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Asian farmer's adaption strategies to climate change: A review

Fazale Rehman*, Hassan Akhtar, Muhammed Zaheer, Filza Fatima Razvi, Sajjad Ali, Jawad Ullah, Faridullah Khan

National University of Science and Technology (NUST), Islamabad, Pakistan

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Abstract

Farmer's everyday activities are being impacted by climate change in Asia. The effects of climate change on farming's economy and environment have received a lot of attention. When the major factor determining the dilemma is drought. The social effects of climate change on Asian farmers have not been thoroughly explored. The goal of this paper was to analyse the available research on Asian farmer's adaption strategies to climate change consequences. A systematic examination of the Scopus database revealed 63 linked papers, which were found using the PRISMA Statement (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) review technique. The six key topics that emerged from a further analysis of these articles are social activities, financial management, physical infrastructure management, farm management, irrigation and water management, and crop management. More qualitative research should be conducted, a standard systematic review methodology should be used to guide research synthesis in the context of climate change adaptation, and complementary searching strategies like citation tracking, reference searching, snowballing, and contacting experts should be used.

* **Corresponding Author:** Fazale Rehman ✉ fazalerehman1995@gmail.com

Introduction

The impact of climate change is expected to intensify across Asia. The core of Asia's continent is where the temperature is raising the fastest (Mavhura *et al.*, 2022). The unpredictable temperature variability and faster glacier melting have raised the danger of extinction for different plant and animal kinds, which is evidence that impact of climate change has a great effect on shortage of water resources. While the effects of extreme climate change on the environment are still being documented, the effects of climate change on people are more severe, especially for those who depend on environmental and climatic stability, such as Asian farmers (Teshome *et al.*, 2021). In its 2014 report, the IPCC emphasized the regional variations in Asia's responses to climate change on food production. The community of Asian coastal communities is at danger of flooding due to projected sea level rise. Furthermore, owing to its devastating effects on the environment and natural resources brought on by fast urbanization, industrialization, and economic growth, climate change will obstruct the sustainable development of several Asian nations (Chan *et al.*, 2018).

The world International Union for Conservation of Nature defines adaptation as "the capability to response to problems by learning, limiting risk and impacts, acquiring new information, and devising efficient alternatives" (2010, p. 5). In the context of this paper, the terms "climate change," "variability of climate," "climate and weather," "huge events," and "weather and natural changes" are utilized interchangeably. Weather is defined as condition of the atmosphere at every day and its small change in minutes to weeks, in other hand climate is the average of the weather over a long duration of time, sometimes 30 years. Climate variability is defined as change occur in the average state and other climate statistics on all spatial and temporal scales behind that of weather conditions separately, whereas extreme weather refers to extremely rare occurrences at a specific location and time of year that produce an average or total that is also extremely rare (e.g., drought or flood) (Limantol *et al.*, 2016). The drought causes fininacial losses and it effects various filed of life with great potentially and enough hazardous consequences. It occurs naturally when there is a less precipitation above an area for huge duration of time (months to years), consequently lack of water and soil moisture availability naturally (Vogt and Somma, 2000). Mainly, the drought can be categorized into four types: meteorological, agricultural, hydrological, and socio-economic drought (Mukherjee *et al.*, 2018). Any climate area, whether dry, semi-arid, or humid, is susceptible to drought, although the geographical and temporal aspects differ greatly across places (Wilhite, 2020). The precipitation that frequently fluctuates inter-annually brings higher drought risk in arid region because of high probability of low rainfall.

An inquiry into a clearly defined topic using systematic and explicit methods to search, choose, and critically assess significant observation along with collection and synthesis of data from the studies that are included in the review is known as a systematic review. The findings of the included research may or may not be analyzed and condensed using statistical techniques. The claims of the authors' study's rigor may be supported by a systematic review, allowing for the gap analysis and desired research directions. There are several researches on farmers' adaptation to climate change, but there haven't been any comprehensive reviews of these studies. This article identifies and describes the pattern of change in adaptation of climate among Asian farmers in an effort to close the knowledge gap. This research gives a comprehensive study of adaptation in the area by using adaptation reports from peer-reviewed literature as a proxy for adaptation. The study closes a significant gap in the literature by conducting the most thorough analysis of the

adaptation efforts made by non-agriculture communities (Babatunde *et al.*, 2017).

