



## REVIEW ARTICLE

## DECISION-MAKING PERSPECTIVE ON DIVERSIFYING FARM SYSTEMS FOR CLIMATE CHANGE ADAPTATION AND PROMOTING ORGANIC AGRICULTURE

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## ABSTRACT

Climate change adaptation refers to natural or human systems changes in response to current or predicted climatic stressors or their consequences. For example, farmers may adapt to unexpected floods, irregular rainfall, or temperature changes. Effective adaptation planning requires data on the effects of real farmer adaptation on agriculture yields. However, analyzing the consequences and outcomes of adaptation and providing practice recommendations can be challenging. The effectiveness of facilitating learning among participants about adaptation practice and planning can be assessed using a social learning-based evaluation methodology. Climate-smart agriculture, which involves adapting to and anticipating shifting weather patterns, can increase agricultural production. A mixed, diverse or diversified system can better withstand the effects of climate change. Successful adoption of technology and environmental and social concerns has been demonstrated in decent agriculture practices in every agro-ecological zone.

## KEYWORDS

Organic Agriculture; Climate Change; Decision; Production

## 1. INTRODUCTION

Despite increased productivity in agriculture over the past few decades, approximately 800 million people are still experiencing food insecurity worldwide. This is especially prevalent in regions such as South and Southeast Asia, the Caribbean, and Sub-Saharan Africa, where high population growth rates, poverty, and low crop production persist (Aggarwal et al., 2018). Furthermore, the effects of climate change, including erratic rainfall patterns, increased temperatures, and more frequent and intense droughts, have led to reduced crop yields and further exacerbation of food insecurity and poverty among small-scale farmers (Bezner Kerr et al., 2018). In order to meet the demands of the growing population, global food production will need to double by 2050 (Aggarwal et al., 2018). World widely higher temperature, more frequent extremes, and increasing climatic variability has been reported as causes of climate change which adversely affects the ecosystem and environment (Flood et al., 2018). To reduce various impacts of climate change, mixed farming systems, agroforestry systems, diversified systems, agroecological systems etc., can be adopted and promoted by various types of institutions and governments. Adopting these systems lowers the use of external inputs, promotes the nutrient cycle, and promotes resource use efficiency (Gil et al., 2017). According to Yadav et al. (2023), the effective management of organic waste can indirectly contribute to mitigating climate change by reducing methane emissions from landfills, industrial energy usage, and other greenhouse gas emissions. The negative effects of climate change have already been clear (Flood et al., 2018). According to Gil et al. (2017), agriculture systems that are more mixed, diverse, or diversified tend to be more resilient to the impacts of climate change. However, the adoption capacity for climate change depends on the vulnerability status of a region or community and their capacity and ability to mobilize (Park et al., 2012). Decent agriculture has been successfully practised in various agroecological zones, indicating the successful adoption of technology and overcoming environmental and socio-

economic challenges (Chhetri et al., 2012).

The role of integrated agricultural systems (IAS) in climate change resilience must be documented. However, their potential to increase agriculture systems' resilience to climate change and variability is still being investigated (Gil et al., 2017). Adoption techniques, such as the adoption of agri-production, aquaculture, and forestry production, provide opportunities for society to increase its capacity to adapt and cope with the changes that may occur due to climate change (Park et al., 2012). Diversification and integration are promoted as adoption methods in Kenya's National Climate Change Response Strategy and Nigeria's National Agricultural Resilience Framework (Gil et al., 2017). However, a knowledge or action gap must be addressed before the scientific understanding of the effects of climate change and enforcement on adoption (Flood et al., 2018). Gil et al. (2017) suggest that agriculture systems can become more resilient to climate change by implementing facilitative or synergistic relationships between multiple components. For example, using livestock manure as crop fertilizer, intercropping to increase soil moisture, or diversifying crop production to mitigate the risks of low market prices. This approach is supported by the Adaptation Action Cycles concept and action framework, which helps decision-makers manage change and implement policies related to climate change adaptation (Park et al., 2012).

## 2. CLIMATE CHANGE ADAPTATION

Climate change results in about 60% yield loss depending on varieties, species, plantation area etc., resulting in food scarcity, poverty and conflict (Aggarwal et al., 2018). Sudden floods, uneven rainfall or temperature change lead to greater acceptance of climate change which is the main reason for the loss of yield of crops (Palm et al., 2017). Climate variation has been observed from the industrial period, from 1750 to the present, and it has been a major issue (Hegerl et al., 2019). Global climate change

