climate-smart agricultural practices (CSAP) are an integrated approach that focuses on attaining triple objectives of increasing productivity, enhancing resilience, and reducing greenhouse gas emissions. The study was conducted in 2024 to assess the knowledge level of climate smart agricultural practices among the paddy growers of Haryana. The data was collected with a structured interview schedule from two groups of villages namely climate smart villages (CSV) and non-climate smart villages (N-CSV), randomly selected from four blocks of Karnal and Kaithal districts. A sample of 15 paddy farmers were randomly interviewed from each of the eight villages, thereby using a sample size of 120 respondents. The knowledge items were divided into five categories, namely water smart, nutrient smart, carbon smart, weather smart and knowledge smart as per FAO guidelines. The analysis found a considerable difference in the knowledge level of CSAP among CSV and N-CSV respondents. The knowledge index of farmers from CSV was higher than those from N-CSV for all five dimensions of CSAP. Further, it was found that variables such as education, extension participation, social participation, economic motivation, scientific and risk orientation were all positively and significantly related to the knowledge index of farmers.

INTRODUCTION

Climate-smart agriculture practices (CSAP) are a holistic approach to sustainable farming that aims to address the challenges posed by climate change, while simultaneously ensuring food security and environmental sustainability (Wakweya, 2023). The main objectives of this initiative are to enhance agricultural output and incomes, improve the ability to withstand the impacts of climate change and reduce greenhouse gas emissions (Aryal et al., 2018; Pabba & Naik et al., 2022). This approach emphasises the importance of adapting agricultural practices to changing climate conditions while minimising the sector's contribution to global warming (Lipper et al., 2014). Implementing climate-smart agricultural practices is essential for cultivating rice crops in India, since it is commonly acknowledged to have the most substantial ecological influence compared to other major crops (Sarkar et al., 2022). In order to fully benefit from applying CSAP, farmers must possess a comprehensive understanding of CSAP and its significance in their crop production system (Mishra et al., 2024).

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Paddy cultivation is extremely susceptible to climatic factors such as temperature, precipitation, and humidity (Singh et al., 2023). These factors have an impact on both the quantity and the quality of the rice that is produced. Climate-smart agricultural techniques for paddy farming encompass water management, crop rotation, integrated pest management, and the utilisation of improved and early-maturing rice varieties (FAO, 2013). These strategies are designed to reduce the negative impacts of climate change while also promoting sustainable rice production. The level of awareness about climate-smart practices among paddy farmers differs considerably among regions and is impacted by factors such as education, information accessibility, and local extension services. (IRRI, 2013; Ghanghas et al., 2015). Research indicates that although some farmers possess an awareness of specific climate smart agricultural practices, they frequently lack comprehensive understanding and application of these techniques (FAO, 2016).

METHODOLOGY

The study was carried out in the eastern climatic zone of Haryana, which is an economically important region in India for paddy cultivation in terms of both total production and productivity. The districts of Karnal and Kaithal were purposely chosen based on their higher productivity paddy compared to other districts of Haryana. Additionally, two blocks were randomly selected from each district and within each block, two villages were selected - one classified as a climate smart village (CSV) and one classified as a non-climate smart village (N-CSV). A climate smart village (CSV) is one of the 250 villages that has been identified under the Climate Smart Village project started by the Department of Agriculture and Farmer's Welfare, Government of Haryana in 2016 to build agricultural resilience through adopting a community-based approach (Anonymous, 2016). A non-climate smart village (N-CSV) is any village other than the 250 villages selected under the project. Fifteen paddy growers were randomly selected from each village, thus a total sample size of 120 respondents, that is 60 respondents from four climate smart villages and 60 from non-climate smart villages were personally interviewed for the study. The knowledge items were divided in five categories based on the five dimensions of climate-smart agricultural practices, which are water-smart, nutrient smart, carbon & energy smart, weather smart and knowledge smart practices. Two terms Knowledge Level and Knowledge Index were used in the research for comparative study. Knowledge Level was operationalized as the ratio of the no. of correct responses for an item with the total no. of responses, multiplied by 100; while the Knowledge Index was defined as the ratio of the total score obtained by the respondent with the maximum possible score, multiplied by 100. Moreover, independent sample t-test was used for comparison between two groups of respondents while Pearson correlation and multiple regression (linear) were used to understand the relationship between the socio-economic profile of the respondents and their knowledge index.

