

A LITERATURE REVIEW ON EXAMINING INDIVIDUAL COMMITMENT OF FARMERS TOWARD ENVIRONMENTALLY CONSERVATIVE AND RESILIENT FARMING: ADOPTION AND DETERMINANTS OF RESILIENT AGRICULTURAL PRACTICE IN THE FACE OF CLIMATE CHANGE

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INTRODUCTION

Although climate change is a gradual process that results in gradual changes in Precipitation and rainfall over a long period causes significant effects on the various properties of soil, especially the fertility of the soil. Changes in the moisture content of soil and increase in the soil temperature and levels of CO₂ mainly cause these effects (NSW, 2023).

Following are the various ways in which climate change can affect soil formation:

- **Erosion and loss of topsoil:**

Increased precipitation and extreme weather events such as heavy rainfall and storms can lead to soil erosion. Intense precipitation can wash away topsoil, which contains important organic matter and nutrients necessary for plant growth. This erosion depletes the fertility of the soil and impacts the productivity of agriculture.

- **Desertification and Aridification:**

Climate change contributes to the expansion of arid and semi-arid areas, causing desertification. Rising temperatures, changing rainfall patterns, and increased evaporation rates can reduce the levels of soil moisture, leading to soil dryness and increased vulnerability to soil erosion. These changes can degrade soil quality, decrease vegetation cover and reduce soil fertility.

- **Alteration of soil micro-organisms:**

Changes in temperature and moisture conditions can affect soil micro-organisms' activity and composition. Microorganisms are vital in nutrient cycling, decomposing organic matter, and maintaining soil structure. Heat stress and moisture fluctuations can impact microbial communities, potentially altering nutrient availability and nutrient cycling processes

- **Changes in nutrient availability:**

Climate change can influence the mobility and availability of nutrients within the soil. Increased rainfall results in leaching, where nutrients are washed out of the root zone and become less accessible to plants. Similarly, in regions that are dry reduced precipitation can limit the breakdown and release of nutrients from organic matter, leading to nutrient deficiencies.

• **Soil Acidification:**

Changes in temperature and rainfall patterns can influence soil pH levels. Rising temperature and increased carbon dioxide concentrations can accelerate Organic matter decomposition, which can release acidic compounds into the soil, causing soil acidification.

• **Permafrost thawing:**

In cold regions, climate change can lead to the thawing of permafrost, which is permanently frozen soil. Permafrost thawing can disrupt soil structure and stability, causing subsidence, sinkholes, and changes in hydrology. It can also release trapped organic matter, potentially leading to increased greenhouse gas emissions, particularly carbon dioxide, and methane.

• **Salinization and Soil Degradation:**

Rising temperatures and changing precipitation patterns can alter water availability and evaporation rates, contributing to soil salinization. Increased evaporation can result in concentrated salt levels in the soil, inhibiting plant growth and degrading soil quality. Additionally, saltwater intrusion from rising levels can affect coastal soils, making them less suitable for agriculture. Although, these are the various impacts of climate change on soil formation, there may be variations in these impacts depending on local conditions and geographical regions.

IMPACT OF CLIMATE CHANGE ON LIVESTOCK (FEEDIPEDIA, 2016)

