



Constraints for Adopting Climate Smart Practices in Major Crops amongst Punjab Farmers

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Abstract: Climate change has evolved into a crucial concern with significant social, economic, and environmental implications in the present era. The concept of climate smart agriculture (CSA) has emerged as holistic approach, incorporating climate adaptation, mitigation and sustainable development principles into agricultural systems as a strategy to combat climate change. Despite the documented benefits, the rate at which farmers are adopting these practices remains notably low. The present study aimed to identify the main climate smart practices (CSPs) adopted and constraints faced a sample of 240 farmers for the adoption of CSA in Punjab agriculture. The main seven practices i.e, short duration varieties (SDV), laser land leveling (LLL), direct seeded rice (DSR), zero tillage (ZT), happy seeder (HS), Super seeder (SS) and baling (B) were identified as CSPs in the study area. The major constraints for adoption of climate resilient technologies were more legal paper work, erratic power supply and limited extension activities. The study suggested that more extension services, education programs for farmers, demonstrating and trainings on new CSP are necessary for making farming more resilient economically and ecologically.

Keywords: Climate change, Climate smart agriculture, Adaptation, Constraints

Climate change presents a significant challenge to global agricultural production, giving rise to both direct and indirect consequences (Kaur et al 2018). Changing climate in agriculture sector impacts crops, livestock, forestry, and aquaculture having serious social and economic implications (Esar and Sachdeva 2023, Chandel et al 2022). Consequences can be low incomes, eroded livelihoods, trade disruptions, adverse health impact etc (Chakrabarty 2016, Kumar et al 2023). In reducing the negative impacts of climate change, the most efficient way seems to be adaptation strategies (Surendran et al 2016, Kumar and Kaur 2018, Gangadhar 2020). The UN Food and Agriculture Organization introduced the concept of Climate Smart Agriculture (CSA) for the first time in 2010. CSA has been presented as a strategy to combat climate change while simultaneously tackling the challenges posed by GHG emissions (Managa and Nkobilemlhlongo 2016).

CSA holds the promise of enhancing productivity and resilience in a sustainable manner, while simultaneously curbing GHG emissions. This, in turn, contributes to advancing both food security and regional development objectives (FAO 2016). It represents a path for reshaping and revitalizing agricultural progress to adapt to the emerging realities of climate change (Lipper et al 2014). The three fundamental pillars of CSA encompass increased productivity, improved resilience in the face of climate change, and the mitigation of greenhouse gas emissions. Within this framework, agricultural techniques and

technologies that align with climate-smart principles can contribute to achieving at least one of these pillars. Despite the profound benefits of these technologies they are securing only a creeping rate of adoption (Aryal et al 2018, Jasna et al 2016). The main critique of CSA concerns its technically oriented nature (Taylor 2018, Autio et al 2021).

Various studies have shown that the farmers' decision of non-adoption or partial adoption could be rational due to the existing conditions that restrain adoption (Rodriguez 2005). Lack of knowledge about cultivation practices, lack of availability of seeds in the market, resistance to change the conventional practices, lack of adequate information on CRA technologies and weather status to plan their farming activities, and high cost for construction of well or farm pond were some of the constraints faced by the farmers (Rohila et al 2018, Mishra and Malik 2024). Constraints hampers the potential to find out, to approach and to handle the risk that decreases the adverse effect related to climatic event and also affects the development and application of adaptation into use. Farmers face number of constraints when adapting to the changing climatic conditions. Therefore, to understand the constraints experienced by the farmers while adapting the change in the climate, become important that too for the adversely affected regions (Shelar et al 2022). The present study aims to identify the main CSA practices being adopted and the reasons for their adoption, sources for disseminating information of these practices and the constraints faced by farmers during adoption of CSA practices.

MATERIAL AND METHODS

The study was conducted in the Punjab state of India. For the selection of the sample farmers, multistage sampling technique was used. In the first stage, one district from the Kandi (Roopnagar), three from the central zone (Sangrur, Patiala and Fatehgarh Sahib) and two from the southwestern zone (Mansa and Sri Muktsar Sahib) were selected based on the percentage distribution of the area under zones in Punjab state. Two villages from each district were selected randomly in the second stage. Total 12 villages had been selected (Table 1).

Later at the third stage, a list of farmers engaged in cultivating paddy and wheat crops was prepared. With the consultation of KVK scientists and other extension specialists like agriculture development officers, various climate smart practices applicable to paddy and wheat cultivation i.e, direct seeding of rice, short duration varieties of paddy, laser land leveling, baling, use of super seeder, happy seeder, zero till drill in wheat sowing were identified. Paddy and wheat are the main crops of Punjab which are dominating the state agriculture. From the list of farmers, 20 farmers, were selected from each village, ensuring a combination of both adopters and non-adopters of climate smart practices. In total, the final sample consisted of 240 farm households engaged in the cultivation of either paddy, wheat, or both crops, while also considering their adoption status of climate smart practices.