This research is significant since there haven't been many papers that present a comprehensive guideline on the level of farmers' adaptation to climate change in Asia. The systematic review studies on adaptation experiments of Asian farmers that have been published in the past are weak in that they don't go into great detail about the review procedures that were used (e.g., databases searched, articles except, search terms utilized), which makes it challenging for future researchers to replicate the study, support the interpretation, or assess the thoroughness. This research is important because it will help us understand where the significances is and where attention necessary to be paid since the Asian area is predicted to continue experiencing climate change pressures (droughts, floods, and winds) that demand for urgent adaptation activities to boost resilience.

How Asian farmers adapt to the effects of climate change was the key research issue that served as the foundation for the present article's comprehensive evaluation. The study's primary emphasis was on human adaptation techniques. Asian agriculture received particular attention since this population is more vulnerable to climate change than other groups because they depend more heavily on natural stability for their socioeconomic activities (Shaffril *et al.*, 2017). Fishermen and people engaged in aquaculture operations were excluded from this evaluation even though they are regarded to be part of the agricultural community since their activities are quite different from those of inland farming.

Materials and methods

This section discusses the technique used to find articles about Asian farmer's adaptability to climate change. The reviewers used the PRISMA methodology, which comprises data abstraction and analysis, inclusion and exclusion criteria, phases of the review process (identification, screening, and eligibility), and Scopus resources utilized to conduct the systematic review.

PRISMA

The PRISMA Statement functioned as the review's direction (Preferred Reporting Items for Systematic reviews and Meta-Analyses). In the subject of environmental management, PRISMA is often used. It has three distinct benefits, including the ability to clearly formulate research questions that allow for systematic study, identify inclusion and exclusion criteria, and try to quickly review a huge database of scientific literature (Sierra-Correa and Cantera Kintz, 2016). Future environmental management evaluations may use coded information and a thorough search of phrases relating to Asian farmers reactions to climate change and its effects thanks to the PRISMA Statement. The tool may be used to track how Asian farmers are adjusting to a harsher climate via their farming methods.

Criteria for inclusion and removal

There are a number of prerequisites and restrictions put in place. In selecting literature, only publications from journals with empirical data are considered; this means that book reviews, book series, novels, book chapters, and conference proceedings are ignored. To avoid confusion and translation issues, the searches limited themselves to English-language articles and excluded any non-English media. Third, an 8-year period (from 2016 to 2023) has been selected since it is sufficient for seeing changes in related research and publications. Due to the review's emphasis on adaptation techniques for climate change, papers from the rigorous scientific index (Science Citation Index Expanded) are disqualified. Finally, the publication's concentration on Asian farmers means that it exclusively publishes articles with an Asian slant.

Systematic evaluation procedure

The procedure of conducting the systematic review included four steps. The initial stage was identifying the search terms. Using terms comparable to and connected to climate change, adaptability, and agricultural communities, prior research and thesaurus were employed (Table 1). At this point, two duplicate items were eliminated following meticulous screening. Screening came in at stage two. At this point, a total of 59 papers were eliminated from the 173 articles that were initially eligible for evaluation. The entire articles were accessible at the eligibility stage, which is the third step. After rigorous review, a total of 41 articles were dropped because they didn't address inland agricultural communities, weren't empirical, didn't address adaptation strategies, or didn't address Asian nations and regions. A total of 63 articles were found after the last round of evaluation and utilized in the qualitative analysis (Fig. 1).

Table 1. The search string used for the systematic review process

Database	Keywords used
Scopus	TITLE-ABS-KEY(((Drought* OR "Drought Stres*" OR "Drought* Adaptibilit*") And("Climat* chang*" OR "Climat* risk* OR " climat* AND variabilit*) AND ("Adapt* abilit*" OR "adapt* strateg*" OR "adapt* capacit*" OR "adapt* capabilit*" OR "adapt* strength*" OR "adapt* potential*" OR "adopt* abilit*" OR "adopt* capacity*" OR "adopt* capabilit*" OR "Adopt* potential*" OR adopt* AND strategy*)) AND (farmers*)) AND (LIMIT-TO (OA,"all"))