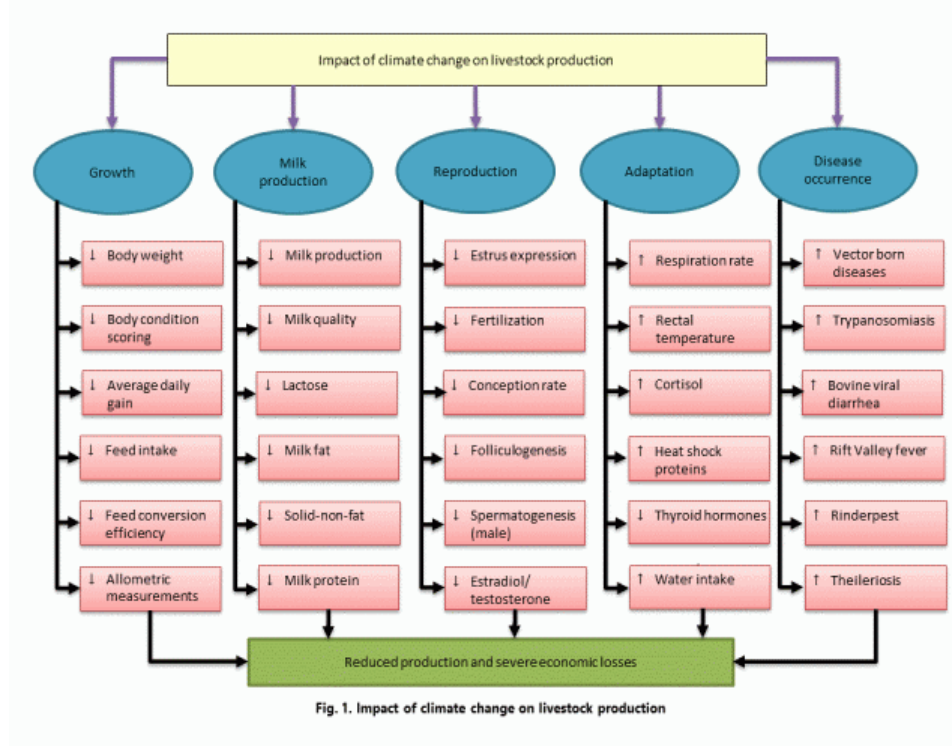


Figure 1 shows the Impact of Climate Change on livestock production

IMPACT OF CLIMATE CHANGE ON FOOD SECURITY:

According to a report by the Agriculture and Food Security Organization of the United Nations in 2015, climate change is found to play a major role in limiting the efforts of the nation against hunger and malnutrition. A report by the Intergovernmental Panel on Climate Change has stressed that climate change can contribute to an increase in cases of hunger and malnutrition in the most vulnerable countries and populations. IPCC AR 5 identified four out of eight important risks caused by climate change which can have direct consequences on food security, namely,

- Loss of rural livelihoods and income
- Loss of marine and coastal ecosystems and livelihoods
- Loss of terrestrial and inland water ecosystems and livelihoods
- Food insecurity and breakdown of food systems

The report has mentioned that the earliest and most affected by climate change are the most vulnerable countries and populations. In addition, to the above-mentioned impacts climate change can also affect the trade flows, and food markets, lead to instability in prices, and cause new risks to human health. The report concluded that earlier interventions are necessary in mitigating climate change.

IMPACT OF CLIMATE CHANGE ON WATER SCARCITY FOR AGRICULTURE:

Following are the various ways in which climate change can contribute to water scarcity for agriculture:

▪ CHANGES IN PRECIPITATION PATTERNS:

Climate change alters precipitation patterns, leading to changes in the timing, intensity, and distribution of rainfall. Some regions may experience more frequent and intense rainfall events, resulting in increased runoff and soil erosion. Simultaneously other areas may face reduced rainfall and prolonged droughts.

Both scenarios can disrupt water availability for agriculture, making it challenging to meet crop water requirements.

▪ INCREASED EVAPORATION AND TRANSPIRATION:

Rising temperatures associated with climate change can enhance evaporation rates and plant transpiration, increasing the water demand. This leads to faster drying of soils and increased water requirements for crops, potentially leading to water stress and inadequate irrigation capacity.

▪ MELTING GLACIERS AND SNOWPACK REDUCTION:

In regions dependent on meltwater from glaciers and snowpack for irrigation and water supply, climate change-induced melting can impact water availability during critical growing seasons, affecting crop productivity and water security.

▪ CHANGE IN RUNOFF AND WATERSHED DYNAMICS:

Climate change can alter the timing and amount of surface water runoff, affecting water availability and downstream irrigation. Changes in precipitation patterns, such as intense rainfall

events can result in increased runoff, leading to flash floods and reduced infiltration into the soil. This can limit the recharge of groundwater aquifers that are vital sources of irrigation water.

▪ **SALTWATER INTRUSION AND SEA LEVEL RISE:**

Climate change-induced sea level rise can increase the risk of saltwater intrusion into coastal areas. Saltwater can contaminate freshwater sources, including groundwater, making them unsuitable for irrigation and leading to soil salinization. This reduces available water supplies for agriculture and decreases the productivity of affected coastal regions.