Garrett Ranking method was used to evaluate the problems faced by farmers for adoption of CSPs (Reddy et al, 2024). The farmers were asked to rank the given problem according to the magnitude of the problem. The orders of merit given by the respondents were converted into ranks by using the following formula:

$$\text{Percent position} = \frac{100 (R_{ij} - 0.5)}{N_j}$$

Where, R_{ij} = Rank given for the i^{th} item by the j^{th} individual

N_j = Number of items ranked by the j^{th} individual.

The percentage position of each rank thus obtained was converted into scores by referring to the table provided by Henry Garrett. Then for each factor the scores of individual sample farmers were added together and divided by the total respondents for whom scores were added. Thus, mean score for each problem was ranked by arranging them in the descending order.

RESULTS AND DISCUSSION

Climate smart practices: For effective management and coping with climate change in Punjab, various popular CSA practices were identified among the sample farmers. Seven CSPs were identified through primary survey of 240 farmers.

Though the farmers used multiple practices, but for analysis the study considered the maximum area adopted under respective CSP as the criteria for distributing farmers under each category (Table 1). The proportion of farmers adopting CSP revealed that major adaptation was short duration varieties like PR126, PR121, PR128 etc of paddy crop which take almost 110 to 120 days for maturity and leaves ample time to manage huge paddy straw. The main CSP adopted during kharif season were SDV, LLL and DSR. On the other hand SS, ZT, HS and B were adopted during *rabi* season (Table 2). The direct seeded rice was followed by only 17.51 per cent of the farmers. The zero tillage (30.57%) and super seeder (33.33%) were the major techniques for in-situ management of paddy straw. The happy seeder was comparatively less popular (20.34%) among the farmers. Farmers have adopted baling (15.82%) as an ex-situ paddy straw management technique.

Out of total sample of 240 farmers, 73.75 % were adopters; in both paddy and wheat crop. In paddy crop 47.08 per cent of the adopters used short duration varieties followed by laser land leveler (13.75%) and direct seeded rice (12.91%). In wheat crop 24.58 per cent have adopted

Table 1. Selected villages

District	Villages	Latitude	Longitude
Ropar	Santhua	30°52'05"N	76°22'43"E
	Katlour	30°53'14"N	76°22'34"E
Sangrur	Kanoi	30°11'33"N	75°51'19"E
	Dhandoli kalan	30°03'27"N	75°55'45"E
Fategarh Sahib	Khanpur	30°38'21"N	76°21'51"E
	Harbanspura	30°38'24"N	76°20'34"E
Patiala	Saholi	30°46'27"N	75°41'12"E
	Bolarkalan	30°17'49"N	76°30'18"E
Mansa	Uddat Bhagatram	29°54'10"N	75°19'49"E
	Mallakpur	30°02'35"N	75°25'23"E
Muktsar	Doda	30°23'04"N	74°38'15"E

Table 2. Adoption pattern of CSA practices as adaptation of climate change (Multiple response)

Particulars	Percentage
Short Duration varieties (SDV)	63.84
Laser Land Leveling (LLL)	18.64
Direct Seeded Rice (DSR)	17.51
Super Seeder (SS)	33.33
Zero Tillage (ZT)	30.57
Happy Seeder (HS)	20.34
Baling (B)	15.82

super seeder for sowing followed by zero tillage (22.50%) and happy seeder (11.67%).

The main reason for adopting climate-smart technologies was the high cost associated with deepening borewells (45.93) (Table 3). This reflected the challenges that farmers faced in maintaining access to groundwater for irrigation, which often involves significant high costs for borewell maintenance and deepening. The second reason for the adoption of CSPs was the expectation of achieving high crop yields. This indicated that farmers are inclined to adopt technologies that promise enhanced productivity and income. This was followed by effective use of agricultural inputs, such as fertilizers, pesticides, and labour scarcity, which ranks fourth. These results emphasized the economic, productivity, and resource management considerations that drive the adoption of climate-resilient technologies among Punjab farmers. The prioritization of these factors underscored the significance of addressing challenges related to input costs, labor availability, and yield enhancement in agricultural practices

Dissemination of information: The majority of sample farmers having average Garrett's score of 59.15 indicated that they predominantly used social media platforms such as YouTube, WhatsApp, and Facebook to gather information about climate-smart practices (Table 4). These digital platforms seem to be the most popular and accessible followed by Television he print media, including newspapers and agricultural magazines like "Kheti Sandesh" and "Changi Kheti" constituted the third major source of information with average Garrett's score of 42.16. Radio ranked fourth in terms of being a source of information for climate-smart practices. These results emphasized the economic, productivity, and resource management considerations that drive the adoption of climate-resilient technologies among Punjab farmers. The prioritization of these factors underscored the significance of addressing challenges related to input costs, labor availability, and yield enhancement in agricultural practices. These results emphasized the economic, productivity, and resource management considerations that drive the adoption of climate-resilient technologies among Punjab farmers. The

Table 3. Reasons for adoption of climate smart practices in Punjab, 2021-22

Particulars	Average Garrett's score	Ranks
High cost of deepening borewell	45.93	I
Expectation of high yield	43.99	II
Labour scarcity	38.33	IV
Effective utilization of inputs	39.30	III

prioritization of these factors underscored the significance of addressing challenges related to input costs, labor availability, and yield enhancement in agricultural practices.