RESULTS

Knowledge level of climate smart agricultural practices

The data in Table 1 reveal that while the knowledge level for practices such as DSR, laser land levelling and peripheral bunding was quite high among the water smart practices, it is very low for practices such as smart irrigation, SRI and raised bed planting among both groups of the respondents. Further, the comparison of respondents from climate smart village (CSV) and non-climate smart village (N-CSV) revealed that, while there was a considerable difference in the knowledge level of practices such as SRI and raised bed planting, no major differences were observed for the other water smart practices.

In terms of nutrient smart practices (Table 2), it was observed that respondents from both CSV and N-CSV have similar knowledge levels for practices such as the application of farm yard manure (FYM), vermicompost, green manure, biofertilizers and soil health cards. However, a considerable and significant difference was observed in the knowledge level of nutrient smart practices such as micronutrient application, precision fertilizer application, intercropping (with legumes) and use of leaf colour charts between both groups of the respondents. Also, it was evident from Table 2 that the knowledge level for practices such as the use of Green Seeker (for nutrient estimation), precision fertilizer application and intercropping were fairly low among both categories of respondents.

For carbon smart practices (Table 3), the knowledge level was found to be high for practices such as conservation tillage, green energy application and crop-residue management (in-situ and ex-situ) among both groups of respondents, however a considerable difference was observed in the knowledge level for practices like incorporation of agroforestry, alternate wetting and drying of fields and soil solarization among CSV and N-CSV respondents, with the later exhibiting a low knowledge level in comparison to the former. Moreover, the knowledge level for biochar application, which is often projected as a powerful mitigation tool to counter climate change, was very low among both respondents.

Table 1. Knowledge level of water smart practices in CSV and N-CSV

S.No.	Knowledge Items	Knowledge Level (CSV)	Knowledge Level (N-CSV)	Difference	t-value
1	Direct Seeded Rice (DSR)	100.00	98.33	1.67	1.40
2	System of Rice Intensification (SRI)	34.16	17.50	16.67	2.99**
3	Laser Land leveling	86.67	81.67	5.00	1.06
4	Smart Irrigation (ICT-enabled)	18.33	9.17	9.16	2.07*
5	Water Harvesting (On field)	56.67	48.33	8.34	1.29
6	Raised Bed Planting	35.83	22.50	13.33	2.29*
7	Peripheral bunding	89.17	86.67	2.50	0.59

** Significant at 1% level; * Significant at 5% level

Table 2. Knowledge level of nutrient smart practices in CSV and N-CSV

S.No.	Knowledge Items	Knowledge Level (CSV)	Knowledge Level (N-CSV)	Difference	t-value
1	Farm Yard Manure (FYM) application	100.00	100.00	0.00	0.00
2	Vermi Compost application	88.33	84.17	4.16	0.94
3	Green Manuring	91.67	88.33	3.34	0.86
4	Leaf colour Chart	55.83	41.67	14.16	2.21*
5	Soil Health Card	86.67	82.50	4.17	0.94
6	Precision fertilizer application	29.17	11.67	17.50	3.43**
7	Biofertilizer(Azolla & Azotobacter)	73.33	62.50	10.83	1.80
8	Liquid-based fertilizer/Slow releasing fertilizers	71.67	55.83	15.84	2.58*
9	Micronutrients application	67.50	46.67	20.83	3.32**
10	Green Seeker	28.33	9.17	19.16	3.91**
11	Intercropping (4:1 with legumes)	31.67	21.67	10.00	2.09*

Table 3. Knowledge level of carbon smart practices in CSV and N-CSV

S.No.	Knowledge Items	Knowledge Level (CSV)	Knowledge Level (N-CSV)	Difference	t-value
1	Conservation Tillage	82.50	79.17	3.33	0.65
2	Green Energy (solar water pumps/biofuel)	90.83	84.17	6.66	1.56
3	Incorporation of Agro-forestry	35.83	14.17	21.66	3.99**
4	Alternate wetting & drying	46.67	29.17	17.50	2.83**
5	Biopesticide application	43.33	34.17	9.16	1.46
6	Pheromone/Light traps for pest management	59.17	51.67	7.50	1.17
7	Biochar application	7.50	3.33	4.17	1.43
8	Crop-residue management- In Situ	97.50	94.17	3.33	1.29
9	Crop-residue management- Ex Situ	79.17	72.50	6.67	1.20
10	Soil Solarization	40.83	26.67	14.16	2.34*

Table 4. Knowledge level of weather smart practices in CSV and N-CSV

S.No.	Knowledge Items	Knowledge Level (CSV)	Knowledge Level (N-CSV)	Difference	t-value
1	ICT based weather forecasts	96.67	94.17	2.50	0.92
2	Personalized agro-met services	68.33	59.17	9.16	1.48
3	Climate analogues	2.50	0.00	2.50	1.75
4	Crop-Insurance	95.83	91.67	4.16	1.68
5	Weather based scheduling of Practices	82.50	70.83	11.67	2.15
6	Timely sowing & Harvesting	93.33	92.50	0.83	0.25

It can be inferred from Table 4 that for weather smart practices, both groups of respondents exhibit a high level of knowledge, except for climate analogues, for which the knowledge level is very low among both CSV and N-CSV respondents. Furthermore, it was observed that there was no significant difference in the knowledge level of weather smart practices among both CSV and N-CSV respondents, as the t-values for all of the practices were found to be non-significant.