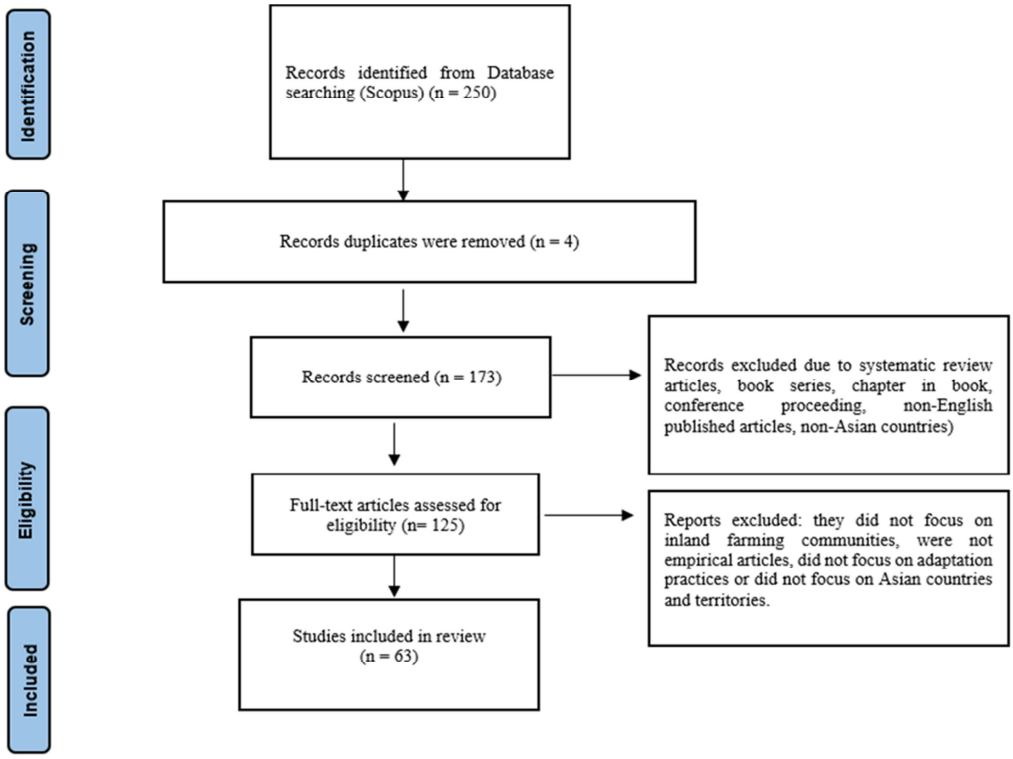

Fig. 1. The flow diagram of the study

Data abstraction and analysis

Assessment and analysis were done on the remaining publications. Focused efforts were made on certain research that provided answers to the posed issues. After carefully reviewing the whole paper and their accompanying abstracts to find pertinent topics and sub-themes, the data were extracted. To find themes relating to Asian farmers' adaptation techniques, qualitative research employing content analysis was conducted. The topics defined by typology were then surrounded by sub-themes by the writers.

Results and discussion

Six primary themes and 35 sub-themes (Fig. 2) of adaptation techniques were generated from the review. Crop management (with five subthemes), irrigation and water management (with six subthemes), farm management (with seven subthemes), revenue management (with six subthemes), physical infrastructure management (with four subthemes), and social activities (with six primary themes) are the six subthemes (seven sub-themes) (Fig. 2). The findings provide a thorough examination of the existing adaption techniques used by Asian agricultural groups.

