



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; SP-9(3): 13-18
Received: 25-12-2025
Accepted: 29-01-2026

Saikiran Chintakindi
Ph.D. Scholar, Department of
Agricultural Extension Education,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

RS Sengar
Professor, Department of
Agricultural Extension Education,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Chintawar Shraddha
Ph.D. Scholar, Department of
Agricultural Extension Education,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Subhash Rawat
Scientist, Agriculture Extension
Education, Krishi Vigyan Kendra,
Alirajpur, Madhya Pradesh, India

Archna Patel
Assistant Professor, Department of
Agricultural Extension and
Communication, Vanbandhu
Polytechnic in Agriculture, SDAU,
Khedbrahma, Gujarat, India

Corresponding Author:
Saikiran Chintakindi
Ph.D. Scholar, Department of
Agricultural Extension Education,
Indira Gandhi Krishi
Vishwavidyalaya, Raipur,
Chhattisgarh, India

Farmers' attitude toward climate smart agriculture technologies under changing climatic conditions

Saikiran Chintakindi, RS Sengar, Chintawar Shraddha, Subhash Rawat and Archna Patel

DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i3Sa.4960>

Abstract

Understanding farmers' attitude toward Climate Smart Agriculture Technologies (CSATs) is crucial for enhancing their adoption and improving agricultural resilience under changing climatic conditions. The present study assessed farmers' attitude toward CSATs in Chhattisgarh, India, with emphasis on component wise and overall attitude patterns. The study was conducted during 2022–23 and 2023–24 across the three agro-climatic zones of Chhattisgarh, Northern Hills, Chhattisgarh Plains and Bastar Plateau. A proportional random sampling technique was employed to select six districts, followed by the selection of two blocks per district and two villages per block, resulting in a sample of 360 farmers. Data were collected through personal interviews and group discussions. The results indicate that a majority of farmers exhibited a moderately favourable attitude toward CSATs across all major components. With respect to land levelling, 66.95% of respondents showed a moderately favourable attitude. For zero tillage, 68.89% of respondents were moderately favourable. In the case of residue management or mulching, 65.56% of farmers exhibited a moderately favourable attitude. Attitudes toward precision nutrient management were predominantly moderate, with 72.77% of respondents falling in this category. Similar trends were observed for crop diversification and alternate wetting and drying, where 66.94% and 68.89% of respondents, respectively, expressed moderately favourable attitudes. Overall attitude analysis revealed that 52.50% of farmers possessed a moderately favourable attitude toward CSATs, 30.56% had a favourable attitude, and 16.94% exhibited a less favourable attitude. The predominance of moderately favourable attitude across components suggests partial awareness and acceptance of CSATs, but also indicates gaps in in-depth knowledge and conviction regarding their benefits.

Keywords: Attitude, climate smart, farmers, climate change

Introduction

Rapid population growth and changing food consumption patterns have intensified pressure on agricultural systems worldwide. The world's population is projected to grow by over 33% by 2050, necessitating significant changes in existing agricultural systems to meet rising food demand (FAO, 2013) ^[6]. Global food demand is expected to increase by 35% to 56% between 2010 and 2050 due to shifts in consumer preferences (van Dijk *et al.*, 2021) ^[21]. In India, food demand is projected to rise substantially as a result of population growth and increasing per capita income (Mittal, 2012) ^[15]. However, domestic production is expected to be constrained by low yield growth, posing serious challenges to meeting long-term food requirements through domestic production alone (Kumar *et al.*, 2009) ^[11]. India accounts for 24.3% of global food demand, second only to China at 16.7% (Islam and Karim, 2019). United Nations demographic projections estimate that India's population may reach approximately 1.718 billion by 2065, requiring nearly 567 million tonnes of food. At the global level, a 60% increase in agricultural productivity by 2050 has therefore been identified as essential to ensure food security (Fischer, 2018) ^[7]. These structural challenges are further compounded by climate change and increasing weather unpredictability, which have rendered agricultural production systems more fragile. Climate change negatively affects not only crop productivity and resource availability but also the mental health and well-being of individuals engaged across agricultural value chains. Smallholder farmers are particularly vulnerable due to limited access to resources, innovative

technologies and financial capital (Badjeck *et al.*, 2010; Shaffril *et al.*, 2017) ^[2, 17]. Climate-induced social unrest and financial instability further contribute to mental health stress (Berry *et al.*, 2010; Kam *et al.*, 2023) ^[3, 9]. These vulnerabilities shape farmers lived experiences with climate risk and form an important backdrop against which their attitude toward adaptation technologies emerge.