Table 5 reveals that for knowledge smart practices such as the use of institutional sources of credit, early maturing varieties and farmer-to-farmer learning, both groups of the respondents had a high level of knowledge while for practices such as the use of community seed banks and online marketing, respondents from both CSV and N-CSV exhibited a low level of knowledge. Furthermore, the comparison of CSV and N-CSV respondents revealed that there was a significant difference in the knowledge level of respondents with respect to knowledge smart practices such as varietal diversification, hiring from custom hiring centres, market intelligence and use of expert systems or artificial intelligence for crop health diagnosis.

Comparison of knowledge index of respondents from climate smart and non-climate smart villages

The comparison of the knowledge index of respondents from climate smart and non-climate smart villages (Table 6) revealed that there was a considerable and significant difference between both groups of respondents in terms of water smart, nutrient smart, carbon smart and knowledge smart practices, while it was somewhat significant for weather smart practices. The mean knowledge index for CSV respondents was higher than that for N-CSV respondents for all dimensions of climate smart agricultural practices.

Table 5. Knowledge level of knowledge smart practices in CSV and N-CSV

S.No.	Knowledge Items	Knowledge Level (CSV)	Knowledge Level (N-CSV)	Difference	t-value
1	Early maturing varieties	92.50	86.67	5.83	1.48
2	Varietal diversification	53.33	36.67	16.66	2.62**
3	Community seed fodder banks	9.17	6.67	2.50	0.71
4	Credits from Institutional Sources (Banks/NBFC/KCC)	98.33	97.50	0.83	0.45
5	Farmer-to-farmer learning	63.33	56.67	6.66	1.05
6	Market intelligence for selling of produce	32.50	21.67	10.83	1.98*
7	Hiring CSA technologies from custom hiring centers	56.67	42.50	14.17	2.21*
8	Expert System/AI tools for crop health diagnosis	30.83	11.67	19.16	3.72**
9	Social Media Marketing/ Online Marketing	14.17	11.67	3.34	0.98

Table 6. Comparison of Knowledge Index (KI) of respondents from CSV and N-CSV

S.No.	Knowledge Dimension	Mean KI (CSV)	Mean KI (N-CSV)	Mean Difference	t Value	P value (2-tailed)
1.	Overall	59.63	50.38	9.25	7.42**	0.000
2.	Water Smart	56.67	47.50	9.17	5.30**	0.000
3.	Nutrient Smart	65.83	54.72	11.11	5.53**	0.000
4.	Carbon Smart	56.74	46.89	9.85	3.96**	0.000
5.	Weather Smart	73.19	68.19	5.00	2.58*	0.011
6.	Knowledge Smart	50.25	41.03	9.22	4.85**	0.000

Table 7. Relationship of the socio-personal profile of the respondents with their knowledge index (KI)

S.No.	Variables	CSV		N-CSV	
		Correlation Coefficient	B-Value	Correlation Coefficient	B-Value
1.	Age	0.041	0.828	0.079	0.291
2.	Education	0.462**	0.196	0.397**	2.556**
3.	Income	0.408**	1.393**	0.189*	1.443
4.	Landholding	0.469**	0.015	0.139	1.653
5.	Farm Mechanization	0.154	0.746	0.154	0.979
6.	Social Participation	0.284**	0.278	0.203*	0.478
7.	Mass Media Exposure	0.237**	0.523	0.196*	0.623
8.	Extension Contact	0.515**	0.953**	0.483**	1.976**
9.	Cosmopoliteness	0.497**	0.470	0.429**	2.787**
10.	Extension Participation	0.557**	0.862*	0.377**	0.862
11.	Economic Motivation	0.440**	0.774**	0.356**	2.840**
12.	Risk Orientation	0.319**	0.072	0.288**	0.079
13.	Scientific Orientation	0.408**	0.929**	0.343**	0.804
14.	Innovativeness	0.381**	0.092	0.267**	1.789*
	R^2	0.672		0.589	
	Constant	9.825		22.743	

Relationship of the socio-personal profile of respondents with their knowledge index