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has been identified as a major issue of day-to-day human activities, including the farming sector, that requires immediate attention for a solution or major that can reduce the impacts of climate change (Palm et al., 2017). Since the advancement in the sector of industrialization, greenhouse gases have caused warming, with trends traceable to greenhouse gases by 1990 in proxy-based temperature reconstructions, their power grew through time, and they now dominate current trends (Hegerl et al., 2019). Even though various research has been conducted on global climate change, we need to learn more about global climate change, and more research is necessary before we take any actions on climate change adaptation (Palm et al., 2017). Long-term climate variability also can be caused by multi-decadal fluctuations in atmospheric modes (Hegerl et al., 2019). Before taking any action related to global climate change, more previous research is needed (Palm et al., 2017). According to Heath and Gifford (2006, 65-66), "those who prefer the free market system to environmental quality tend to believe that global warming isn't happening and that the causes of global are not human-made and said that climate change is more natural than human-caused and that will not have harmful implications (Palm et al., 2017). It is believed that long-term climate variability also can be caused by multi-decadal fluctuations in atmospheric modes (Hegerl et al., 2019). Climate change is predicted to disrupt the agriculture production system worldwide, creating huge difficulties for millions of people's livelihood and food security, so perfect decisions should be made to adopt climate change with proper research planning and strategies (Aggarwal et al., 2018).

Appropriate farming practices are a hotly debated area of climate change adaptation expertise (Bezner Kerr et al., 2018). Increased temperature, altered rainfall patterns, and more frequent and violent floods and droughts will influence food production (Aggarwal et al., 2018). Climate-smart agriculture (CSA) aims to boost long-term agricultural production by adapting to and preparing for climate change. It focuses on food security and national development goals, as well as reducing or eliminating GHG emissions where practicable (Aggarwal et al., 2018). Before adopting any practice to eliminate the climate change effect, proper evaluation of challenges that might come while adopting a new practice, its impact, outcome, and proper recommendation should be made for adopting new practice (Flood et al., 2018). The strategies of CSV are to understand the effectiveness of varieties not only to improve productivity but also to improve climate change adaptive capacity, develop various type of solution to solve future climate change impact and also understand various constraints related to social environment like gender, biophysical, socio-economic etc. (Aggarwal et al., 2018). Adaptation to climate change in agriculture is often challenging due to a need for long-term information about changes/impact that are arising on agriculture due to climate change (Gil et al., 2017).

As a result, effective implementation necessitates an integrated approach incorporating research technology and policy (Aggarwal et al., 2018). The more adaptation of mixed, diverse, or diversified systems in agriculture, the more to resist the climate change effect (Gil et al., 2017). The CSV method is an important component of the agriculture research for development agenda as CSV provide information about weather forecasts, value addition, information and communication technology based on agro advisories (Aggarwal et al., 2018). Adoption capacity to climate change is greatly affected by the vulnerability status of the region and community and the capacity to adopt the ability to mobilize the community or region (Park et al., 2012). Farmers should receive tactical advice on how to use weather forecasts or the importance of weather forecasts on agriculture, proper information and communication technology about various processes that can be adapted to emit climate change impact (Aggarwal et al., 2018). People's relative position in society and access to different forms of knowledge can influence their vulnerability to climate change (Bezner Kerr et al., 2018). Climate change can be adopted by altering planting time, cropping system, land use system etc. (Aggarwal et al., 2018).

### 3. DECISION-MAKING AND PLANNING FOR CLIMATE CHANGE ADAPTATION

Adaptation to climate change refers to changes in natural or human systems in response to present or anticipated climatic stimuli or their impacts to minimize harm and maximum profit, the planning horizon (short-term or long-term), timing (reactive or anticipatory), shape (technical, institutional, legal, behavioural, or educational) are all considered when categorizing adaptations (private or public) (Khanal et al., 2018). Understanding the adaptation process is more recognized as a critical component of creating and implementing sustainable management practices (Park et al., 2012). The employment of synthetic pesticides harms human and climatic segments (Yadav et al., 2022a). Therefore,

integrating different pest control methods and using environmentally friendly insecticides can be an effective way to manage pests without causing harm to the ecology (Yadav et al., 2022b; Yadav et al., 2022c). If any approach is being made, proper examination, specification, inclusion, and criteria should be examined based on available and relevant information (Flood et al., 2018). Adaptation strategy, on the other hand, has the potential to be a highly effective technique for future-proofing productive and resilient agroecological systems. Many local, regional, and national solutions are needed to increase agroecological systems' resilience and reduce their vulnerability to land degradation and climate change (Webb et al., 2017). Agricultural adaptability also differs per country (Khanal et al., 2018). Impart information and expertise with climate change issues; make aware of the problems caused by global warming and inspire them to propose solutions (Flood et al., 2018). Farmers use a variety of adaptation tactics based on climatic, social, economic, and institutional considerations; as a result, information on the effects of real farmer adaptation on crop yields will be useful for effective adaptation planning (Khanal et al., 2018). The planning for adaptation focuses on adaptation participation and decision-making across various industries, activities, and ecosystems (Flood et al., 2018).