In this context, climate-smart agriculture (CSA) has been promoted as a strategic response to climate change, aiming to reduce adverse impacts on agricultural production while enhancing environmental sustainability. CSA focuses on adapting agricultural inputs and practices to improve efficiency, productivity and resilience. Despite its documented potential, the adoption of climate-smart agricultural technologies has remained low in developing countries such as India. One probable explanation identified in the literature is fear among end users regarding the potentially negative effects of such technologies. This indicates that farmers' attitude play a critical role in shaping their willingness to adopt Climate Smart Agriculture Technologies (CSATs), even in the presence of substantial investments in agricultural research and development.

The persistence of low adoption is also associated with the manner in which agricultural innovations are generated and disseminated. Conventional top-down and linear approaches to extension and technology transfer have made limited progress in encouraging adoption, largely because they fail to recognise and support interactive social learning and innovation processes that help farmers manage the increasing complexity of their farming systems (Kilelu *et al.*, 2013) ^[10]. As a result, farmers' attitudes toward CSATs are influenced not only by the technical attributes of technologies but also by their experiences with participation, trust, communication and learning. A growing body of literature highlights the importance of shifting from a technology-focused approach to a systems-focused perspective to better understand farmers' responses to CSA. Farming systems are shaped by political influences, market infrastructure, institutional arrangements and interactions between public and private sectors (Kakzan *et al.*, 2013; Thornton *et al.*, 2018) ^[8, 19]. Empirical evidence indicates that CSA practices can increase crop output, improve resource-use efficiency, raise farm incomes, and reduce greenhouse gas emissions (Dinesh *et al.*, 2015; Ugochukwu and Phillips, 2018) ^[15, 20]. However, farmers' attitude toward these practices are shaped by how they perceive associated risks, trade-offs and benefits within their specific socio-economic and institutional contexts.

Despite extensive research on climate adaptation and technology adoption, there remains a significant gap in studies examining the relationship between CSAT adoption, subjective well-being and farmers' attitude. Existing research has largely focused on digital technologies and related behaviours in relation to subjective well-being (Zheng *et al.*, 2023a; Li *et al.*, 2023; Ma *et al.*, 2022; Zheng *et al.*, 2023b) ^[22, 12, 14, 22]. However, no studies have explicitly investigated the causal link between adaptation to climate change through CSAT and subjective well-being. Climate-smart agricultural practices such as minimum tillage, improved planting techniques, irrigation management, fertilizer management and crop residue assimilation have been shown to enhance yields and reduce greenhouse gas emissions (Branca *et al.*, 2011) ^[4]. Similarly, the use of improved seeds, ICT-based agro-advisories, crop and livestock insurance, and rainwater harvesting can help farmers mitigate climate variability and risk (Altieri and Nicholls, 2017; Mittal, 2012) ^[15, 1]. Farmers' exposure to and experiences with these practices influence their

perceptions of adaptability, reliability and usefulness, which collectively shape their attitude toward CSAT adoption.

Methodology

The present study was conducted in the state of Chhattisgarh during the agricultural years 2022–23 and 2023–24. Chhattisgarh comprises three agro-climatic zones, namely the Northern Hills, Chhattisgarh Plains and Bastar Plateau, which differ in their climatic and agricultural characteristics. To ensure representation of the entire state, districts were selected from each agro-climatic zone using a proportional random sampling technique, wherein twenty per cent of the districts from each zone were included in the study. Accordingly, one district, Sarguja, was selected from the seven districts of the Northern Hills zone. From the Chhattisgarh Plains, which consist of twenty districts, four districts Raipur, Rajnandgaon, Bemetara and Dhamtari were selected. From the Bastar Plateau zone, comprising six districts, one district, Kanker, was selected. Thus, a total of six districts were included in the study. From each selected district, two blocks were chosen and from each block, two villages were selected. Farmers from the selected villages constituted the respondents for the study, resulting in a total sample size of 360 farmers. Primary data were collected from the respondents through personal interviews and group discussions. The collected data were systematically coded, tabulated and subjected to statistical analysis in line with the objectives of the study.

