Breaking the Mold : A Constraint Analysis in Adoption of Climate Smart Agricultural Technologies

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Abstract

This study focuses on the constraints faced by farmers in adoption of Climate-Smart Agriculture (CSA) technologies in Southern Karnataka. Through a structured approach involving purposive and snowball sampling, 180 farmers were interviewed, including both adopters and non-adopters of CSA technologies. The research categorized constraints into financial, technical, socio-personal and situational/other factors. Financial constraints encompassed issues such as inadequate financial assistance and scarcity and high cost of labour . Technical challenges include poor maintenance, non-availability of required implement's in CHSC's and small and marginal holdings. Socio-personal factors involved land tenure disputes, lack of coordination and reluctance to adopt new practices and lack of regular meetings. Situational constraints encompassed unpredictable rainfall and youth migration. Non-adopters expressed reasons for not embracing CSA technologies, including limited knowledge, resource access, financial limitations and lack of need-based trainings. The study also assessed non- adopters' willingness to embrace different components of CSA technologies, revealing preferences for crop production and natural resource management. Lastly, the research highlighted the importance of government support for CSA technologies adoption among non-adopters. Overall, addressing these constraints requires a holistic approach involving financial aid, technical training, community engagement, and targeted policy initiatives to promote sustainable agriculture in the context of changing climate patterns.

Keywords : Adoption, Constraints, Climate smart agriculture Technologies

Indian agriculture stands as one of the most vulnerable sectors to the impacts of climate change and variability. Compounded by a dynamic interplay of shifting climate patterns and economic conditions, the sector faces the formidable challenge of ensuring food security for a population exceeding one billion. Within this context, strategies that bolster resilience and mitigate vulnerability emerge as paramount adaptations to climate change. Recognizing this imperative, the Indian Council of Agricultural Research (ICAR) initiated a noteworthy network project in February 2011, subsequently rebranded as the National Innovations in Climate Resilient Agriculture (NICRA). This transformative endeavour aims to champion the propagation of Climate Resilient Agricultural (CRA) technologies with the overarching goal of fortifying the resilience of Indian Agriculture (Pabba *et al*., 2021). Looking into the climatic constraints in the area, natural resource assessments, farming communities, crop production limits, climatic sensitivity, yield gaps and potentials for climate change adoption (Reddy *et al*., 2022) the Indian Council of Agricultural Research initiated the National Innovation for Climate Resilient Agriculture (NICRA) across the country in collaboration with ICAR research institutes, SAUs and KVKs.

In the prevailing context, it becomes imperative to ensure the effective on-ground utilization of NICRA's interventions by farmers. Numerous studies have highlighted that farmers' decisions to either not adopt or partially adopt these interventions can be logically reasoned due to existing constraints. Challenges such as insufficient familiarity with cultivation practices, limited accessibility to seeds within the market, reluctance to deviate from conventional methods, inadequate information about CRA technologies and real-time weather conditions for informed farming decisions and the elevated costs associated with constructing wells or farm ponds, have been identified as key constraints faced by beneficiaries of NICRA (Mohokar, 2019). The adoption of comprehensive climate-resilient technologies by farmers is encumbered by various hindrances. However, with meticulous planning, appropriate strategies and the efficient utilization of available resources, these constraints can be surmounted. To facilitate the extensive adoption of these technologies, implementing agencies must proactively address the barriers faced by farmers, ensuring their mitigation in both the short and long term. The pursuit of sustainable and resilient agricultural systems in the face of escalating climate change has given rise to the concept of climate-smart agriculture (CSA), which aims to enhance productivity, mitigate greenhouse gas emissions and foster adaptation to changing environmental conditions. While the adoption of CSA technologies holds significant promise for safeguarding food security and rural livelihoods, the realization of these benefits often faces formidable constraints at the grassroots level.