• **INCREASED WATER DEMAND AND COMPETITION:**

Climate change impacts, such as changing rainfall patterns, droughts, and temperature fluctuations can lead to increased demand for water resources across different sectors. This heightened competition for water resources which can strain agricultural water supplies as other sectors, such as households, industry, and ecosystems, also require access to limited water resources.

RESILIENT FARMING:

Resilient agricultural practice is an important practice that ensures food security and sustainable food system in developing countries. The practice regulates the balance between producing food, managing natural resources, dealing with uncertainty, and providing a livelihood base for the rural population. The term specifies the role of public, private, and civic entities in combating climate change (Barbara, 2019)

NEED FOR THE STUDY:

The present paper is a literature review that is conducted to analyze two different concepts- the impact of climate change on agriculture and the individual commitment of farmers to mitigate climate change. Examining the impact of climate change on agriculture may involve understanding how farmers respond psychologically to environmental changes. The understanding of psychological factors enables the researchers to identify effective strategies, barriers, and facilitators of behavior change in the agricultural sector, contributing to the development of evidence-based policies and interventions. The study also highlights the need for resilient farming practices to fight climate change.

2. RESEARCH METHODOLOGY

2.1. AIM OF THE STUDY:

The study was conducted for the following two purposes-

1. To study the impact of climate change on agriculture and
2. To study the individual commitment of farmers in adopting resilient farming practices to fight climate change.

2.2. TOOLS USED FOR THE STUDY:

The study analyzed various literatures related to the above topic.

2.3. RESULTS:

This section analyses the tables and figures of a review on individual commitment of farmers in adopting climate-resilient farming practices.

Table 2.1 shows the adoption of climate-resilient crops as part of broader climate-resilient strategies:

Types of responses to papers related to Climate Change	Percentage list of the responses	Examples of specific activities associated with each response to climate change
New Variety Planted	24%	Introduction of a new variety of an existing crop to the farmer
Modified Planting Activities	32%	Change in planting date, plant diversification, crop rotation, and intercropping
Irrigation Water Management	32%	Water conservation strategies, Irrigation, micro-irrigation, water harvesting, and improving drainage
Seeking of Farm Work and Migration	5%	Outmigration, seeking of employment and diversification beyond the farm
Storage and Infrastructure Development	5%	Crop storage and development, community sharing, and road building
Use of fertilizers and pesticides	16%	Use of fertilizers, including manure and pesticides, change of use in fertilizers, compost manure, and green manure.
Planting trees	12%	Planting Forest trees and agroforestry

From the above table, it can be inferred that a percentage of 24% of the papers listed the introduction of a new variety of plants to the farmer as an example of the specific activities associated with the type of response titled “new varieties planted”. About 32% of papers mentioned changes in planting date, plant diversification, crop rotation, and Intercropping is an example of the specific activities associated with the type of response titled “Modified Planting Activities”. 32% of papers mentioned Water conservation strategies, Irrigation, micro-irrigation, water harvesting, and improving drainage as examples of the specific activities associated with the type of response titled “Irrigation and water management. About 5% of papers mentioned out-migration, seeking off-farm employment, and diversification of activities beyond the farm as examples of specific activities associated with the type of response titled “seeking off-farm work or migration”. 5% of papers mentioned crop storage development and improvement, community sharing and road building as examples of specific activities associated with the type of response titled “Storage and Infrastructure Development”. 16% of papers mentioned the Use of fertilizers, including manure and pesticides, and change in the use of fertilizers, compost nature, and green manure as examples of specific activities associated with the type of response titled “Use of fertilizers and pesticides”. 12% of papers mentioned

Planting Forest trees and agroforestry as examples of specific activities associated with the type of response titled “Planting trees”.