It can be inferred from Table 7 that independent variable such as education, income, landholding, social participation, mass media exposure, extension contact, cosmopoliteness, extension participation, scientific orientation, risk orientation, innovativeness and economic motivation, showed a positive and high significant relationship with the knowledge index of respondents from climate smart village. Also, the value of R square was found to be 0.672 which revealed that 67.20 per cent of all variations in the knowledge index can be explained by the independent variables selected for the study. Also, for respondents from non-climate smart villages, independent variables such as education, income, social participation, mass media exposure, extension contact, cosmopoliteness, extension participation, scientific orientation, risk orientation, innovativeness and economic motivation, showed a positive and significant relationship with their knowledge index. The value of R square for N-CSV respondents was found to be 0.589, which can explain the 58.90 per cent variation in the data.

DISCUSSION

The findings of the study reveal that there were considerable differences in the knowledge level of different dimensions of climate smart agricultural practices among the two groups of respondents. While the knowledge level for practices that are comparatively simple, easy to adopt and was being propagated since a long time such as direct seeded rice, peripheral bunding, farm yard manure, green manuring, vermicomposting, biofertilizer application, use of soil health card, conservation tillage, crop residue management, crop insurance, ICT based weather forecasts, crop insurance, early maturing varieties, etc. exhibit no major difference among CSV and N-CSV respondents, other practices such as system of rice intensification (SRI), smart irrigation, raised bed planting of paddy, micronutrient application, leaf colour chart for site specific nutrient application, intercropping, alternate wetting and drying, varietal diversification and use of expert systems, that are more complex, requires investment and technical support from extension functionaries showed a significant difference between in the two groups respondents in terms of their knowledge level. This could be attributed to the fact that climate smart villages (CSV) are better connected with extension agencies, both public and private, and are provided with better support and services for increased adoption of climate smart agricultural practices for paddy crop. For example, most of the CSVs are linked with one or more custom hiring centers that ensures the farmers from CSV has greater access to climate smart technologies at economical prices as compared to N-CSV farmers, who generally lack awareness of hiring of machineries from the custom hiring centers. The findings were similar with Pandey et al., (2019) & Suriyo et al., (2020) who revealed that a network of strong technological and extension support is necessary for increasing the access of farmers to climate smart agricultural technologies. The combination of technologies and practices can help in achieving optimum resource stewardship and resource conservation in the farmers' field (Shitu et al., 2018). Also, farmers from CSV have greater involvement in training programmes and demonstrations organized by public extension system (Govt. of Haryana) under climate smart village project, as compared to farmers from N-CSV, which played a significant role in greater knowledge level of CSAP among CSV farmers. This was also observed by Aggarwal et al. (2018) who found that public extension services play a huge role in increasing the climate change adaptation of Indian villages.

Furthermore, socio-personal variables such as education, extension contact, cosmopoliteness, extension participation, social participation, economic motivation, scientific and risk orientation and innovativeness were found to be significantly and positively correlated with the knowledge index of respondents, which signifies that socially active farmers, make contacts outside their immediate groups, possess scientific temperament, are innovative and ready to take risks possess greater knowledge of recent advances and technologies in the field of agriculture. In order to support farm level decisions and minimize the loses in adverse climatic and weather conditions farmers' understanding about interaction of climate and agro-ecosystem need to be bridged through inclusion of farmers' communication network (Ravikumar et al., 2015) Moreover, the R square value of 0.672 and 0.589 for CSV and N-CSV respondents respectively, signified the suitability and effectiveness of the regression model in explaining the variation in the dependent variable, i.e., the knowledge index of farmers. The findings were supported by Ghimire et al., (2015) & Saha et al., (2019) who observed that education, cosmopoliteness, social & extension participation, risk orientation and innovativeness were directly related to the greater awareness and adoption of climate smart agricultural practices by farmers.

CONCLUSION

The study concludes that is a considerable difference in the knowledge level of climate smart agricultural practices among the respondents from climate smart and non-climate smart villages. The CSV respondents generally exhibit a higher knowledge level for CSAP practices, however for many complex practices such as the use of Green Seeker, climate analogues, smart irrigation, etc. the knowledge level of both CSV and N-CSV respondents is very low. Also, the socio-personal variables show a positive and significant relationship with the knowledge index of respondents, indicating a strong effect of these variables on the knowledge index of the farmers. The research highlights the importance of high social mobility and delivery of quality extension services for greater spread of climate smart agriculture as evident in case of CSV respondents, and advocates specialised training programmes and holistic extension support for increasing the knowledge level of climate smart agricultural practices among the paddy growers.

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