Attitude was conceptualized as a learned evaluative tendency reflecting an individual's favourable or unfavourable judgment toward specific objects, situations, or practices. In the present study, it refers to farmers' evaluative orientation toward Climate-Smart Agricultural Technologies (CSATs), which varies in intensity across individuals and influences their responses to such practices. Farmers' attitude toward CSATs was measured using the standardized attitude scale developed by Shitu *et al.* (2018) ^[18]. The scale comprised a total of 30 statements, including 18 positive and 12 negative statements. These statements were distributed across six major components of CSATs, namely, land levelling (4 statements), zero tillage (5 statements), residue management or mulching (4 statements), precision nutrient management (5 statements), crop diversification (6 statements) and alternate wetting and drying practices (6 statements). Respondents were asked to indicate their level of agreement with each statement on a five-point Likert-type continuum consisting of strongly agree, agree, undecided, disagree, and strongly disagree. For positive statements, scores were assigned from 5 (strongly agree) to 1 (strongly disagree), whereas for negative statements, the scoring pattern was reversed from 1 to 5 to maintain directional consistency. The total attitude score for each respondent was computed by summing the scores obtained across all 30 statements. Based on the aggregate attitude scores, respondents were classified into three categories according to their level of attitude toward CSATs. In addition to the overall attitude assessment, component-wise analysis was carried out to examine farmers' attitude toward specific CSAT practices. For each component, mean scores were calculated for the respective statements and rank orders were assigned based on the aggregated mean values to determine the relative importance of different CSAT components.

Results and Discussion

Attitude of farmers towards Climate Smart Agriculture Technologies (CSATs)

It's crucial to understand respondents' attitude regarding Climate

Smart Agriculture Technologies (CSATs) because a positive attitude will help adoption of Climate Smart Agriculture Technologies. Respondents' attitude provide insight into what they perceive about CSA Technologies, which aids policymakers in developing CSA policies for adoption.

Attitude of farmers towards land levelling

Data presented in Table 1 showed those respondents who had a favorable attitude about the statement run-off occur in unlevelled field which ranked 1st average score 4.21 followed by the statement adapt water harvesting strategies ranked 2nd with average score 4.01 and statement, new land levelling methods are difficult ranked 3rd with average score 3.78. whereas the respondents had a less favorable attitude about the statement traditional levelling methods was good which ranked 4th with average score 3.63.

Table 1: Distribution of respondents according to attitude towards land levelling of Climate Smart Agriculture Technologies

Sl. No.	Land Levelling	Score	
		Mean	Rank
1.	Run-off occur in unlevelled field	4.219	I
2.	Traditional levelling methods are good	3.636	IV
3.	Adapt water harvesting strategies	4.013	II
4.	New land levelling methods are difficult	3.788	III

Table 2 described that the majority of the respondents (66.95%) had a moderately favorable attitude regarding land levelling. Where 20 per cent of the respondents were found to have

favorable attitude towards land levelling. 13.05 per cent of respondents showed their less favorable attitude regarding land levelling. It can be inferred from the above findings that a limited per cent of the respondents had a favorable attitude regarding land leveling.

The majority of respondents had a moderately favourable attitude toward land levelling. The reason for farmers' moderately favourable attitude is a lack of precise understanding about land levelling and its benefits.

