CLIMATE SMART AGRICULTURE AND SMALL HOLDER FARMERS

Abstract

One of the biggest risks to humanity today is climate change. Agriculture is most impacted by climate change, which is having a severe impact on many facets of human life. Since climate variations have an impact on crop productivity, ongoing climate change lowers crop productivity, which has an impact on farmers' income and way of life. Already, agriculture faces the difficulty of feeding a growing population. Food security would suffer as a result of climate change. Climate resilience is a pressing necessity, and climate smart agriculture is the most practical approach to farming that is also climate resilient. In order to be robust to climate change, farmers should implement climate smart farming widely. It is insufficient to use one or two lone instances of climate-smart farming. Therefore, it is important to promote the widespread adoption of climate-resilient agricultural. The current study looks at how climate resilient farming is used, its effects, and how small farmers might use it.

Keywords: Climate change, Climate Resiliency, Climate Smart Agriculture, Farming Practices, Small farmers

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I. INTRODUCTION

Climate change poses a threat to the environment's biotic (living) and abiotic (physical) components as well as to economic development and social well-being, particularly in emerging nations. The intensity and frequency of extreme weather events, the increase in temperature and rainfall unpredictability, ecological disruptions, and other factors all have an impact on agriculture. These could result in increased production variability, decreased production in certain areas, and changes in production geography. Strengthening agricultural resilience for adaptation is the only method to combat the problems caused by climate change. The dire reports regarding climate change's effects on agriculture call for a change in farming methods. The ability of human populations to foresee, absorb, accommodate, and recover from the effects of disturbances is referred to as resilience by the Intergovernmental Panel on Climate Change (IPCC) (IPCC,2012). Resilience assessments have become an essential tool for comprehending how people react to catastrophes and helping them create better plans to lessen their negative consequences, equipping a community to resist and adapt to a variety of future calamities (Burton,2015). Resilient communities can thereby prevent or lessen the effects of calamities. One of the most urgent problems of the twenty-first century is climate change, which poses a danger to systems that ensure food security (FAO, 2013). The global population must deal with the effects since it is widely understood that the ability to decrease the rate of climate change by maintaining temperature increases within a 2°C threshold in the long run is now restricted (IPCC, 2014). The world's population, which is anticipated to grow to 9.1 billion people in 2050 and more than 10 billion by the end of the century, will be fed by agriculture (World Bank, 2011).

Because it helps with agricultural planning in the face of climate change, climate smart agriculture is becoming more and more popular on a global basis. A method for agricultural development called "climate-smart agriculture" (CSA) seeks to solve the interrelated problems of food security and climate change (Lipper et al., 2014). The CSA has three goals:

1. Sustainably increasing agricultural output to enable equitable growth in farm income, food security, and development;
2. Adapting and strengthening food systems' resilience to climate change; and
3. Minimising agricultural greenhouse gas (GHG) emissions whenever possible (FAO, 2013). A technology's effect on these results determines whether it is considered CSA, and agricultural interventions that achieve these objectives are referred to as "climate-smart" (FAO, 2013).

These objectives may be attained by interventions ranging from field management to climate information services (Faures et al., 2013; Khatri-Chhetri et al., 2016; Nyasimi et al., 2017). Global food security is greatly threatened by climate change. A difficulty for the agricultural sector already is providing for a growing population, which is made worse by climate change. The idea of "climate smart agriculture" is extremely pertinent in this context. In 2010, FAO first proposed this idea. When the Brundtl and report was released in 1987, the discussion about climate change officially began in the early 1980s. Globally, humanity has made an effort to address climate change through modifying ecological, social, and economic systems in response to present or anticipated climatic stimuli, their consequences, or implications (IPCC, 2001; Smit & Olga, 2001).