Small holder farmers face significant challenges in adopting new climate-smart technologies that are suitable for their local socio-economic conditions. These farmers often have small, fragmented land holdings and limited access to credit systems, making it difficult for them to embrace climate-smart agriculture (CSA) technologies. One critical barrier to the adoption of CSA practices is the lack of access to high-yielding, disease-resistant seed varieties. Additionally, inadequate institutional support, policy frameworks and access to information and knowledge hinder the conducive environment required for CSA technology adoption. Sub-Saharan Africa has experienced unbalanced and unpredictable agricultural policies, which have increased the vulnerability of farming systems (Meijerink and Roza, 2007), leading to a decline in livelihoods and compromising smallholder farmers' resilience and adaptive abilities.

The lack of comprehensive knowledge and awareness about climate-smart agricultural practices inhibits farmers' ability to comprehend the benefits and implementation of these technologies. And also, the cost implications associated with adopting climate-smart technologies, such as building infrastructure for water management, pose economic challenges for resource-constrained farmers (Jasna, 2014). Farmers' limited access to crucial resources, such as climate-resilient seed varieties and affordable technologies, hampers their capacity to transition towards climate-smart practices. The deeply ingrained nature of conventional farming practices can create resistance to change, impeding the integration of innovative climate-smart technologies (Nyasimi, 2017). The absence of timely and accurate information on climate forecasts, weather patterns and appropriate agronomic practices hinders farmers' ability to make informed decisions (Mohokar, 2019).

This research enhances the current body of knowledge on climate change adaptation by delving into the intricate ways in which both physical and socio-economic constraints influence the adoption of novel farm and land management practices. Additionally, it explores the potential restructuring of Climate-Smart Agriculture (CSA)-based intervention strategies by local stakeholders, aiming for greater inclusivity in the process. Given this context, the study aimed to distinguish the challenges experienced from the perspective of adopters and nonadopters of Climate-Smart Agriculture (CSA) technology. Recognizing farmers as key stakeholders in any technological or innovative intervention, the analysis focused on understanding the constraints encountered from their point of view.

METHODOLOGY

The study was carried out in Southern Karnataka State. For the execution of this study, a methodical approach involving multistage purposive and snowball sampling techniques was employed to select the sample group of farmers. The selection process was based on two key criteria: the degree of adoption of climate-smart agricultural technology interventions and the diversity in cropping patterns. Consequently, four villages were carefully chosen in collaboration with officials from the Krishi Vigyan Kendra (KVK's) and the Agriculture Technology Application Research Institute (ATARI), ensuring representation from both the districts - Chikkaballapur and Tumakuru.

In each of these selected villages, a total of 45 sample farmers were identified, resulting in 90 adopters and 90 non-adopters of climate-smart agricultural technologies. Thus, a cumulative total of 180 sample farmers were included from the two districts. The gathered information encompassed various socio-economic aspects of the sample farmers, such as age, educational background, family size, farming experience, landholding size and the involvement of family labour in farming activities.

Data Collection

To fulfil the specific objective of the investigation, primary data essential for the study were acquired by directly conducting interviews with a selected group of farmers, employing a pre-tested questionnaire. The districts were selected because they had effectively integrated climate-smart agricultural technologies at the level of individual farm households.

The primary data for the study was obtained through in-person interviews. These interviews utilized meticulously crafted, pre-evaluated and all-encompassing questionnaires specifically developed for this study. The respondents consisted of farmers who had implemented climate-smart agricultural technologies through the NICRA project, along with farmers in the same regions who had not adopted these technologies.