Table 2: Distribution of respondents according to level of attitude towards land leveling of Climate Smart Agriculture Technologies

Sl. No.	Category	Frequency	Percentage
1.	Less favourable	47	13.05
2.	Moderately favourable	241	66.95
3.	Favourable	72	20

Attitude of farmers towards zero tillage

It is clear from Table 3 that respondents had a favorable attitude about the statement of traditional tillage does not lead to degradation of soil resources which ranked 1st with average score 3.75 followed by the statement regarding innovative tillage technology improve usage of water ranked 2nd with average score 3.75 and sowing in un ploughed field reduces cost of production ranked 3rd with average score 3.28 and zero-tillage reduces greenhouse gas emission ranked 4th with average score 3.22. Whereas farmers had a less favorable attitude about the statement early sowing of wheat is not necessary which ranked 5th with average score 3.16.

Table 3: Distribution of respondents according to attitude towards zero tillage of Climate Smart Agriculture Technologies (CSATs)

Sl. No.	Zero tillage	Score	
		Mean	Rank
1.	Innovative tillage technology improves usage of water	3.73	II
2.	Traditional tillage does not lead to degradation of soil resources	3.75	I
3.	Sowing in unploughed field reduces cost of production	3.28	III
4.	Zero-tillage reduces greenhouse gas emission	3.22	IV
5.	Early sowing of wheat is not necessary	3.16	V

As shown in the Table 4, the majority of respondents (68.89 percent) had a moderately favourable attitude towards zero tillage, whereas 16.94 percent had a favourable attitude towards zero tillage. Only 14.17 percent of respondents had less favourable attitude towards zero tillage. Few respondents had a favourable attitude towards zero tillage, and the majority had a moderately favourable attitude towards it. This could be because they were unaware of how zero tillage helps to reduce energy consumption during land preparation without influencing production levels, as well as crop water requirements and moisture evaporation

Table 4: Distribution of respondents according to level of attitude towards zero tillage of Climate Smart Agriculture Technologies (CSATs)

Sl. No.	Category	Frequency	Percentage
1.	Less favourable	51	14.17
2.	Moderately favourable	248	68.89
3.	Favourable	61	16.94

Attitude of farmers towards residue management

In Table 5 narrated that respondents had a favorable attitude towards the statement leaving residue on the field will compete with fodder availability ranked 1st with average score 3.91 followed by the statements Mulching increases cost of

cultivation and Mulching is useful for weed control ranked 2nd with average score 3.68 and 3rd with average score 3.60 respectively. Whereas few respondents had a less favourable attitude about the statement Mulching maintains productive soil layer which ranked 4th with average score 3.50.

Table 5: Distribution of respondents according to attitude towards management/mulching of Climate Smart Agriculture Technologies

Sl. No.	Residue management/mulching	Score	
		Mean	Rank
1.	Leaving residue on the field compete with fodder availability	3.91	I
2.	Mulching is useful for weed control	3.60	III
3.	Mulching maintains productive soil layer	3.50	IV
4.	Mulching increases cost of cultivation	3.68	II

Table 6 described that majority of the respondents (65.56%) were found to possess a moderately favourable attitude regarding residue management/mulching and 20.27 per cent of the respondents were found to have less favourable attitude. While only 14.16 per cent of respondents show favourable attitude regarding residue management/mulching. According to the findings, a few respondents had a favourable attitude toward residue management/mulching, whereas the majority of

respondents had a moderately favourable attitude. It is possible that respondents were unaware that mulching protects soil erosion from wind and rain, conserves soil moisture, increases organic matter in the soil, promotes infiltration, aeration and tilth. The reason behind moderately favorable attitude might be due to lack of knowledge, interest and conviction, towards mulching practices.

Table 6: Distribution of respondents according to level of attitude towards Residue management/mulching of Climate Smart Agriculture Technologies

Sl. No.	Category	Mean	Percentage
1.	Less favourable	73	20.27
2.	Moderately favourable	236	65.56
3.	Favourable	51	14.17

Attitude of farmers towards precision nutrient management

From Table 7 it can be seen that respondent's attitude was favourable towards the statements excessive use of fertilizer rises the production cost ranked 1st with the highest average score 3.61 followed by the adaptation of precision nutrient management will help to mitigate climate change cost of precision nutrient management technologies discourages one to adapt which ranked 2nd and 3rd with average score of 3.63 and 3.47, respectively. While, the statement education is required to use precision nutrient management technologies ranked 5th with average score of 3.42.