While climate-induced yield loss in agriculture is a major concern, some studies suggest that agriculture may benefit from future climate change if suitable adjustments are made (Khanal et al., 2018). Diversified farming strategies such as agroecological farming, agroforestry, and landscapes that integrate functional biodiversity can help to maintain ecosystem services that provide important inputs to agricultural systems (Gil et al., 2017). However, agricultural adaptation planning must adequately consider the potential benefits of restoring degraded land and the risks of continuous land degradation (Webb et al., 2017). Understanding the factors influencing farmers' adaptation to climate change and their implications for agricultural production is crucial because many developing countries are currently designing and implementing climate change adaptation plans (Khanal et al., 2018). The Adaptation Cycle includes determining who or what adapts, to what they adapt, how they adapt, the resources utilized, and the implications of adaptation within and across sectors (Park et al., 2012). Various surveys provide data to help policymakers establish and promote realistic and effective adaptation strategies (Khanal et al., 2018).

Flood et al. (2018) suggest that planning for adaptation requires addressing the challenge of assessing potential impacts and outcomes and providing guidance for practical action. To facilitate informed decision-making on transformative change, an evaluation framework based on social learning was employed to assess the effectiveness of promoting cognitive, normative, and relational learning among participants about adaptation planning and practice. As transformative actions become increasingly necessary to address climate change (Park et al., 2012), it is crucial to understand and support farmers' adaptation strategies. Khanal et al. (2018) conducted surveys to gather data on the overall characteristics of communities under investigation and their perceptions of climate change and adaptation strategies. They posed three contingent questions to ensure that farmers' adaptation strategies were due to climate change rather than other constraints. These questions were: (1) Have you observed any changes in the local climate over the past 15-20 years? If so, what were they exactly? (2) What effects have these changes had on rice production? (3) What measures have you taken to address these changes? The need for changes in crop types and livestock breeds and the timing and placement of management activities has been a major focus of crop and livestock production systems (Webb et al., 2017). Moreover, diversifying farming strategies and landscapes, employing agroecological farming methods, and practising agroforestry can help maintain ecosystem services that provide essential inputs to agricultural systems (Gil et al., 2017). To develop effective and robust adaptation strategies, it is critical to understand the factors that influence farmers' adaptation to climate change and the implications for agricultural output, particularly in low-income countries such as Nepal (Khanal et al., 2018). By analyzing shared characteristics of adaptation and the assessment of learning, Flood et al. (2018) discuss their findings and guide decision-making and planning.

### 4. CHALLENGES TO CLIMATE CHANGE ADAPTATION

- According to Bezner Kerr et al. (2018), only one-third of individuals reported receiving visits from an extension agent in a year, indicating unequal dissemination of agricultural information.
- Feola et al. (2015) suggest that integrating tools and methodologies from multiple backgrounds can pose challenges in interdisciplinary studies, resulting in difficulty linking to current scholarly discourses and hindering collaboration and synthesis.

- Reckien et al. (2018) argue that there are considerable synergies and trade-offs between mitigation and adaptation, particularly in urban areas, which can play a significant role in developing and implementing climate change programs.
- Khanal et al. (2018) found that farmer households with low levels of education are less likely to adopt climate change adaptation measures, and authorized agencies' decision-making and planning can be difficult to understand, leading to poor implementation.
- Reckien et al. (2018) also note that many rural farmers need more planning and process to reduce climate change effects due to a lack of linkage between local governments and sub-national organizations. Officers may want to avoid visiting rural areas.
- Feola et al. (2015) suggest that policies and plans are made but only sometimes implemented, and they may change with changes in government.
- Reckien et al. (2018) highlight the need for more support for learning and exchanging plans and decisions between local governments and sub-national organizations, leading to miscommunication and a lack of information for farmers.
- Plan, policy, and decision-making processes often need more proper investigation and coordination, resulting in ineffective implementation (Feola et al., 2015).
- Farmer households with higher levels of education, modernized households, and strong leadership skills are more likely to apply climate change adaptation measures (Khanal et al., 2018).
- Participatory approaches taken by farmers lead to a lack of equity and knowledge flows in climate change adaptation (Bezner Kerr et al., 2018).
- The relationship between climate change adaptation and farm productivity is a significant problem largely overlooked in the literature (Khanal et al., 2018).
- Cities can support processes of learning and exchange between local governments and other sub-national organizations to facilitate climate change adaptation (Reckien et al., 2018).
- Determining what constitutes actual adaptation in agricultural management and technology can be challenging, as many changes only sometimes represent adaptation (Khanal et al., 2018).
- Selecting a research framework that aligns with the desired research goals is essential (Feola et al., 2015).

## 5. CONCLUSION

This review highlights that climate change adaptation is an emerging field of practice, and new adaptation methods are being developed and implemented in various contexts as the impact of climate change becomes more evident. However, the research has some limitations, such as overlooking potential benefits and focusing mainly on the educational aspect. Additionally, many of the examined solutions are still in the early stages and may be improved after testing. Nevertheless, the research consistently indicates that serious games have a positive impact and potential for continued growth in this area. To enhance the effectiveness of future games, optimize their impact, and create new opportunities for learning and innovation, it is necessary to review the current state of knowledge and provide guidelines for game design.

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