Extension contacts: The role of agricultural extension plays an important role in the adoption decision process of CSPs. The significant proportion of the sample farmers, 74.17 per cent were, engaged with Agricultural Development Officers (ADOs) (Table 5). Among the adopters of CSP, this engagement was even higher, with 86.44 per cent seeking guidance from ADOs. In comparison, 39.68 per cent of non-adopters reached out to them. This was followed by Krishi Vigyan Kendra (KVK) (46.25 per cent) of for offering practical agricultural advice and disseminating new techniques to improve farming practices. Scientists from Punjab Agricultural University (PAU) were approached by 30.42 per cent of the sample farmers, highlighting their significance among farmers. The higher proportion of adopters (34.36%) consulted PAU scientists compared to non-adopters (19.05%) for their expertise in agricultural research and technology dissemination. Farmers had least interactions with Soil Conservation Officers and Horticulture Development Officers. These findings underscored the essential role that various extension officers, experts, and institutions play in disseminating knowledge and facilitating the adoption of climate-smart practices. The higher engagement rates among adopters, especially with ADOs demonstrate the pivotal role of extension services in

Table 4. Distribution of sample farmers according to source of information, Punjab 2021-22

Particulars	Average Garrett's score	Ranks
Radio	40.62	IV
Television	57.20	II
Social media (<i>you tube, whatsapp, facebook etc</i>)	59.15	I
Print media (<i>newspaper, magazines- kheti sandesh, changi kheti etc</i>)	42.61	III

Table 5. Distribution of respondents according to their extension contacts, 2021-22 (Numbers)

Particulars	CSP adopters	Non-adopters
Agricultural development officer	153 (86.44)	25 (39.68)
KVK experts	61 (47.46)	27 (42.86)
PAU scientists	61 (34.36)	12 (19.05)
Soil conservation officer	32 (18.08)	9 (14.29)
Horticulture development officer	39 (22.03)	14 (22.22)

Note: Figures in parentheses are percentages to total

Table 6. Constraints faced by sample farmers during a.doption of CSP in Punjab, 2021-22

Particulars	Frequency	Percentage
Low seed germination	77	43.50
More weed occurrence in the fields	87	49.15
More disease and pest infestation	92	51.98
Small land size	78	44.07
Erratic power supply	98	55.37
Non availability of labour	63	35.59
Lack of access to credit	52	29.38
High cost of machinery and other inputs	68	38.42
Lack of machinery at the time of harvesting and sowing of succeeding crop	85	48.02
More time consuming legal formalities in getting subsidies on farm machinery	102	57.63
Poor information dissemination about technologies through limited extension activities	95	53.67

promoting and supporting the adoption of sustainable agricultural techniques.

Constraints faced by sample farmers during adoption of CSP:

The most pronounced constraint, affecting more than half of the adopters (57.63%), was the extensive legal paperwork and time-consuming process required to access subsidies for agricultural machinery (Table 6). Erratic power supply emerged as the second major issue (55.37%), causing disruptions to farming operations as inconsistent power availability can adversely impact irrigation, mechanization, and other energy-dependent tasks. Also, the significant portion of farmers (53.67%) faced challenges due to poor information dissemination and limited extension activities about climate resilient agricultural technologies. High weed occurrence, especially in direct seeded rice fields, posed a significant challenge for 49.15 per cent of the CSPs adopters. Many farmers (48.02%) faced issues related to the availability of machinery during crucial phases of harvesting and sowing, impacting operational efficiency. About 43.50 per cent of the CSPs adopters faced challenges with low seed germination underscored the importance of using high-quality seeds and effective planting practices. Limited access to credit posed a challenge for investment in modern agricultural machinery and inputs (29.38 per cent). The financial burden associated with high cost machinery and inputs was a constraint faced by many adopters (38.42%) which affected CSPs adoption. Addressing these issues through policy interventions, technological advancements, and extension activities is crucial to facilitate smoother and more effective adoption of sustainable agricultural practices.

CONCLUSION

The current climate change situation is a clear indication of growing threat for the agricultural sector in India as well as in Punjab state. The study identified the climate smart

practices adopted by farmers in Punjab to mitigate the impacts of climate change and the major constraints faced by the farmers during their adoption. The most widely practiced technologies are LLL, SDV, DSR, SS, ZT, HS and B. The study found that digital platforms such as you tube, facebook and whatsapp etc., seem to be the most popular and accessible means for farmers to access up-to-date information regarding CSPs. The major constraints for adoption of climate resilient technologies were more legal paper work, erratic power supply and limited extension activities etc. This calls for redesigning the implementation mechanism of such smart practices in order to enhance adoption of climate resilient technologies. The study suggested that more extension services, financial support to agriculture sector, educational programs for farmers, demonstrating and trainings on new CSP are necessary for making farming more resilient economically and ecologically.

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