Authors/countries	Study Design	Crop Management						Irrigation manag					Farm Management								Financial Managen				Physical Infr			Social Activties				
		RP	CL	FZ	IV	RC	OT	IS	EX	WP	CW	OT	TP	AF	HG	I	IF	SC	LL	NF	LN	SY	LV	HE	OT	UT	UG	BL	OT	RA	IS	CE	TR	TK	WG	BT
(Shar et al., 2023)	QN	•	•				•			•					•			•				•		•		•		•			•			•		•
(Habib et al., 2022)	QN			•				•																												
(Mavhura et al., 2022)	MM	•									•					•				•							•		•		•	•	•		
(Kogo et al., 2022)	QN		•			•		•		•				•					•		•	•			•	•			•			•		•	
(Zakari et al., 2022)	MM	•			•				•		•		•		•		•					•		•						•			•		•
(Saddique et al., 2022)	QN					•				•		•				•		•		•							•		•			•			
(Shrestha et al., 2022)	QN	•		•				•					•					•	•	•					•	•					•		•	•	
(Kom et al., 2022)	QN	•					•		•	•			•					•				•					•		•					•	
(Tofu et al., 2022)	QN		•		•					•		•			•				•	•		•			•			•		•		•			
(Arifah et al., 2022)	QN			•		•		•					•				•																		
(Čejka et al., 2022)	QL	•	•			•	•		•				•	•		•												•							•
(Arifah et al., 2022)	MM				•						•			•						•					•				•		•				
(Kom et al., 2022)	QN	•					•	•		•			•				•	•		•								•		•	•		•	•	
(Fayera, 2022)	QN		•	•			•		•		•	•				•		•	•	•		•		•							•				
(Landaverde et al., 2022)	QL	•					•		•	•				•					•	•								•		•						•
(Habte et al., 2021)	QL	•		•	•				•							•						•		•			•	•		•				•		
(Atube et al., 2021)	QL	•				•							•		•			•	•			•				•						•		•		
(Hilemelekot et al., 2021)	QN				•	•		•			•								•	•			•					•	•		•					
(Asfaw et al., 2021)	QN		•			•		•	•			•	•	•		•	•				•	•		•				•		•	•	•				
(Dharmasiri, 2021)	QN	•	•						•		•							•	•											•						•
(Mushore et al., 2021)	QN	•					•						•	•	•					•							•				•			•		
(Diarra et al., 2021)	MM			•	•	•		•				•	•				•			•		•						•								
(Adaawen, 2021)	MM	•							•				•		•		•							•			•		•			•				
(Menghistu et al., 2021)	QN		•			•	•		•			•			•					•		•						•		•				•	•
(Teshome et al., 2021)	QN	•				•		•		•	•		•	•			•			•																
(Abubakar et al., 2021)	QN															•						•			•			•		•			•			
(Singh, 2021)	QN			•				•				•				•		•		•									•					•	•	
(Vilakazi et al., 2019)	QN					•									•						•		•			•		•			•					
(Bekele et al., 2019)	MM	•		•				•					•		•	•			•	•		•					•		•			•		•		
(Agesa et al., 2019)	MM		•		•		•			•		•				•		•						•				•		•		•		•		
(Bagagnan et al., 2019)	QN			•		•					•		•							•		•				•		•							•	
(Zin et al., 2019)	MM	•						•			•	•			•				•	•					•		•	•			•					
(Gezie, 2019)	QN		•	•			•				•					•					•		•					•		•						
(Amare & Simane, 2018)	QN			•		•			•				•	•		•		•			•			•		•								•		•
(Phuong et al., 2018)	QN	•						•					•		•		•	•		•	•			•	•		•									
(Bezner Kerr et al., 2018)	QL		•				•	•														•								•						•
(Ayanlade et al., 2018)	QN				•			•							•				•			•				•					•	•				
(Mubiru et al., 2018)	QL	•		•			•			•	•		•				•					•		•	•			•	•						•	•
(Gori Maia et al., 2018)	QN		•		•	•						•		•		•		•		•					•		•									
(Ouedraogo et al., 2018)	QN		•	•									•		•						•		•									•				
(Yoshimura, 2018)	AI	•			•				•		•		•		•						•									•			•	•	
(Chan et al., 2018)	MM					•				•		•				•	•	•	•			•					•		•		•					
(Phuong et al., 2018)	QN	•		•				•					•				•	•	•	•	•		•	•			•		•					•		
(Gori Maia et al., 2018)	QN	•					•		•	•			•				•	•	•			•		•							•			•		•
(Quandt et al., 2017)	QN		•		•				•		•					•		•	•		•		•					•		•					•	
(Guodaar et al., 2017)	QN			•		•		•					•				•	•		•		•				•			•		•		•			
(Nyikahadzoi et al., 2017)	QN		•		•	•		•					•	•		•					•		•		•			•					•		•	
(Jiri et al., 2017a)	MM				•						•			•			•	•	•		•						•		•		•					
(Mupakati, 2017)	MM	•					•	•		•			•				•	•	•	•	•						•	•		•		•				•
(Kabir et al., 2017)	QN		•	•			•			•	•					•							•				•							•	•
(Mthembu, 2017)	MM	•					•	•		•				•						•		•				•					•					
(Shaffril et al., 2017)	QN			•	•				•											•	•		•	•				•	•							
(Church et al., 2017)	QN	•				•							•		•		•	•		•		•	•				•				•			•		
(Jiri et al., 2017b)	QN				•	•		•			•										•	•						•	•				•	•	•	
(Rodriguez et al., 2017)	QL		•		•		•	•				•	•			•	•	•		•						•		•			•				•	•
(Babatunde et al., 2017)	QN		•					•		•		•								•		•		•				•				•				
(Guodaar et al., 2017)	QL	•					•						•	•	•					•		•			•	•	•		•		•					
(Church et al., 2017)	QN			•	•	•		•				•	•									•		•				•				•	•	•		•
(Limantol et al., 2016)	QN	•								•			•			•				•						•	•	•								
(Sierra-Correa, 2016)	AI		•		•						•			•			•			•		•	•			•	•			•				•	
(Sutcliffe et al., 2016)	MM		•	•		•				•	•					•		•	•												•					
(Kolawole et al., 2016)	QN	•						•				•								•		•	•	•			•									•
(Dhanya 2016)	QN			•	•		•			•			•									•				•			•	•		•	•		