Table 7: Distribution of respondents according to attitude towards precision nutrient management of Climate Smart Agriculture Technologies

Sl. No.	Precision nutrient management (PNM)	Score	
		Mean	Rank
1.	Excessive use of fertilizer rises the production cost	3.69	I
2.	Cost of PNM technologies discourages one to adapt	3.47	III
3.	Precision nutrient management helps maximize productivity and income	3.42	IV
4.	Education is required to use precision nutrient management technologies	3.10	V
5.	Adaptation of precision nutrient management will help to mitigate climate change	3.63	II

The data presented in table 8 described that majority of the respondents (72.78%) were found to possess a moderately favorable attitude and 14.73 per cent of the respondents were found have a less favourable attitude towards precision nutrient management. While only 12.50 per cent of respondents had favourable attitude. Because precision nutrient management is one of the key components of climate smart agriculture and it governs all of the major issues of improving productivity, sustainability, profitability, and climate change related turbulences, the need is to create awareness among respondents and encourage them to change their attitudes.

Table 8: Distribution of respondents according to attitude towards precision nutrient management of Climate Smart Agriculture Technologies

Sl. No.	Category	Frequency	Percentage
1.	Less favourable	53	14.73
2.	Moderately favourable	262	72.77
3.	Favourable	45	12.50

Attitude of farmers towards crop diversification

It is revealed from table 9 that respondent's attitude was favourable to grow different crops for higher yield which ranked 1st with the highest average score 3.72 followed by multiple cropping increase yield and income and diversified cropping system reduces risk ranked 2nd and 3rd with average score 3.70 and 3.62 respectively. It also shows that the practices one type of crop depletes nutrition and adaptation of crop diversification was a big challenge and income ranked 4th and 5th with average score 3.55 and 3.54. Whereas less favourable attitude was shown towards the multiple crops do not assure increase in productivity and income which ranked 6th with lowest average score 3.43.

Table 9: Distribution of respondents according to attitude towards crop diversification of Climate Smart Agriculture Technologies

Sl. No.	Crop diversification	Score	
		Mean	Rank
1.	Multiple cropping increase yield and income	3.7	II
2.	Diversified cropping system reduces risk	3.62	III
3.	Multiple crops do not assure increase the productivity and income	3.43	VI
4.	Grow different crops for higher yield	3.72	I
5.	Adaptation of crop diversification is a big challenge	3.54	V
6.	One type of crop depletes nutrition	3.55	IV

It is clear from the data presented in table 10 that the majority of the (66.94) respondents were found to possess a moderately favorable attitude regarding crop diversification followed by 18.89 per cent of the respondents were having a favorable attitude towards crop diversification. While the remaining 14.17 per cent of respondents showed less favorable attitude towards crop diversification.

The following findings shows that only a limited percentage of respondents had a favourable attitude toward crop diversification and the majority having a moderately favourable attitude. Crop diversity provides a number of advantages, including the ability to overcome water scarcity and act as a mechanism to reduce weather-induced losses and stabilize incomes. As a reason, respondents' attitudes should be favorable. But the reason behind moderately favorable attitude might be their lack of knowledge about crop diversifications and its benefits.

Table 10: Distribution of respondents according to attitude towards crop diversification of Climate Smart Agriculture Technologies

Sl. No.	Category	Frequency	Percentage
1.	Less favourable	51	14.17
2.	Moderately favourable	241	66.94
3.	Favourable	68	18.89

Attitude of farmers towards alternate wetting and drying

Table 11 showed that the respondent's attitude was favorable for the practices efficient water use in paddy is now a priority which ranked 1st with the highest average score 3.77 followed by the statement prefer the technology related to flood and dry the field and alternate wet and drying decrease the cost of irrigation in paddy ranked 2nd and 3rd and the average scores were 3.62 and 3.50 respectively. Whereas, the statement Excess moisture might because of infestation of diseases and pests in paddy crops and Alternate wet and drying may promote weeds ranked 4th and 5th with average mean score 3.32 and 3.22.

