**CLIMATE SMART AGRICULTURE AND SMALL HOLDER FARMERS**

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**ABSTRACT:**

Climate change is one of the most serious threats to humanity today. Climate change is having a negative impact on many aspects of human life, with agriculture being the most affected. Because crop productivity is affected by climate variations, continuous climate change reduces crop productivity, affecting farmers' income and livelihood. Agriculture is already dealing with the challenge of feeding a growing population. Climate change would have a negative impact on food security. Climate resiliency is an urgent need, and climate smart agriculture is the most convenient method of climate resilient farming. Climate smart farming should be widely adopted by farmers in order to be climate change resilient. One or two isolated examples of climate smart farming will not suffice. As a result, large-scale adoption of climate-resilient farming should be encouraged. The current study examines the use and impact of climate resilient farming, as well as the potential for small farmers to adopt it.

**Key Terms:** Climate change**,** Climate Resiliency, Climate Smart Agriculture, Farming Practices, Small farmers

**INTRODUCTION**

Climate change threatens both the abiotic (physical) and biotic (living) components of the environment, as well as economic growth and social well-being, particularly in developing countries. Climate change affects agriculture in a variety of ways, including increased temperature and rain variability, the intensity and frequency of extreme weather events, and ecosystem perturbations. These could result in increased production variability, decreased production in certain areas, and changes in production geography.The only way to meet the challenges posed by climate change is to strengthen agricultural resilience for adaptation. The globally alarming news about climate change and its impact on agriculture necessitates a shift in farming practises. Resilience is defined by the Intergovernmental Panel on Climate Change (IPCC) 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 critical method for understanding human responses to disasters and assisting them in developing better strategies to mitigate the subsequent negative effects, thereby empowering a community to withstand and adapt to various future disasters (Burton,2015). As a result, resilient communities are capable of avoiding or minimising disasters.Climate change is a threat to food security systems and one of the most pressing challenges of the twenty-first century (FAO, 2013). It is widely acknowledged that the ability to slow the rate of climate change by keeping temperature rises within a 2°C threshold in the long run is now limited, and the global population must deal with the consequences (IPCC, 2014). Agriculture is expected to produce food for the world's population, which is expected to reach 9.1 billion in 2050 and more than 10 billion by the end of the century (World Bank, 2011).

Climate Smart Agriculture is gaining popularity on a global scale because it aids in agricultural planning in the face of climate change. Climate-Smart Agriculture (CSA) is an agricultural development strategy that aims to address the interconnected challenges of food security and climate change (Lipper et al., 2014). The CSA has three goals:

1. Increasing agricultural productivity in a sustainable manner to support equitable increases in farm income, food security, and development;
2. adapting and building resilience of food systems to climate change; and
3. , where possible, reducing greenhouse (GHG) emissions from agriculture (FAO,2013). Whether a 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 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 the global food security. Agricultural sector is already facing a challenge by meeting food demand for a growing population which is exacerbated by climate change. In this frame, 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-economic systems to actual or expected climatic stimuli, their effects or impacts (IPCC, 2001;Smit & Olga, 2001).

**Climate Smart Agriculture:**

The Food and Agriculture Organization (FAO) of the United Nations introduced the concept of climate-smart agriculture (CSA) in 2010 to address climate change in the agricultural sector (FAO, 2010). It is an integrated farming approach to addressing climate change issues in the farming system (Ramamasy & Baas, 2007). It can help increase crop yields and improve food security by employing environmentally friendly techniques (FAO, 2010; World Bank, 2011; Ho & Shimada, 2019). Transformation of agricultural systems is critical and urgent in areas that rely primarily on rainfed agriculture and are vulnerable to climate change (Belay et al, 2017). Agricultural system conservation prevents further degradation of soil structure, increases organic content in the soil, and retains more water. keep soil erosion and downstream flooding at bay (Olawuyi, 2020). Furthermore, these environmental benefits contribute to the economic sector's resilience in the face of adversity (FAO, 2010). Agroforestry systems are CSA practises that combine agricultural crop production, trees, forestry plants, and animal husbandry in the same unit of land in accordance with local population culture for public welfare (Suryani & Dariah,2012). Planting trees improves soil organic matter. As a result, soil fertility and moisture levels rise (FAO, 2010). Furthermore, the presence of forests reduces the rate of small to moderate rainfall. Water falling 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). However, temperature projections are generally reliable. General warning of global warming in Sub-Saharan Africa is projected to be larger than the global annual average (IPCC, 2007). As regarding temperature, increased temperature levels will cause additional soil moisture deficits, crop damage and crop diseases; unpredictable and more intense rainfall; and higher frequency and severity of extreme climatic events (Boruru et al., 2011). Similarly, the drivers of climate change have the potential of altering 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 water use efficiency of both categories of plants (Lotze et al., 2009).