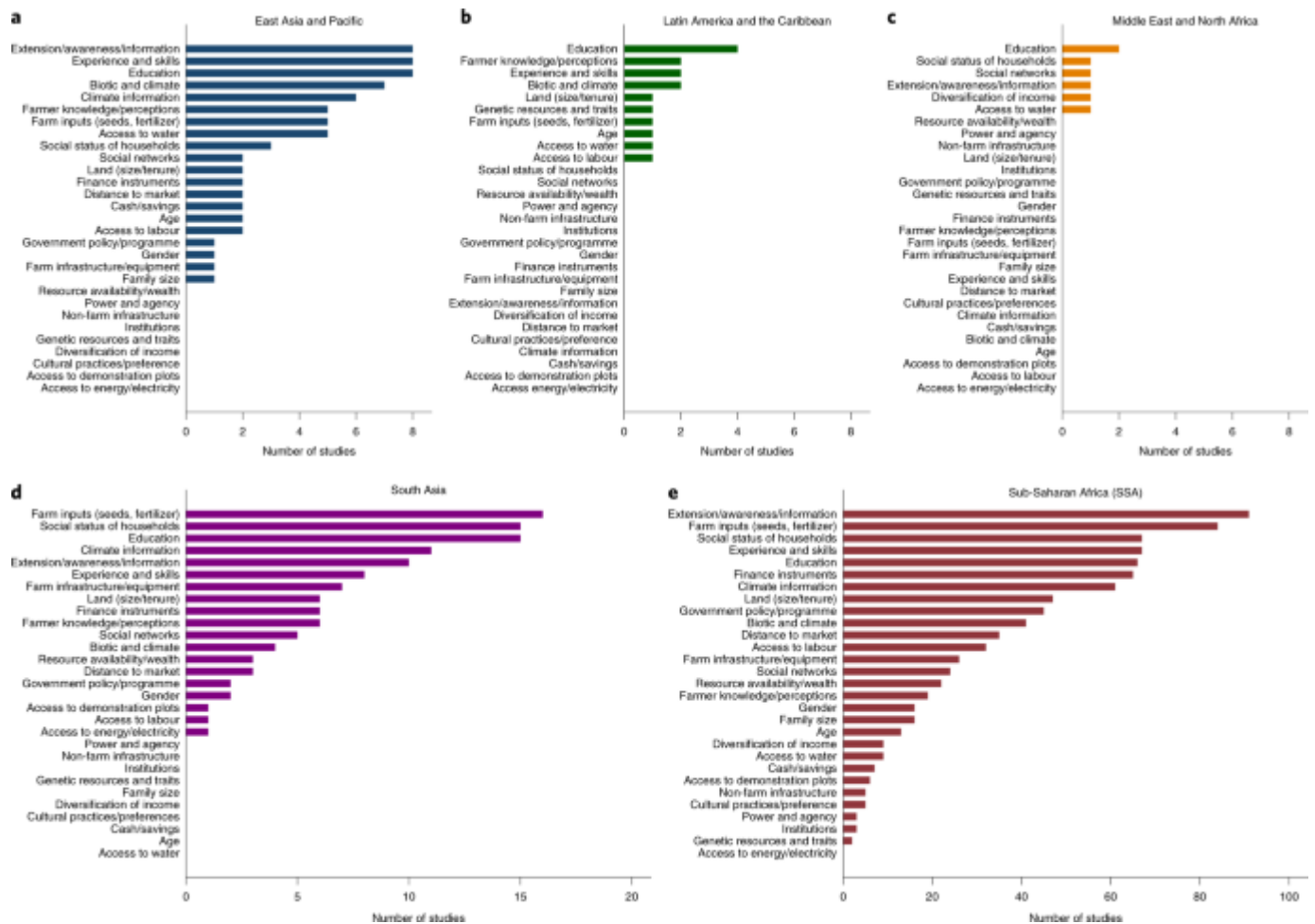


Fig. 2.1: Relevance of social, environmental, and economic determinants of adoption of climate-resilient crops by region.