Analytical Tools Used

a) Rank Based Quotient (RBQ)

Rank based quotient (RBQ) was calculated using following formula as given by Sabaranthnam (1988):

$$\text{RBQ} = \frac{\sum f_i(n+1-i)\text{x}100}{\text{N x } n} \quad \dots (1)$$

Where,

i = Concerned ranks

N = Number of farmers

n = Number of ranks

f_i = Frequency of farmers for i^{th} rank of the technological need

b) Percentage Method

This method is used to draw specific inference from the collected data. The formula used:

$$P = \frac{\text{Q}}{\text{R}} \text{ x } 100 \quad \dots (2)$$

Where,

P = Percentage

Q = Number of respondents falling in a specific category to be measured

R = Total number of respondents or the population as a whole

c) Garrett's Ranking Technique

The Garret's ranking technique (Garret and Woodworth, 1969) was used to rank the major constraints associated with the adoption of climate smart agricultural technologies. The scoring technique, recommended by Garret for converting the ranks into scores when particular rank is reported by a different farmer for each effect, was used to analyse the constraints faced by farmers in adoption of CSA technologies. The conversion process is as follow:

$$\text{Percent position} = \frac{100\ (\text{Rij} - 0.5)}{\text{Nj}} \quad \dots (3)$$

Where,

R_{ij} = Rank given for i^{th} item by j^{th} respondent

N_j = Number of items ranked by j^{th} respondent

Scores are obtained by converting the estimated per cent position. The scores of each individual are then added together for each factor and the sum of the scores as well as the mean scores are determined. The most significant factor is that which is having the highest mean value.

The study aimed to identify the obstacles that farmers face while trying to implement Climate-Smart Agriculture (CSA) technologies. These constraints are widespread and hinder the farmers' efforts to adopt CSA practices. The researcher collected and analysed the farmers' perceptions regarding these challenges. They categorized and provided insightful comments on each constraint, shedding light on the difficulties faced by the farming community in the region when it comes to implementing CSA technologies in their agricultural practices.

Results and Discussion

Constraints Faced by the Respondents in Adoption of CSA Technologies in the Study Area

Major Financial Constraints Perceived by the Respondents in Adoption of CSA Technologies in the Study Area

Table 1, shows the financial constraints faced by farmers in the study area. To adopt several CSA technologies access to credit facility had crucial factor as perceived by the respondents of the study.

In Chikkaballapur district, inadequate financial assistance to adopt CSA technologies was the most perceived under financial constraint with RBQ score of 96.44, this was due to the fact that adoption CSA technologies such as construction of farm pond, different types of bunds around the farm, check dams etc. requires huge time and cost, hence it was occupied first position. However, scarcity and high cost of labour during peak season to adopt CSA practices was ranked second with RBQ score of 73.33. These findings are similar to the results reported by (Kumar *et al*., 2018). Lack of collateral security and lengthy procedure to obtain credit was ranked third, with a RBQ score of 59.56 followed by lack of savings (RBQ score of 42.67) and high initial operational costs (RBQ score of 24.89) was ranked fourth and fifth, respectively.

Similarly, in Tumakuru district, scarcity and high cost of labour during peak season was ranked first position with a RBQ score of 81.78, which might be due to the fact that majority of people moving to the nearby towns and cities in search of work other than agriculture. Followed by high initial operational costs were the next most important perceived financial constraint (Rank II) with RBQ score of 67.55, in the study area. This was due to the fact that any better or a new technology involves some investment to be made initially to reap better profits later. Majority of the farmers being small and marginal and with medium level of annual income, lack financial resources to afford the high-cost machinery. Lack of financial assistance and longer gestation period for the visibility of results from CSA might have contributed to the results.

Lack of savings, inadequate financial assistance to adopt CSA technologies and finally lack of collateral security and lengthy procedure to obtain credit, were

Table 1

Financial constraints perceived by the respondents in the study area

Financial constraints	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	RBQ score	Rank	RBQ score	Rank
Inadequate financial assistance to adopt CSA technologies	96.44	I	51.11	IV
Scarcity and high cost of labour during peak season	73.33	II	81.78	I
Lack of collateral security and lengthy procedure to obtain credit	59.56	III	46.67	V
Lack of savings	42.67	IV	54.67	III
High initial operational costs	24.89	V	67.55	II

Note : RBQ indicates Rank Based Quotient the least important financial constraints in the study area with RBQ score of 54.67, 51.11, 46.67, respectively.

