**CLIMATE-SMART AGRICULTURE AND SMALLHOLDER FARMERS**

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**ABSTRACT:**

Climate change is one of the major threats facing humanity in the present world. Climate change is negatively affecting various fields of human life, and agriculture is the main sector affected by climate change. Since crop productivity depends on climate variances, continuous climate change lowers productivity which would in turn affect the income and livelihood of farmers. Agriculture is already facing the issue of providing food to a growing population. Climate change would harm food security. Climate resiliency is the need of the hour and the adoption of climate-smart agriculture is a convenient method of climate-resilient farming. To be resilient to climate change, climate-smart farming should be adopted by farmers in large numbers. One or two isolated adoptions of climate-smart farming will not do the job. Hence, the adoption of climate-resilient farming on a large scale should be encouraged. The present study analyses the use and impact of resilient farming along with the scope of small farmers in adopting the same.

**Key Terms:** Climate Change**,** Climate Resiliency, Climate Smart Agriculture, Farming Practices, Small Farmers

**INTRODUCTION**

Climate change poses significant threats to both the abiotic (physical) and biotic (living) parts of the environment as well as economic growth and social well-being – especially in less developed countries. Climate change impacts the agricultural sector in various ways, like increased variability with respect to temperature and rain, intensity and frequency of extreme weather events, and perturbations in ecosystems. These could cause an increased variability of production, a decrease in production in certain areas as well as changes in the geography of production. The only way to cope with the challenges posed by climate change is by building resilience for adaptation in the agriculture sector.

The worldwide alarming news about climate change, as well as its impact on agriculture, necessitates a shift in farming practices. The Intergovernmental Panel on Climate Change (IPCC) has defined resilience as: "the ability of human communities to anticipate, absorb, accommodate and recover from the effects of disturbances" (IPCC,2012). Resilience Assessments have emerged as a key method of understanding human responses to disasters and help them to prepare better strategies to reduce the subsequent negative effects, thus empowering a community that can withstand and adapt to various future disasters (Burton,2015). Thus, resilient communities are capable of either avoiding or minimizing the negative impacts of climate disasters. Climate change is a threat to food security systems and one of the biggest challenges in the 21st century (FAO, 2013). It is widely accepted that the ability to contain the pace of climate change by keeping change in temperature rise within the 2°C thresholds, in the long run, is now limited and the global population will have to deal with its consequences (IPCC, 2014). Agricultural production systems are expected to produce food for the global population that is expected to reach 9.1 billion people in 2050 and over 10 billion by end of the century (World Bank, 2011).

The concept of climate-smart agriculture is getting considerable attention at the international level as it helps in agricultural planning under climate change. Climate-Smart Agriculture (CSA) is an approach to agricultural development that aims to address the intertwined challenges of food security and climate change (Lipper et al., 2014). CSA targets three objectives:

1. Increasing agricultural productivity in a sustainable manner to support equitable increases in farm income, food security, and development;
2. Adapting and building the resilience of food systems to climate change; and
3. Reduce greenhouse gas (GHG) emissions from agriculture wherever possible (FAO, 2013). Whether technology is CSA is based on its impact on these outcomes, and agricultural interventions that meet these goals are considered "climate-smart" (FAO, 2013)

Interventions ranging from climate information services to field management have the potential to achieve these goals (Faures et al., 2013; Khatri-Chhetri et al., 2016; Nyasimi et al., 2017). Climate change is a major threat to global food security. The agricultural sector is already facing the challenge of meeting food demand for a growing population, which is exacerbated by climate change. In this context, the concept of climate-smart agriculture is very relevant. This concept was introduced by FAO in 2010. The climate change debate started in the early 1980s with the publication of the Brundtland report in 1987. Global humanity has endeavoured to respond to climate change through adjustments in ecological, social, and economic systems to actual or expected climatic stimuli, their effects, or impacts (IPCC, 2001; Smit & Olga, 2001).

**Climate Smart Agriculture:**

The concept of climate-smart agriculture (CSA) was introduced in 2010 by the Food and Agriculture Organization (FAO) of the United Nations to face climate change in the agricultural sector (FAO, 2010). It is an integrated approach to farming to address the problems of climate change in the farming system (Ramasamy & Baas, 2007). It can help improve crop yields and enhance food security by using environmentally friendly techniques (FAO, 2010; World Bank, 2011; Ho & Shimada, 2019). Transformation in agricultural systems is crucial and urgent to be implemented in areas that mainly rely on rainfed agriculture and face the changing climate (Belay et al., 2017). The conservation of the agricultural system avoids further destruction of soil structure, improves the organic content in the soil, and retains more water to maximize the crop yield and prevent soil erosion and downstream flooding (Olawuyi, 2020). Moreover, these environmental benefits help strengthen the economy's ability to face poverty (FAO, 2010). An agroforestry system is one of the CSA practices that combine agricultural crop production, including trees, forestry plants, and animal husbandry, in accordance with the local population culture for public welfare (Suryani & Dariah,2012). Planting trees improves the organic matter in the soil. As a result, soil fertility and soil moisture increased as well (FAO, 2010). Moreover, the presence of forests lessens the rate of small-to-moderate rain flows. The water that falls to the ground is more controlled and does not erode the soil (Asdak, 2010).