Table 2.2 shows the seed factors associated with climate-resilient crops and crop varieties

Emergent themes about seed	Summary of the Findings
Access	Access to seed or the ability to afford seed was a principal for small-scale farmers adoption of climate-resilient varieties. Several papers mentioned that cost was even more challenging for women and farmers with fewer assets, smaller parcels of land, or lower economic status. At least four papers suggested seed subsidies as a strategy to improve access to seeds.
Availability	Availability, or the ability to acquire the seed on time, in the quantity needed, and within reasonable proximity was a determination of adoption related to seed. Community seed banks also enhance the availability of seeds.
Social Networks	Participation in social networks that enable the exchange of seeds was a climate-resilient strategy for the farmers. Participation in social networks, which included community seed banks, seed organizations, farmer

	<p>groups, and intra-village or neighbour networks increased the adoption of seed, and these social networks also increased the spread of seed that was distributed as a part of development projects. Conversely, one paper reported that seed did not spread beyond the immediate beneficiaries of the project. Another report stressed the importance of reciprocity within strong social networks as important for maintaining access to seed, and several others recommend supporting social networks to strengthen seed systems. According to three papers, community seed banks strengthened social networks for the exchange provided landraces for participatory crop improvement, and increased availability of seed. Integration of informal and formal seed system elements is important because most of the seeds planted by small farmers are uncertified and sourced through informal seed system channels or social networks. Social networks also have an important role in enhancing farmers' access to information.</p>
Information	<p>Farmers lacked information about varieties, adaptation, and attributes, or did not know where to acquire seed. Extension services, seed companies, seed suppliers, and seed traders were a source of information about seeds and, in some cases, increased the use of seed and other management practices. In a few cases, there was evidence that access to extension services positively influenced the use of certified seed, and in another, the authors suggested that extension services positively influenced the use of certified seed, and in another, the authors suggested that extension services could help farmers become aware of different adaptive strategies and help in the distribution of seeds of improved varieties.</p>
Gender	<p>A Few papers explicitly linked gender and seed. Improved seed was more difficult to acquire for female-headed households and women were less likely to use improved seeds or have access to extension services; small, affordable seed packs were suggested as a potential solution.</p>
Strategy	<p>Improved or hybrid seed and exchanging seed with other villages were considered to be climate-resilient strategies for farmers.</p>
Policy	<p>A few papers discussed agricultural policies related to seeds, arguing that policies should enable the seed sector to provide suitable varieties and aim to increase the availability of funds for seed distribution research and access to improved seed, and one paper indicated that government policies restrict farmers' options for obtaining their preferred seed.</p>

Experience	One paper indicated that farmers’ experience had a positive effect on the adoption of new seeds, whereas another indicated the opposite.
Seed or Variety Attributes	Four papers reported on concerns related to the attributes of hybrid seed varieties and their adaptation to the environment, suitability for storage, flour-to-grain ratio, and other processing issues. One study found that farmers favour composite varieties and local landraces under conditions of abiotic stress.
Seed Sovereignty	One paper discussed issues related to seed sovereignty, reporting that farmers wanted a say in where seeds came from and were resistant to the use of transgenic crops. They expressed a belief that seed industries are appropriating a resource that belongs to humanity. Autonomy is highly valued by these communities, and local varieties are valued in part for their contribution to maintaining independence from commercial hybrid sources.

From the above table, it can be inferred that, on the emergent theme of access, the summary of evidence states, Access to seed or the ability to afford seed was a principal barrier for small-scale farmers' adoption of climate-resilient varieties. Several papers mentioned that cost was even more challenging for women and farmers with fewer assets, smaller parcels of land, or lower economic status. At least four papers suggested seed subsidies as a strategy to improve access to seed. On the emergent theme of availability, the summary of evidence mentions that availability, or the ability to acquire seed on time, in the quantity needed, and within reasonable proximity, was a determination of adoption related to seed. Community seed banks also enhanced the availability of seeds. On the emergent theme of social networks, the summary of the evidence mentions that Participation in social networks that enable the exchange of seeds was a climate-resilient strategy for farmers. Participation in social networks, which included community seed banks, seed organizations, farmer groups, and intra-village or neighbor networks improved the adoption of seed, and these social networks also increased the spread of seed that was distributed as a part of development projects. Conversely, one paper reported that seed did not spread beyond the immediate beneficiaries of the project. Another report stressed the importance of reciprocity within strong social networks as important for maintaining access to seed and several others recommend supporting social networks to strengthen seed systems. According to three papers, community seed banks strengthened social networks for the exchange provided landraces for participatory crop improvement, and increased availability of seed. Integration of informal and formal seed system elements is important because most of the seeds planted by small farmers are uncertified and sourced through informal seed system channels or social networks. Social networks also have an important role in enhancing farmers’ access to information. On the emergent theme of Information, Farmers lacked information about varieties, adaptation, and attributes, or did not know where to acquire seed. Extension services, seed companies, seed suppliers, and seed traders were a source of information about seeds, and in some cases increased the use of seed and other management practices. In a few cases, there was evidence that access to extension services positively influenced the use of certified seed, and in another, the authors suggested that extension services positively influenced the use of certified seed, and in another, the authors suggested that extension services could help farmers become aware of different adaptive strategies and help in the distribution of seed of improved varieties. On the emergent theme of gender, Few papers explicitly linked gender and seed. The improved seed was more difficult to acquire for female-headed households and women were less likely to use improved seeds or have