Major Technical Constraints Perceived by the Respondents in Adoption of CSA Technologies in the Study Area

Table 2, indicates that the constraints like poor maintenance and non-availability of required implements in Custom Hiring Service Centre's was most perceived technical constraint faced by farmers with RBQ score of 80.37 and has occupied first rank. This might be due to the fact that at the time of sowing season due to limited number of farm machineries farmers who come first will get the required implements to carry out the agricultural operations and hence farmer who comes next to him will not be able to get the required implements during the peak season.

Uncertain returns and results was the second most important constraint, which was ranked II, with RBQ score of 75.92. This was attributed to failure of some technologies such as Groundnut deseeder, introduction of Swarnadara and Kadaknath breeds were not performed well in the local conditions. Small and marginal holdings/Undulated land was the challenging constraint ranked III, with RBQ score of 60.37. This was due to fact that limited size of landholdings poses a significant challenge for farmers in adopting climate-resilient technologies.

Likewise, poor availability and high cost of required agri inputs (*viz.,* quality seeds, fertilizers and pesticides) (RBQ score of 57.03), laborious and time-consuming process (RBQ score of 50.37), this was because to carry out certain CSA technologies such as construction of bunds, land levelling and construction of water storage structure requires huge labour and time. Similar findings were reported by Yarazari, 2022. Followed by 'Poor implementation of location specific CSA technologies' (RBQ score of 27.03) were found to be comparatively least important constraints and were ranked fourth, fifth and sixth, respectively among the technical constraints. These results are in line with (Ouedraogo *et al*., 2019)

In Tumakuru district, small and marginal holdings/ Undulated land (Rank I) with a RBQ score of 87.93, this might be due to the fact that in case of small holding and undulated land its difficult adopt the CSA practices such as land levelling, construction on rain water harvesting structures and mechanical harvesting etc., was occupied top position. Followed by poor maintenance and non-availability of required implements in CHSC's (Rank II) and uncertain returns and results (Rank III) were found to be next most important technical constraints faced by the farmers with a RBQ score of 80.31 and 60.07, respectively. This might be due to the failure of some technologies hinders the adoption of CSA technologies.

TABLE 2

Technical constraints as perceived by the respondents in the study area

Technical constraints	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	RBQ score	Rank	RBQ score	Rank
Poor maintenance, non-availability of required implements in CHSC's	80.37	I	80.31	II
Uncertain returns and results	75.92	II	60.07	III
Small and marginal holdings/Undulated land	60.37	III	87.93	I
Poor availability and high cost of required agri inputs	57.03	IV	46.98	V
Laborious and time-consuming process	50.37	V	56.19	IV
Poor implementation of location specific CSA technologies	27.03	VI	35.55	VI

TABLE 3

Socio-personal constraints as perceived by the respondents in the study area

Socio-personal constraints	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	RBQscore	Rank	RBQscore	Rank
Land tenure issues	85.33	I	70.67	II
Poor coordination and reluctance to share ideas among the members of the community	74.22	II	60.89	III
Lack of regular meetings	62.22	III	88.00	I
Unable to accept new practices	46.66	IV	44.44	IV
Illiteracy of farmers	31.55	V	33.78	V

Furthermore, laborious and time-consuming process (RBQ score of 56.19), poor availability and high cost of required agri inputs (RBQ score of 46.98) and poor implementation of location specific CSA technologies (RBQ score of 35.55) are least perceived technical constraints in the study area.

Major Socio-Personal Constraints Perceived by the Respondents in Adoption of CSA Technologies in the Study Area

Table 3, represents the results of socio-personal constraints in the study area. In Chikkaballapur district, land tenure issues was the important perceived constraint ranked I, with a RBQ score of 85.33. Followed by poor coordination and reluctance to share ideas among the members of the community (Rank II) and lack of regular meetings (Rank III) were the next important socio-personal constraints in the study area with a RBQ score of 74.22 and 62.22, respectively. This might be due to the fact that land tenure problems, such as insecure land rights or disputes over land ownership, can create uncertainties and deter farmers from making long-term investments in sustainable agricultural practices.