1. **Climate smart agriculture:** In order to address climate change in the agricultural sector, the Food and Agriculture Organization (FAO) of the United Nations proposed the concept of climate-smart agriculture (CSA) in 2010. (FAO, 2010). To address concerns related to climate change in the farming sector, it uses an integrated farming method (Ramamasy & Baas, 2007). By using eco-friendly methods, it can assist enhance crop yields and improve food security (FAO, 2010; World Bank, 2011; Ho & Shimada, 2019). In regions that predominantly rely on rainfed agriculture and are at risk from climate change, transformation of agricultural systems is crucial and urgent (Belay et al, 2017). Conservation of the agricultural system stops further deterioration of the soil's structure, boosts its organic content, and improves water retention. prevent soil erosion and flooding downstream (Olawuyi, 2020). Additionally, these environmental advantages help the economy remain resilient in the face of difficulty (FAO, 2010). Agroforestry systems are CSA practises that integrate animal husbandry, forestry, and agricultural crop production on the same plot of land in accordance with local population culture (Suryani & Dariah,2012). Tree planting increases soil organic matter. Soil fertility and moisture levels increase as a result (FAO, 2010). Additionally, trees slow down the rate of light to moderate rainfall. The amount of water that falls to the ground is more controlled, and the soil is not eroded (Asdak, 2010).

2. **Climate change and agricultural production:** Future rainfall, floods, and drought projections due to climate change are uncertain (Okumu, 2013). However, predictions of the temperature are typically accurate. Sub-Saharan Africa is expected to see general global warming warnings that are greater than the region's annual average (IPCC, 2007). Temperature increases will result in more soil moisture deficits, crop damage, and crop diseases, unexpected and heavy rains, and an increase in the frequency and severity of extreme climatic events (Boruru et al., 2011). Similar to this, the causes of climate change could impact plant development and harvestable yield due to the effects of carbon dioxide fertilisation (UNDP, 2012). Experiments with Free Air Carbon Enrichment (FACE) show productivity increases of between 15 and 25% for crops like wheat, rice, and soy beans, and between 5 and 10% for crops like corn (maize, sorghum and sugarcane). Both types of plants use water more efficiently when CO_2 levels are higher (Lotze et al., 2009).

   Climate-smart practises include tried-and-true methods like mulching, intercropping, integrated pest and disease management, minimum soil disturbance practises (MSD), crop rotation, agroforestry, integrated crop-livestock management, aquaculture, improved water management, improved weather forecasting for farmers, and cutting-edge methods like early warning systems (FAO, 2010; World Bank, 2011; 2012). It also requires utilising new technology, such as crop genetic diversity to provide farmers an advantage over a changing climate and the development of legislative environments that facilitate adaptation (World Bank, 2011). Without climate smart agriculture, marginal areas can lose their suitability for growing crops due to land degradation brought on by logging, tillage, soil erosion, and overgrazing (World Bank, 2012). However, it is acknowledged that in order to reform the entire agricultural system, smallholder farmers in underdeveloped countries must be at the centre of Climate Smart initiatives. Another addition to the overall scope of the original concept of CSA is the policy support and financing of agricultural techniques (FAO, 2013).

A better CSA technique is also thought to be the intercropping system, in addition to agro forestry. It is advantageous because they can grow two or more varieties of plants simultaneously, which boosts diversity, ensures ecological balance, makes better use of natural resources, and improves and sustains agricultural productivity (Maitra et al., 2019). Another CSA technique, soil management, is a helpful method for sustaining crop growth. By preserving its fertility, it aids in improving soil performance when used in conjunction with compost and manure.

3. **Climate smart agriculture and small holder farmers:** The long-term effects of climate change are addressed with the aid of climate adaptation. To reduce negative effects and increase crop yield, smallholder farmers adopt CSA techniques such soil management, agroforestry, tree planting, intercropping systems, and balanced use of organic pesticides. Farming practises that include the soil enrich the soil with nutrients have a good impact on crop growth (Kuwornu et al., 2013). The farmers' age and level of education has an impact on the conservation measures used on the farm (Obayelu et al., 2014; Tazeze et al., 2012). Farmers with larger plots of land are better able to use more techniques and have more chances to increase their income (Belay et al., 2017). Additionally, a crucial element in relation to the social and cultural components is the solidarity of farmers (Adger et al., 2013). Similar experiences coping with local issues help people's efforts to improve their prosperity and standard of living (Turasih & M. Kolopaking, 2016). (Adger et al., 2013).

Enhancing synergies and minimising trade-offs between agricultural productivity and natural resource management are necessary to transform traditional agricultural practises, which prioritise productivity and show less concern for environmental degradation, into CSA, which increases food security by conserving natural resources. In this regard, financial investment, such as working with the private sector, plays a vital role in building the infrastructure and capability for the farmers (FAO, 2010).