RP = Rescheduling Planting	EX = extending, maintaining or reserving water supplies
CL = Changing farming location/relocate their accommodation	SC = Soil conservation
RC =Diversify/Mixed/Change/Intercropping/Rotating/multiple crops	I = Insurance
FZ = Using organic fertilizer/fertilizer/bio-fertilizer/insecticides/pesticides	HG = Homestead Gardening
IS = Irrigation system	AF = Argo-Forestry/Organic Farming
WP = water pumps/pipes	TP = Tree planting
CW = Conserving water resources	IF = Indoor Farming
RW = Reduce water consumption	LL = Levelling land/reducing farmland
RT = Rainwater harvesting technique	IV = Improved crops/seeds (including short duration crops, seeds)

Fig. 2. Processing and finding

Asian farmers coping mechanisms for climate change

Irrigation and water management, Crop management, financial management, farm management, physical infrastructure management, and social activities are some of the primary adaptation strategies discussed in this section, which focuses on farmers belongs to Asian nations.

Crop Management: Several studies of crop management, according to research studies, revealed that crops mostly affect climate change. Diversifying crops is the most common crops management that has been found in 23 studies, while the farmers depend on improved varieties has discussed in 18 studies that make sure the effect of climate change. The rescheduling of planting calendars has proposed in 16 studies while fertilizer or insecticides/pesticides has used as a strategy in 8 studies. Kogo *et al.*, 2022 suggested that the location of farming has been changed by farmers to mitigate the effect of climate change.

In India the climate change is greatly affect the crops such as sugarcane due to variation of speed of wind from one region to other region, therefore the farmers have decided to change the sugarcane crop to peppermint crop, that get more profit (Singh *et al.*, 2020). In Bangladesh farmers have started to crop rice called Swarma, which is more drought and pest tolerant. To minimize the risk of crops damaged due to certain factors such as climate change, a rescheduling method is proposed. The most farmers in Bangladesh take the advantages from the rainfall during wet-season and do the crop growing during the season having less stress such as no drought or storm (Kabir *et al.*, 2017).

Irrigation and water management: Studies have documented that farmers utilize irrigation and water management as strategies to mitigate the impacts of climate change. Key areas under this topic include micro and supplementary irrigation, water conservation, the use of natural resources for irrigation, and overall water management. Fourteen articles revealed that most Asian farmers rely on natural resources for irrigation, while seven studies highlighted the practice of storing water as a resource during drought periods. In Nepal, methods such as underground storage, water tanks, ponds, and wells are commonly employed for water storage (Mushore *et al.*, 2021). Similarly, Malaysian farmers strategically cultivate crops near water storage facilities to reduce costs and promote faster crop growth (Abubakar *et al.*, 2021).

Farm management: Farm management practices adopted by Asian farmers have been extensively studied, with 42 studies highlighting various strategies. Key areas under this theme include soil conservation, tree planting, insurance schemes, in-house farming, and organic farming. Nine studies focused on tree planting, while eight discussed organic farming. Shaffril *et al.* (2017) presented the mulching technique used by farmers in Bangladesh and Nepal. This technique enhances soil quality by reducing erosion and nutrient leaching, increasing soil moisture and fertility, and protecting the soil from high temperatures during summer. In western Bangladesh, farmers use jute biomass to improve soil fertility for the next harvest season (Kabir *et al.*, 2017). Additionally, in countries like Bangladesh, farmers utilize remaining land for tree planting, which provides extra income and essential nutrients.