Whereas, enable to accept new practices (RBQ score of 46.66) and illiteracy of farmers (RBQ score of 31.55) are the least socio-economic constraints faced by the farmers. This was due to the fact that some of the introduced technologies such as groundnut deseeder, introduction Kadanath and Swarnadara poultry breeds were not performed well. Hence, farmers were unable to accept and implement the innovative technologies.

In Tumakuru district, lack of regular meetings, land tenure issues are the most important perceived socio-economic constraints perceived by the farmers with RBQ score of 88.00 and 70.67, respectively. This might be due to the poor co-operation and collective decision making expressed by adopters.

Additionally, poor coordination and reluctance to share ideas among the members of the community (RBQ score of 60.89), inability to accept new practices (RBQ score of 44.44) and illiteracy of farmers' (RBQ score of 33.78) were the least important constraints faced by farmers. These results are in similar to the findings by Naik *et al*., 2022.

Major Situational / Other Constraints Perceived by the Respondents in Adoption of CSA Technologies in the Study Area

Situational / other constraints faced by the farmers in adoption of CSA technologies was presented in Table 4. The observed results shows that migration of youth and unpredictable and uneven rainfall, are the most important constraints perceived by farmers with a RBQ score of 82.59 and 71.85, respectively. Even though many efforts are being made by the governments, NGOs and SAUs for the betterment of agriculture sector and the farmers, the retainment of youth in agriculture is not being possible to a visible extent. Because they are being attracted towards more profitable and standardized occupations which might be a reason for the migration of youth to cities and towns. Besides farmers were highly depends on mansoon season. These results are in line with (Bilaiya, 2022). And the selected villages are highly prone to drought and heat stress.

Likewise, difficulties in shifting to different cropping patterns in short period of time (RBQ score of 60.00), poor information accessibility and utilization of weather based agro advisory services (RBQ score of 53.33) were the next important constraints ranked III and IV, respectively. Whereas, lack of support from line departments (RBQ score of 41.85) it could be due to could be due to the lack of convergence of various line departments during the project implementation process and insufficient need-based trainings on CSA technologies (RBQ score of 40.37) are the least important situational constraints perceived by the farmers in Chikkaballapur district.

Similarly, unpredictable and uneven rainfall was the important constraint faced by the farmers with RBQ score of 89.25 in Tumakuru district and it as occupied first position among situational constraints. It was due to the fact that even though they have well irrigated facility still majority of farmers in the off season depends on rainwater harvested during monsoon season for agricultural operations as expressed by the farmers in the study area.

Difficulties in shifting to different cropping patterns in short period of time and poor information accessibility and utilization of weather based agro advisory services were the next important constraints faced by the farmers with RBQ score of 74.07 and 62.59, respectively. It was probably due to the lack of awareness, hands on experience in utilizing ICT platforms, etc. this is in line with the similar findings by Pabba *et al*., 2021.

Furthermore, lack of support from line departments (RBQ score of 54.81), migration of youth (RBQ score of 41.48) and insufficient need-based trainings on CSA technologies (RBQ score of 28.51) were least important constraints perceived by farmers in the study area.

Category Wise Over all Position of Constraints in the Study Area

Overall position of constraints as perceived by the farmers in adoption CSA technologies are presented in Fig. 1. The results revealed that majority of the farmers in Chikkaballapur district, faced the technical constraints and situational constraints with a RBQ score of 77.78 and 73.89, respectively and these constraints occupied first and second most perceived constraints. Whereas, socio-personal constraints and financial constraints are the next most important constraints faced by the farmers with an RBQ score of 54.44 and 43.89, respectively.