access to extension services; small, affordable seed packs were suggested as a potential solution. On the emergent theme of strategy, the summary of evidence mentions that Improved or hybrid seed and exchanging seed with other villages were considered to be climate-resilience strategies for farmers. On the emergent theme of policy, the summary of evidence mentions that a few papers discussed agricultural policies related to seeds, arguing that policies should enable the seed sector to provide suitable varieties and aim to increase the availability of funds for seed distribution research and access to improved seed, and one paper indicated that government policies restrict farmers' options for obtaining their preferred seed. On the emergent theme of experience, according to the summary of evidence, one paper indicated that farmers' experience had a positive effect on the adoption of new seeds, whereas another indicated the opposite. On the emergent theme of seed or variety attributes, according to the summary of the evidence, four papers reported on concerns related to the attributes of hybrid seed varieties and their adaptation to the environment, suitability for storage, flour-to-grain ratio, and other processing issues. One study found that farmers favour composite varieties and local landraces under conditions of abiotic stress. On the emergent theme of seed sovereignty, according to the summary of evidence, One paper discussed issues related to seed sovereignty, reporting that farmers wanted a say in where seeds came from and were resistant to the use of transgenic crops. They expressed a belief that seed industries are appropriating a resource that belongs to humanity. Autonomy is highly valued by these communities and local varieties are valued in part for their contribution to maintaining independence from commercial hybrid sources.



Figure 2.2. Summary of determinants of adoption of climate-resilient crops and crop varieties by farmers. The inner ring outlines the five broad categories to which the 29 social and economic factors are mapped. The outer ring shows the factors within each broad category that were most frequently mentioned across the included studies. The relative area occupied by categories indicates their relevance.

3. SUMMARY AND CONCLUSION

3.1. SUMMARY:

The present study was conducted to study the impact of climate change on agriculture and the impact of individual commitment of farmers in adopting resilient farming practices to fight climate change. The first chapter of the paper briefly presents a definition of climate change and agriculture. The various impacts of climate change on agriculture are briefly outlined. This Chapter also gives a short description of resilient farming. In the second chapter, the researcher analyses reviews related to the impacts of climate change on agriculture concerning three domains, namely, soil erosion, food security, and water scarcity, and a review related to resilient farming. The Third Chapter of the paper analyses the aim of the study, the tools used for the study, and the results of the review on resilient farming practices mentioned in Chapter 2 of the paper.

3.2. CONCLUSIONS:

From the analysis of the literature in Chapter 2, it can be concluded that climate change has profound impacts on aspects of agriculture such as soil erosion, water scarcity, and food scarcity. The fertility of the soil is determined by its moisture. Changes in climatic conditions make it difficult to cultivate various seasonal crops for the farmers. Apart from the above-mentioned impact, climate change also influences the scarcity of food in many countries serving as a major driver of hunger and starvation, especially, in developing countries like India. Also, irregular patterns of rainfall contribute to the scarcity of water for cultivation. The study concludes by discussing the results of a review on climate- resilient practice.

3.3. LIMITATIONS:

A major limitation of the study is it is not based on empirical data. The researcher concluded the study by analyzing existing sources of literature. Hence, the findings of the study cannot be generalized.

3.4. SCOPE FOR FURTHER RESEARCH:

An extension of the study can be carried out in the future by collecting data concerning various demographic factors such as region of residence (Urban/ Rural), age of farmers, educational background and socio-economic status.

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