Financial management: Some of studies concluded that the financial perspective of Asian farmers relies on climate change. Fish rearing, non-farmers activities, making loans, and minimizing the expenditure of house holding are the emerging elements of financial management. The driving license plays an important role in agriculture fields therefore its essential for every employer. Fish rearing is one the source of

income for the farmers to increase its income by decreasing the associated risk with productivity due to climate variation impact (Bagagnan *et al.*, 2019). In Bangladesh, the farmers' income also depends on buying and sailing of goat and cattle. They buy the goat at lower price and then sale it at high price during peak time (Kabir *et al.*, 2017). Most farmers of Asia take loan from various sources such as bank. The western Bangladesh farmer's taken loan from relatives and other agencies such as NGOs (Malek *et al.*, 2020). The farmer's takes loan from different bank in In Vietnam. Most farmers also save their income for live off.

Physical infrastructure management: Physical infrastructure management in farming encompasses key areas such as technology related to farming, upgrading farm infrastructure, and building structures. In Bangladesh, a type of roof called Golpata is commonly used by farmers for its durability, while house walls are typically constructed using wood and bamboo instead of mud. These materials not only enhance the structural strength of houses but also minimize risks during severe weather conditions (Malek *et al.*, 2020).

Social activities: The Asian farmers' relation with each other depends on social activities such as traditional/local knowledge, migration, community, and motivational events. Sharing of information is popular in its tradition. Migration is the common social activity due to climate change. Migration is done due lack of facilities and having no land, this mostly happens in Bangladesh. The most common cause of migration is loss in crops and buys land in city to migrate (Habib-ur-Rahman *et al.*, 2022). In paper (Nyikahadzoi *et al.*, 2017) explains the different methods for awareness of climate change in people. The various functional activities play vital role for awareness in farmers to share information with each other to make its strength against climate change.

Results show that Asian farmers have used a wide range of methods. Six main themes and thirty-five secondary themes emerged from the data used in this analysis. The A farmers principal adaptation tactics were irrigation and water management, crop management, financial management, farm management, and in addition to infrastructure management (physical) and social activities.

Crop diversification has one of the many ways in which Asian farmers adapt to changing conditions. Rainfall patterns and flood have delayed the planting of many crops and may damage the sorts of crops that can be grown, throughout the Asian continent, producing a ripple effect on the price of food and harming the populations. In the future, scientists predict, these storms and floods will become more often. Asian farmers adopted the technique of intercropping and mixed cropping with high-tech varieties of crops in response to these unusually severe weather patterns and occurrences. This method not only helped them generate additional money but also mitigated the danger of financial ruin due to the failure of a single crop.

Even if many farmers of Asia are now residing in the contemporary world, this does not imply that they have abandoned their traditional and local wisdom. Researchers are currently looking at issues including monitoring climate change's effects, carbon abatement activities, and the creation of locally tailored adaptation plans to see how they might be improved by using local and traditional environmental knowledge. Improved physical infrastructure is another adaptation measure taken by Asian farmers as rising temperatures, sea level and precipitation, reduce the quality service. Farmers understanding climate change and how these beliefs may influence future decisions regarding local adaptation to climate change are mediated in large part by local and traditional knowledge. Some of the adaptation measures they are taking

include enhancing their transportation and communication networks and constructing new or enhancing existing infrastructure. This plan shields farmers from climate change's deadly impacts and lessens the likelihood of physical harm or even death. The speed with which help may be sought or supplied can be increased by a well-developed transportation and communications infrastructure, which in turn strengthens the adaptation strategy.

Asia's farmers require community backing to adopt the various adaptation strategies. As this analysis demonstrates, many people and organizations have assisted farmers to be prepared for impacts of extreme climate. Having people that live with them and who care about them may help individuals be ready for climate-related disasters, speed up recovery, and adapt more effectively over time.

Conclusion

This review has shown how critical it is for Asian farmers to develop strategies to deal with climate change. Extreme occurrences, such as frequent flood and drought, are becoming more common in the Asian environment, and these changes disrupt the water supply, soil, and have a negative impact on farmer's production of both quality and quantity. Farmers have used a variety of adaptation measures in response to this. Crop management, farm management, irrigation and water management, financial management, social activities and physical infrastructure management are the adaptation patterns identified by the authors based on the systematic reviews conducted. The scope of these alterations was widened to include thirty-five more topics.

Recommendation(s)

Several suggestions for further research are offered by the review. To begin, there should be a greater emphasis on qualitative research because of the wealth of information it provides on farmers adaptation strategies, as well as farmers viewpoints and decision-making processes around adaptation techniques. The second is to use supplementary search strategies including snowballing, reference searching, citation tracking, and contacting experts, and the third is to use a specialized and systematic standardized review process to guide the research synthesis to climate change in the context of adaptation.

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