TABLE 4

Situational and other constraints as perceived by the respondents in the study area

Situational/other constraints	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	RBQ score	Rank	RBQ score	Rank
Migration of youth	82.59	I	41.48	V
Unpredictable and uneven rainfall	71.85	II	89.25	I
Difficulties in shifting to different cropping patterns in short period of time	60.00	III	74.07	II
Poor information accessibility and utilization of weather based agro advisory services	53.33	IV	62.59	III
Lack of support from line departments	41.85	V	54.81	IV
Insufficient need-based trainings on CSA technologies	40.37	VI	28.51	VI

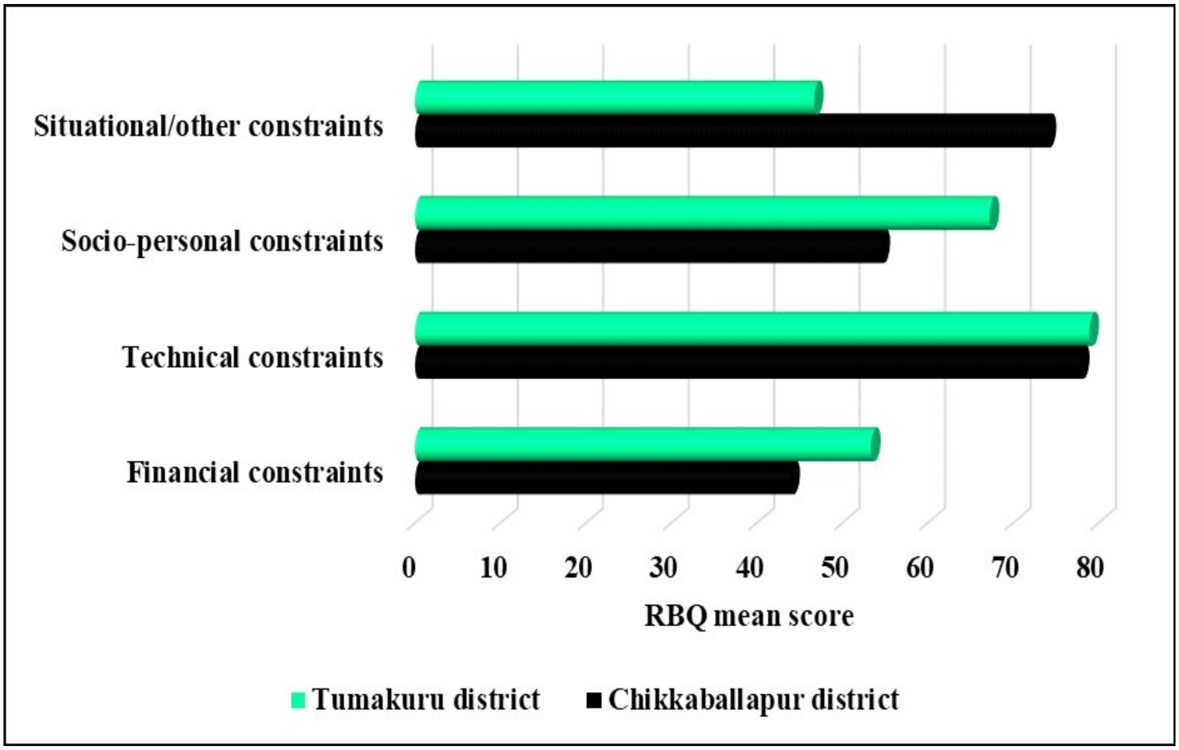

Fig. 1 : Category wise overall position of constraints as perceived by the farmers in the study area

Similarly, in Tumakuru district, technical constraints and socio-personal constraints were the most important constraints perceived by the farmers with RBQ value of 78.89 and 67.22, respectively and these constraints occupied first and second rank. While financial constraints and situational / other constraints were the next important constraints faced by the farmers with RBQ value of 53.33 and 46.67, respectively.