Table 11: Distribution of respondents according to attitude alternate wet and drying of Climate Smart Agriculture Technologies

Sl. No.	Alternate wet and drying	Score	
		Mean	Rank
1.	Efficient water use in paddy is now a priority	3.77	I
2.	Prefer the technology related to flood and dry the field	3.62	II
3.	Alternate wet and drying decrease the cost of irrigation in paddy	3.50	III
4.	Yield is important than water use efficiency in paddy field	3.19	VI
5.	Alternate wet and drying may promote weeds	3.22	V
6.	Excess moisture may cause infestation of diseases and pests in paddy crops	3.32	IV

Table 11 also showed that the yield is important than water use efficiency in paddy Field had a less favourable attitude which ranked 6th with the lowest average score of 3.19. Table 12 showed that 68.89 percent of the respondents had moderately favorable attitude regarding alternate wet and drying followed by 18.61 per cent of respondents had favorable attitude and 12.50 per cent of the respondents had less favorable attitude towards alternate wet and drying. It can be concluded from the following findings that only a limited proportion of respondents had a favourable attitude towards alternate wet and dry management practices. This could be due to a lack of detailed knowledge about alternate wet and dry management practices and their benefits, such as saving water and reducing greenhouse gas emissions while maintaining yields.

Table 12: Distribution of respondents according to their overall attitude about alternate wet and drying of Climate Smart Agriculture Technologies

Sl. No.	Category	Frequency	Percentage
1.	Less favourable	45	12.50
2.	Moderately favourable	248	68.89
3.	Favourable	67	18.61

Overall Attitude

The attitude of the respondents according to overall attitude level towards Climate Smart Agriculture Technologies (CSATs) was ascertained and the results obtained are reported in Table 13. The majority of the respondents (52.50%) were found to possess moderately favourable attitude and 30.56 per cent were found favorable attitude towards the Climate Smart Agriculture Technologies (CSATs). While 16.94 per cent of respondents showed less favorable attitude regarding Climate Smart Agriculture Technologies (CSATs). It can be inferred from the findings that a meager percent of respondents had favourable attitude regarding Climate Smart Agriculture Technologies (CSATs).

Table 13: Distribution of respondents according to overall attitude level towards Climate Smart Agriculture Technologies

Sl. No.	Category	Mean	Percentage
1.	Less favourable	61	16.94
2.	Moderately favourable	189	52.50
3.	Favourable	110	30.56

Conclusion

The present study highlights that farmers' attitudes are central to the adoption of Climate Smart Agricultural Technologies (CSATs) in Chhattisgarh. The dominance of a moderately favourable attitude across all CSAT components including land levelling, zero tillage, residue management, precision nutrient

management, crop diversification and alternate wetting and drying indicates that farmers are aware of and receptive to climate-smart practices but have not yet developed strong confidence in their consistent use. This attitudinal pattern reflects partial acceptance rather than resistance, suggesting that farmers are in a transitional phase between awareness and full adoption. The overall attitude results further confirm this trend, with a majority of respondents expressing moderately favourable attitude and a comparatively smaller proportion demonstrating favourable attitude toward CSATs. This indicates that while farmers recognize the relevance of CSATs in addressing climate variability, resource constraints and productivity challenges, their attitude are constrained by limited technical understanding, perceived complexity and uncertainty regarding long-term benefits. The findings underscore that knowledge gaps and limited experiential learning are key factors shaping farmers' moderate attitudes. Conventional extension approaches appear insufficient to build the level of conviction required for widespread adoption. Therefore, improving farmers' attitude requires focused efforts on capacity building, field-level demonstrations and participatory learning approaches that enhance understanding and trust in CSATs.

Acknowledgement

I would like to extend my heartfelt gratitude to my esteemed major advisor, Dr. R.S. Sengar, for his trust, insightful discussions, invaluable advice, and unwavering support throughout the entire study. I am especially grateful for his patience and guidance during the writing process.

Conflict of Interest

The authors of the paper declare no conflict of interest.

