**CLIMATE SMART AGRICULTURE AND SMALL HOLDER FARMERS**

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**ABSTRACT:**

Climate change is one of the major threats faced by 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 the crop productivity depends on the climate variances, continuous climate change lowers the 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 changes, along with it would harm the food security. Climate resiliency is the need of the hour and adoption of climate smart agriculture is the convenient method of climate resilient farming. To be climate change resilient, climate smart farming should be adopted by farmers in large number. One or two isolated adoption of climate smart farming will not do the job. Hence the adoption of climate resilient farming in large scale should be encouraged. The present study analyses the use and impact of climate 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, decrease of production in certain areas as well as the changes in the geography of production. The only way to cope up with the challenges posed by climate change is by building resilience for adaptation in the agriculture sector. The globally alarming news on climate change as well as its impact on agriculture demands a change in the 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, the resilient communities are capable for either avoiding or minimizing the negative impacts of climate disasters. Climate change is a threat to food security systems and one of 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 2°C threshold 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 in 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. sustainably increasing agricultural productivity to support equitable increases in farm incomes, 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 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 (Ramamasy & Baas, 2007). It can help improve crop yields for enhancing 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 agricultural system avoids further destruction of soil structure, improves the organic content in the soil and retains more water to maximize the crop yield, prevent soil erosion and downstream flooding (Olawuyi, 2020). Moreover, these environmental benefits help to strengthen the economic sector to face poverty (FAO, 2010). Agroforestry system is one of the CSA practices that combine agricultural crop production including trees, forestry plants, and animal husbandry in the same unit of land in accordance with the culture of the local population for public welfare (Suryani & Dariah,2012). Planting trees improve the organic matter in the soil. As a result, soil fertility and soil moisture increase 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 doesnot 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).

The ability to prepare for climate disturbance, recovering from 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 practices can be developed by utilizing ecosystem services. For instance, farmers implement agroforestry that combines trees and shrubs in forests and gardens. On one side, this technique gives direct benefits to them, such as improving their income and diversifying food productivity. On the other side, it provides merits 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

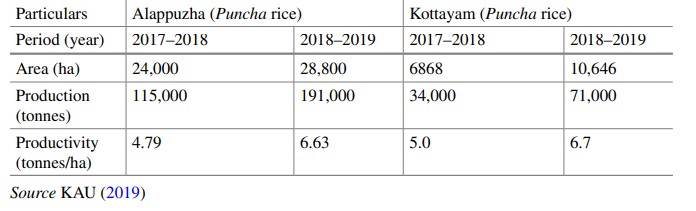
8. Improvement of farmers’ awareness of environmental protection

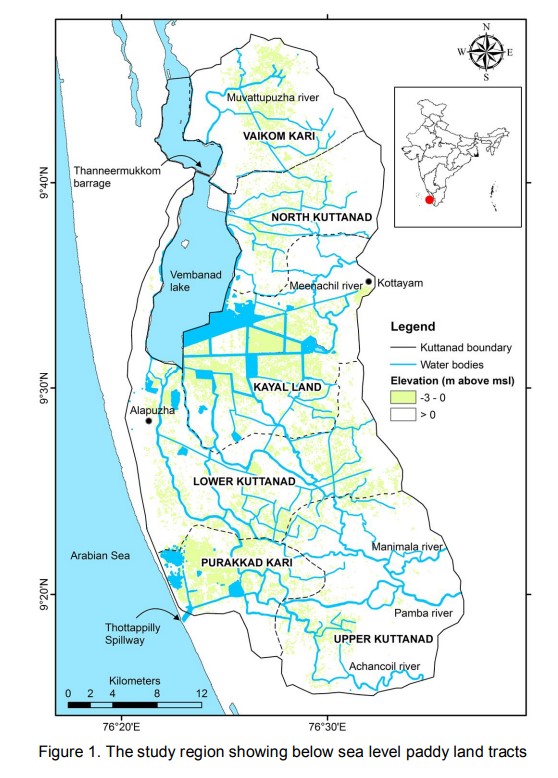
**STUDY UNIT- KUTTANAD**

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 districts. It is one of the major 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 the area of 1100 km sq in the deltaic region of the five Western Ghats River basins. In Kuttanad, the paddy farming system is situated 0-3 metres below the 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 for preventing 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.

Kuttanad paddy farming system, which is declared as the 'Globally Important Agricultural Heritage System' by the U.N. (Koohafkan and Altieri, 2010) is a part of the largest wetland complex and Ramsar site in India, the Vembanad-Kol ecosystem (Ramsar, 2014). The paddy fields in this region, is situated 0-3 metres below the 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 field polders enclosed by dykes and coconut groves 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 uses 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 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 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 fragile ecological unit whose vulnerability can be attributed to the issues of water logging and soil acidity along with the climatic changes. They are facing the issues of crop damage due to summer rains and due to floods in the monsoon time.Thus,Kuttanad is a region where climate variations and natural calamities needs to be mitigated. Kuttanad followed a unique rice cultivation system which is of more than 150 years, developed by farmers of that region. Farming operations were dependant on the local water cycle. Sowing was done in 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 in a year and the paddy fields were kept fallow between successive crops so that the soil could regain its fertility. Thus,inorder to mitigate the climatic variation and natural calamities,farmers in Kuttanad need to blend traditional methods with the climate smart farming methods.

**CONCLUSION**

Farmers face the challenges of climate change. Food security is an important concern of the present world with 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 need less skill and resources on the part of the farmer, whereas it would help in increasing productivity as well as in 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 changes and natural disasters.

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