Major Reasons Perceived by Non-Adopters in Adoption of CSA Technologies

The results of the Table 5, revealed the major reasons faced by farmers for the adoption of climate smart agriculture technologies.

The majority of farmers in Chikkaballapur district expressed that lack of need-based training on CSA technologies (Rank I), lack of knowledge on CSA

TABLE 5

Major reasons perceived by non-adopters in the study area

Constraints	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	RBQ	Rank	RBQ	Rank
Lack of need-based training on CSA technologies	81.26	I	73.33	III
Lack of knowledge on CSA technologies	71.11	II	82.53	I
Demands more resources like water, land and money	69.63	III	65.07	IV
Lack of access to improved crop varieties and other inputs	60.63	IV	41.90	V
Inaccessibility of farmers to proper credit facilities	45.39	V	35.23	VI
Lack of support from line departments	40.95	VI	78.09	II
Lack of confidence among the farmers to adopt CSA technologies	30.15	VII	23.80	VII

technologies (Rank II) and demands more resources like water, land and money (Rank III) were the major perceived reasons by the farmers with RBQ score of 81.26, 71.11 and 69.63, respectively. This might be due to lack of need-based training and they do not have proper technical guidance in adoption of CSA technologies. If the government is ready to provide such technologies, farmers are ready to implement those smart technologies to cope with drought, as expressed by majority of the farmers in the study area. These results are in line with Majumder *et al*., 2020.

Likewise, lack of access to improved crop varieties and other inputs, inaccessibility of farmers to proper credit facilities, lack of support from line departments and lack of confidence among the farmers to adopt CSA technologies are the next important reasons perceived by the farmers with a RBQ score of 60.63, 45.39, 40.95 and 30.15, respectively. Similarly, in Tumakuru district, expressed certain constraints in adoption of CSA technologies. Lack of knowledge on CSA technologies (RBQ score of 82.53), lack of support from line departments (RBQ score of 78.09), and lack of need-based training on CSA technologies (RBQ score of 73.33) were the most important reasons perceived by farmers and ranked as first, second and third, respectively.

Demands more resources like water, land and money (RBQ score of 65.07) lack of access to improved crop varieties and other inputs (RBQ score of 41.90), inaccessibility of farmers to proper credit facilities (RBQ score of 35.23) and lack of confidence among the farmers to adopt CSA technologies (RBQ score of 23.80) were the next reasons occupied fourth, fifth, sixth and seventh position, respectively in the study area.

Willingness to Adopt different CSA Technologies in the Study Area

The Table 6, represents the willingness of non-adopter farmers in two study areas, Chikkaballapur and Tumakuru distrcits, to adopt different components of CSA technologies. The Garret score is used to rank the components based on their acceptance and adoption potential among the non-adopter farmers.

In Chikkaballapur district, the results indicate that the most favoured technological component among non-adopter farmers was crop production, with a high Garret score of 78.89, ranking it at the top. This suggests that farmers in this region are more willing to adopt CSA technologies related to crop production practices. The second-highest ranked component is natural resource management, with a Garret score of 65.56. While it is ranked second, the score is significantly lower than the top-ranking crop production component other components such as livestock and institutional interventions are ranked and third and fourth, respectively.

In Tumakuru district, the pattern of willingness to adopt CSA technologies among non-adopter farmers is somewhat different. Here, natural resource management takes the lead with a remarkably high Garret score of 87.78, suggesting that non-adopter farmers have a strong inclination towards adopting CSA technologies related to sustainable management of natural resources. This component was ranked first, indicating its high potential for widespread adoption.