Climate-smart measures includes 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, 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, there is recognition that Climate Smart efforts must have at their heart smallholder farmer in the developing nation who is key to change across the entire agricultural system. Policy accompaniment and financing of the agricultural practices is yet another inclusion in the general scope of the original concept of CSA (FAO, 2013).

Besides agro forestry, intercropping system is also considered to be a better CSA technique. It is profitable since they could grow two or more different plants in the same time and it increases diversity, assures ecological balance, more utilization of natural resources, enhancement and sustainability in 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 the crop productivity. Soil-related farming activities increase the soil’s nutrients, positively affecting crop growth (Kuwornu et 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 wider 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 the 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 the traditional agricultural techniques, which prioritize productivity and show less concern on 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 resources management. In this regard, developing the infrastructure and capacity for the farmers through financial investment, such as by collaborating with private sectors, plays a significant role (FAO, 2010).

Climate resilience is defined as the ability to prepare for climate disruption, recover from shocks and distress, and grow from destructive experiences (World Bank, 2021; Obrist et al., 2010; Djalante & Thomalla, 2011). By utilising ecosystem services, climate resilience can be developed through CSA practises. Farmers, for example, use agroforestry, which combines trees and shrubs in forests and gardens. On the one hand, this technique directly benefits them by increasing their income and diversifying their food productivity. On the other hand, it benefits the environment by preventing erosion, increasing infiltration and biodiversity, and balancing the ecosystem (FAO, 2010). These benefits allow farmers to be more adaptable in dealing with nuisances caused by climate change in their surrounding areas.

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**

 Kerala, India's southernmost state, is a narrow strip of land extending from the Western Ghats to the Arabian Sea. Kuttanad is a wetland zone located around the Vembanad lake that spans the districts of Alappuzha, Kottayam, and Pathanamthitta. It is one of the most flood-prone areas in the state due to the region's ecological sensitivity. It is densely populated and one of the state's main rice producing tracts, spanning 1100 km2 in the deltaic region of the five Western Ghats River basins. The paddy farming system in Kuttanad is located 0-3 metres below sea level and is recognised by the Food and Agriculture Organization (FAO) as a sustainable system. To enable farming in Kuttanad, a series of artificial embankments are built to prevent saltwater intrusion and floodwater entry into the fields. Rice production in this ecosystem is distinguished by the active participation of strong community institutions such as the farmers' collective 'padasekhara samiti.' Kuttanad's major ecological problems can be attributed to mismanagement of its hydrological regime.

The Kuttanad paddy farming system has been designated as a 'Globally Important Agricultural Heritage System' by the United Nations. (Koohafkan and Altieri, 2010) is a component of the Vembanad-Kol ecosystem, India's largest wetland complex and Ramsar site (Ramsar, 2014). The paddy fields in this area are 0-3 metres below sea level and are surrounded by artificial embankments. Because of its resemblance to the Dutch landscape, Kuttanad is often referred to as the "Holland of the East." The entire region is a patchwork of backwaters, rivers, and numerous waterways and canals, vast paddy field polders surrounded by dykes, and coconut groves interspersed with multi-cropped homesteads (Sreejith, 2013). Upper Kuttanad, Lower Kuttanad, North Kuttanad, Kayal lands, Purakkad, and Vaikom Kari are the six agro-ecological zones in this region.

Kuttanad regularly suffers from natural disasters like flooding as well as salt water 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 death of 433 persons 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 climate like floods and its impact on the 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, also known as Kerala's rice granary, is one of the few regions where rice is grown below the mean sea level. It is a unique and fragile ecological unit whose vulnerability can be attributed to water logging, soil acidification, and climatic changes. They are experiencing crop damage as a result of summer rains and monsoon floods. As a result, Kuttanad is a region where climate variations and natural calamities must be mitigated. Kuttanad has followed a unique rice cultivation system developed by farmers in that region for more than 150 years.. The local water cycle was critical to farming operations. Sowing took place at the start of the northeast monsoon, and harvesting took place before the southwest monsoon. Organic fertilisers were used exclusively, native crop varieties were grown, and no chemicals were used in the field. They only grew one crop per year, and the paddy fields were left fallow between crops to allow the soil to replenish its fertility. Thus, in order to mitigate climatic variation and natural disasters, farmers in Kuttanad must combine traditional farming methods with climate smart farming methods.

**CONCLUSION**

Farmers are facing climate change challenges. With a growing population, food security is a major concern in today's world. Adopting climate resilient farming practises is critical, and climate smart agriculture is a better option in this regard. It would require less skill and resources on the part of the farmer, while increasing productivity and mitigating the negative effects of climate change. Though adoption of climate smart farming by the entire farming community may take time, spreading climate smart farming awareness is critical at this time of climate change and natural disasters.

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