**Climate Change and Agricultural Production:**

Climate change projections in relation to future rainfall, floods, and drought are uncertain (Okumu, 2013). Climate-smart measures include proven techniques such as mulching, intercropping, integrated pest, and disease management, minimum soil disturbance practices (MSD), crop rotation, agroforestry, integrated crop-livestock management, aquaculture, improved water management, better weather forecasting for farmers, and innovative practices.

However, temperature projections are generally reliable. The general warning of global warming in Sub-Saharan Africa is projected to be larger than the global annual average (IPCC, 2007). As regards temperature, increased temperature levels will cause additional soil moisture deficits, crop damage, and crop diseases; unpredictable and more intense rainfall; and a higher frequency and severity of extreme climatic events (Boruru et al., 2011). Similarly, the drivers of climate change have the potential to alter plant growth and harvestable yield through carbon dioxide fertilization effects (UNDP, 2012). Free Air Carbon Enrichment (FACE) experiments indicate productivity increases in a range of 15–25% for crops like wheat, rice, and soya beans and 5–10% for crops like maize, sorghum, and sugarcane. Higher levels of CO2 also improve the water use efficiency of both categories of plants (Lotze et al., 2009).such as early warning systems (FAO, 2010; World Bank, 2011; 2012).

It also entails embracing new technologies such as diversifying genetic traits of crops to help farmers edge against an uncertain climate and creating an enabling policy environment for adaptation (World Bank, 2011). In the absence of climate-smart agriculture, marginal areas may become less suited for arable farming as a result of land degradation through deforestation, soil erosion, repetitive tillage, and overgrazing (World Bank, 2012). However, it is recognized that climate-smart efforts must center on smallholder farmers in developing countries, who are critical to affecting change across the entire agricultural system Policy accompaniment and financing of agricultural practices is yet another inclusion in the general scope of the original concept of CSA (FAO, 2013).

Besides agroforestry, intercropping systems are also considered to be a better CSA technique. It is profitable because they can grow two or more different plants at the same time, and it increases diversity, ensures ecological balance, maximizes natural resource utilization, and improves and sustains agricultural production (Maitra et al., 2019). Soil management, which is another CSA practice, is a beneficial strategy in maintaining crop growth. It helps in developing soil performance using compost and manure by maintaining its fertility.

**Climate Smart Agriculture and Small holder farmers**

Climate adaptation helps in addressing the long-term impacts of climate change. Small holder farmers make use of CSA practices such as soil management, agro - forestry, tree planting, inter-cropping system, and balanced use of organic pesticides so as to minimize the negative impacts and improve crop productivity. Soil-related farming activities increase the nutrients in the soil, positively affecting crop growth (Kuwornuet al., 2013). The age and education of the farmers influence the conservation techniques applied on the farm (Obayelu et al., 2014; Tazeze et al., 2012). Farmers who have broader land are able to adopt more strategies and have more opportunities to improve their income (Belay et al., 2017). In addition, farmers’ cohesion is a key factor related to social and cultural dimensions (Adger et al., 2013). Similar experiences in dealing with the local phenomena (Turasih & MKolopaking, 2016) contribute to the efforts of improving their prosperity and quality of life (Adger et al., 2013).

Transforming traditional agricultural techniques, which prioritise productivity and show less concern about environmental degradation, into CSA, which enhances food security by conserving natural resources, requires improving the synergies and reducing the trade-offs between agricultural productivity and natural resource management. In this regard, developing farmers' infrastructure and capacity through financial investment, such as collaboration with private sectors, is critical (FAO, 2010).

The ability to prepare for and recover from climate disturbances, shocks and distress, and grow from destructive experiences is defined as climate resilience (World Bank, 2021; Obrist et al., 2010; Djalante & Thomalla, 2011). Climate resilience through CSA practises can be developed by utilising ecosystem services. For instance, farmers implement agroforestry that combines trees and shrubs in forests and gardens. On the one hand, this technique gives direct benefits to them, such as improving their income and diversifying food productivity. On the other hand, it provides benefits to the environment, such as preventing erosion, increasing the infiltration rate and biodiversity, and balancing the ecosystem (FAO, 2010). These advantages enable farmers to be more flexible to cope with nuisances in their surrounding areas due to climate change.