References

- Altieri MA, Nicholls CI. The adaptation and mitigation potential of traditional agriculture in a changing climate. *Climatic Change*. 2017;140:33-45.
- Badjeck MC, Allison EH, Halls AS, Dulvy NK. Impacts of climate variability and change on fishery-based livelihoods. *Marine Policy*. 2010;34:375-383.
- Berry HL, Bowen K, Kjellstrom T. Climate change and mental health: A causal pathways framework. *International Journal of Public Health*. 2010;55:123-132.
- Branca G, McCarthy N, Lipper L, Jolejole M. Climate-smart agriculture: A synthesis of empirical evidence of food security and mitigation benefits from improved cropland management. Rome: Food and Agriculture Organization; 2011.
- Dinesh D, Frid-Nielsen S, Norman J, Mutamba M, Loboguerrero Rodriguez AM, Campbell B. Is climate-smart agriculture effective? A review of selected cases. CCAFS Working Paper No. 129. Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security; 2015.
- Food and Agriculture Organization. Livestock and landscapes. Rome: Food and Agriculture Organization; 2013. p. 1-4.
- Fischer G. Transforming the global food system. *Nature*. 2018;562:501-502.
- Kakzan D, Arslan A, Lipper L. Climate-smart agriculture? A review of current practice of agroforestry and conservation agriculture in Malawi and Zambia. ESA Working Paper No. 13-07. Rome: Food and Agriculture Organization; 2013.

9. Kam S, Hwang BJ, Parker ER. The impact of climate change on atopic dermatitis and mental health comorbidities: A review of the literature and examination of intersectionality. *International Journal of Dermatology*. 2023;62:449-458.
10. Kilelu CW, Klerkx L, Leeuwis C. Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme. *Agricultural Systems*. 2013;118:65-77.
11. Kumar P, Joshi PK, BIRTHAL PS. Demand projections for foodgrains in India. *Agricultural Economics Research Review*. 2009;22(2):237-244.
12. Li J, Vatsa P, Ma W. Small acts with big impacts: Does garbage classification improve subjective well-being in rural China? *Applied Research in Quality of Life*. 2023;18:1337-1363.
13. Likert R. A technique for the measurement of attitudes. *Archives of Psychology*. 1932;22(140):1-55.
14. Ma W, Vatsa P, Zheng H. Cooking fuel choices and subjective well-being in rural China: Implications for a complete energy transition. *Energy Policy*. 2022;165:112992.
15. Mittal S. Modern ICT for agricultural development and risk management in smallholder agriculture in India. *Socio-Economic Working Paper No. 3*. Mexico: CIMMYT; 2012.
16. Sahoo D, Mohanty P, Mishra S, Behera MK, Mohapatra S. Does climate-smart agriculture technology improve farmers' subjective well-being? Micro-level evidence from Odisha, India. *Farming Systems*. 2024;3(1):100124.
17. Shaffril HAM, Abu Samah A, D'Silva JL. Climate change: Social adaptation strategies for fishermen. *Marine Policy*. 2017;81:256-261.
18. Shitu GA, Nain MS, Kobba F. Development of a scale for assessing farmers' attitude towards precision conservation agricultural practices. *Indian Journal of Agricultural Sciences*. 2018;88(3):498-503.
19. Thornton PK, Rosenstock T, Förch W, Lamanna C, Bell P, Henderson B, *et al.* A qualitative evaluation of climate-smart agriculture options in mixed crop–livestock systems in developing countries. In: Lipper L, McCarthy N, Zilberman D, Asfaw S, Branca G, editors. *Climate-smart agriculture: Building resilience to climate change*. Cham: Springer; 2018. p. 385-423.
20. Ugochukwu AI, Phillips PWB. Technology adoption by agricultural producers: A review of the literature. In: Kalaitzandonakes N, Carayannis EG, Grigoroudis E, Rozakis S, editors. *From agriscience to agribusiness*. Cham: Springer; 2018. p. 361-377.
21. van Dijk M, Morley T, Rau ML, Saghai Y. Systematic review and meta-analysis of global food security projections to 2050. 2021.
22. Zheng H, Vatsa P, Ma W, Zhou X. Working hours and job satisfaction in China: A threshold analysis. *China Economic Review*. 2023;77:101902.