TABLE 6

Willingness to adopt CSA technologies by non-adopter farmers in the study area

Technological components	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	Garret score	Rank	Garret score	Rank
Crop production	78.89	I	67.22	II
Natural resource management	65.56	II	87.78	I
Livestock management	62.78	III	53.33	III
Institutional interventions	42.78	IV	41.67	IV

TABLE 7

Consciousness towards the adoption of CSA technologies by non-adopter farmers

Particulars	Chikkaballapur district (n=45)		Tumakuru district (n=45)	
	Frequency	%	Frequency	%
I, am satisfied with my situation	9	20.00	12	26.67
I, am poor, and can't pay	6	13.33	9	20.00
Govt. has to provide CSA technologies	30	66.67	24	53.33

Crop Production, which was occupied the second position with a Garret score of 67.22. Livestock Management is ranked third with a lower Garret score of 53.33, suggesting a relatively lesser willingness to adopt livestock management-related CSA. Lastly, Institutional interventions, remain at the fourth position with a Garret score of 41.67, which indicates that non-adopter farmers in this area are less receptive to institutional interventions related to CSA technologies. Further research and analysis could be conducted to identify the factors contributing to this difference and explore ways to improve livestock management adoption in Tumakuru district.

Farmers Perception towards the Adoption CSA Technologies

Farmer's perception towards the adoption of CSA technologies were represented in Table 7. The results indicates that an average 20.00 and 26.67 per cent of the respondents in Chikkaballapur and Tumakuru districts, expressed their satisfaction with their current situation.

In Chikkaballapur district, 13.33 per cent of the respondents indicated that they were poor and unable to pay, followed by 20.00 per cent in case of Tumakuru district. Whereas, a significant 66.67 per cent of the respondents believed that the government should provide CSA technologies, followed by 53.33 per cent of the respondents in Tumakuru district.

The study reveals valuable insights into the constraints faced by farmers in adopting Climate-Smart Agriculture (CSA) technologies in Chikkaballapur and Tumakuru districts. These include financial constraints, requiring accessible credit facilities; technical challenges, necessitating technological interventions and training; socio-personal barriers, emphasizing the importance of social and community-based approaches; and situational constraints, urging targeted interventions for resource availability, infrastructure development and youth engagement. The major reasons perceived by the non-adopters were lack of need-based training on CSA technologies and lack of knowledge on CSA technologies in Chikkapallapur district. Whereas, lack of knowledge on CSA technologies and lack of support from line department were the major perceived constraints. Addressing these concerns requires improved information dissemination, training and incentives. Willingness to Adopt CSA technologies among non-adopters, reveals majority of the farmers were interested in adopting CSA technologies related to natural resource management, crop production and livestock management. This highlights the potential for targeted interventions in these areas to encourage technology adoption.

The government's role is seen as crucial in addressing these concerns, which underscores the importance of policy interventions and support in both regions. Addressing the multifaceted constraints faced by farmers in adopting CSA technologies requires a comprehensive approach involving financial support to alleviate the initial operational costs and streamline credit procedures to make them more efficient and less time-consuming. Providing technical training to address issues related to poor maintenance, non-availability of implements and labour-intensive processes. Besides provide comprehensive training programs to enhance farmers' technical skills and knowledge about CSA technologies and ensure a steady and reliable supply of agricultural inputs to overcome technical constraints. Under the NICRA project of Government of India as established Village Level Climate Risk Management Committee so such committees should facilitate regular meetings and coordination among community members to foster a supportive environment for technology adoption, develop outreach programs to enhance awareness and acceptance of new agricultural practices and implementing measures to address the migration of youth by creating opportunities for employment and engagement in agriculture need to be taken care to overcome such constraints in adoption of CSA technologies.

Additionally, Non-adopters in the study area were very keen about the adoption of CSA technologies to increase their production, performance and build the resilience against changing climate. Therefore, investing in educational programmes and awareness campaigns, strengthening and expanding farmer groups, enhancing the role of extension agents, dissemination of accurate and timely weather information, increasing the availability of CSA training programs and government initiatives have to be undertaken in order to diversify farmers income sources which can create a conducive environment for the widespread adoption of climate-smart agriculture technologies. By targeting these areas, stakeholders can pave the way for sustainable agricultural practices that enhance both productivity and resilience in the face of changing climatic conditions.

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