Several indicators for assessing the benefits of CSA practices are formulated as follows (FAO, 2017a; Kpadonou et al., 2017):

 1. Improvement of agricultural productivity;

 2. Improvement of resilient crops to climate variability;

 3. Improvement of soil fertility;

4. Improvement of income from crop diversification;

5. Improvement of water and soil conservation;

 6. Improvement of irrigation system for drought prevention;

7. Improvement of forest area that applies CSA practices

8. Improvement of farmers’ awareness of environmental protection

**STUDY UNIT- KUTTANAD**

 The southern Indian state of Kerala is a narrow strip of land extending from the Western Ghats into the Arabian Sea. Kuttanad is a wetland zone that is situated around the Vembanad lake and is spread across the districts of Alappuzha, Kottayam, and Pathanamthitta. It is one of the most flood-prone areas in the state as the region is very ecologically sensitive. It is thickly populated as well as one of the main rice producing tracts in the state, spread over an area of 1100 km2 in the deltaic region of the five Western Ghats River basins. In Kuttanad, the paddy farming system is situated 0–3 metres below sea level and is acknowledged by the Food and Agriculture Organisation (FAO) as a Globally Important Agricultural Heritage System. A series of artificial embankments are constructed to prevent saltwater intrusion and floodwater entry into the fields so as to make farming in Kuttanad possible. Rice production is characterised in this ecosystem by the active involvement of strong community institutions like the farmers' collective 'padasekhara samiti'. Major ecological problems faced by Kuttanad can be attributed to the mismanagement of its hydrological regime.

The Kuttanad paddy farming system, designated as a 'Globally Important Agricultural Heritage System' by the United Nations (Koohafkan and Altieri, 2010), is part of India's largest wetland complex and Ramsar site, the Vembanad-Kol ecosystem (Ramsar, 2014). The paddy fields in this region are situated 0–3 metres below sea level and are enclosed by artificial embankments. Kuttanad is often referred to as the "Holland of the East" because of its resemblance to the Dutch landscape. The entire region is a mosaic of backwaters, rivers, and numerous waterways and canals, extensive paddy fields in Polders are enclosed by dykes and coconut groves are interspersed with multi-cropped homesteads (Sreejith, 2013). This region can be classified into 6 agro-ecological zones: Upper Kuttanad, Lower Kuttanad, North Kuttanad, Kayal lands, Purakkad, and Vaikom Kari lands. Kuttanad farmers use the method of advancing, whereby the land is expanded into water by the use of dikes.

Kuttanad regularly suffers from natural disasters like flooding as well as saltwater intrusion that limits the growing season to a few months. Though 14.5% of the state’s land area is prone to floods, the 2018 August floods were the worst in about a century, resulting in the deaths of 433 people and destroying infrastructure and livelihood worth USD3.8 billion. Over 65,000 ha of land was inundated and 1259 out of 1664 villages across all the 14 districts of Kerala were affected by the flood (Government of Kerala, 2019). Climate change in the form of variability in the climate like floods and its impact on agriculture has to be studied and the resilient mechanisms such as crop management, crop improvement, and crop protection strategies should be adapted to mitigate the negative effects of climate change as well as for sustainable agricultural production.



**CLIMATE SMART AGRICULTURE IN KUTTANAD**

Kuttanad is one of the few regions where rice is produced below the mean sea level and is also known as the rice granary of Kerala. It is a unique and fragile ecological unit whose vulnerability can be attributed to the issues of water logging and soil acidity, along with climatic changes. They are facing the issue of crop damage due to summer rains and flooding in the monsoon season. Thus, Kuttanad is a region where climate variations and natural calamities need to be mitigated. Kuttanad followed a unique rice cultivation system that was more than 150 years old, developed by farmers of that region. Farming operations were dependent on the local water cycle. Sowing was done at the beginning of the northeast monsoon and harvest was completed before the southwest monsoon. Purely organic fertilizers were used, native varieties of crops were cultivated, and there was no chemical application in the field. They cultivated only one crop per year, and the paddy fields were kept fallow between successive crops so that the soil could regain its fertility. Thus, in order to mitigate the climatic variation and natural calamities, farmers in Kuttanad need to blend traditional methods with climate-smart farming methods.

**CONCLUSION**

Farmers face the challenges of climate change. Food security is an important concern in the present world with a growing population. Adoption of climate resilient farming practices is the need of the hour and climate smart agriculture is a better option in this regard. It would require less skill and resources on the part of the farmer, whereas it would help in increasing productivity as well as mitigating the negative effects of climate change. Though the adoption of climate smart farming by the entire farming community might take time, it is a necessity to spread the awareness of climate smart farming at this hour of climate change and natural disasters.

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