Climatic resilience is the capacity to anticipate climate change, bounce back from setbacks and adversity, and develop from negative experiences (World Bank, 2021; Obrist et al., 2010; Djalante & Thomalla, 2011). Through CSA practises, climate resilience can be built through utilising natural services. For instance, farmers use agroforestry, which blends plants from gardens and woodlands. On the one hand, this method directly benefits them by boosting their income and increasing the variety of food they can produce. However, it also protects against erosion, boosts infiltration and biodiversity, and maintains the ecosystem's balance (FAO, 2010). These advantages enable farmers to deal with the annoyances brought on by climate change in their local areas with greater adaptability.

The following are some indicators for evaluating the advantages of CSA practises (FAO, 2017a; Kpadonou et al., 2017):

1. An increase in agricultural output;
2. Improvement of climatic variability-resistant crops;
3. An increase in soil fertility;
4. An increase in crop diversification's financial benefits;
5. Enhancing soil and water conservation;

6. Enhancing the irrigation system to avert drought;
7. Enhancement of the forest area using CSA principles
8. Increasing farmers' understanding of environmental protection

II. STUDY UNIT- KUTTANAD

Kerala, the most southern state of India, is a slender peninsula that juts out into the Arabian Sea from the Western Ghats. The Alappuzha, Kottayam, and Pathanamthitta districts make up the Kuttanad wetland zone, which surrounds the Vembanad lake. Due to the area's biological sensitivity, it is among the state's most flood-prone places. It covers 1100 km2 in the deltaic zone of the five Western Ghats River basins and is one of the state's key rice producing tracts. It is also highly populated. The Food and Agriculture Organization (FAO) recognises Kuttanad's paddy farming system, which is positioned 0–3 metres below sea level, as a sustainable system. A number of artificial embankments are constructed in Kuttanad to facilitate farming by preventing seawater intrusion and retaining soil. In order to allow for farming in Kuttanad, a number of man-made embankments have been constructed to block floodwater and saltwater incursion into the fields. In this environment, rice cultivation is characterised by the active involvement of powerful local institutions like the farmers' collective "padasekhara samiti." Mismanagement of Kuttanad's hydrological regime is the primary cause of its ecological issues.

The Kuttanad paddy farming method has been recognised by the United Nations as a "Globally Important Agricultural Heritage System." (Koohafkan and Altieri, 2010) is a part of India's largest wetland complex and Ramsar site, the Vembanad-Kol ecosystem (Ramsar, 2014). This region's paddy fields are encircled by man-made embankments and are 0–3 metres below sea level. Kuttanad is frequently referred to as the "Holland of the East" because of how much its terrain resembles that of the Netherlands. The entire area is a mosaic of rivers, canals, backwaters, enormous rice fields, and coconut trees mixed with multi-cropped homesteads (Sreejith, 2013). The six agro-ecological zones in this region are Upper Kuttanad, Lower Kuttanad, North Kuttanad, Kayal lands, Purakkad, and Vaikom Kari.

Regular natural calamities like flooding and salt water intrusion, which shorten the crop season to a few months, plague Kuttanad. Despite the fact that 14.5% of the state's geographical area is at risk for flooding, the August 2018 floods were the worst in roughly a century, killing 433 people and destroying livelihoods and infrastructure worth USD3.8 billion. Over 65,000 acres of land were submerged, and the flood affected 1259 out of 1664 villages throughout Kerala's 14 districts (Government of Kerala, 2019). Climate change in the form of climatic variability, such as floods, and its impact on agriculture need to be studied, and resilient mechanisms like crop management, crop improvement, and crop protection strategies need to be adjusted to lessen the negative effects of climate change as well as for sustainable agricultural production.

Particulars	Alappuzha (*Puncha* rice)		Kottayam (*Puncha* rice)	
Period (year)	2017–2018	2018–2019	2017–2018	2018–2019
Area (ha)	24,000	28,800	6868	10,646
Production (tonnes)	115,000	191,000	34,000	71,000
Productivity (tonnes/ha)	4.79	6.63	5.0	6.7

Source KAU (2019)

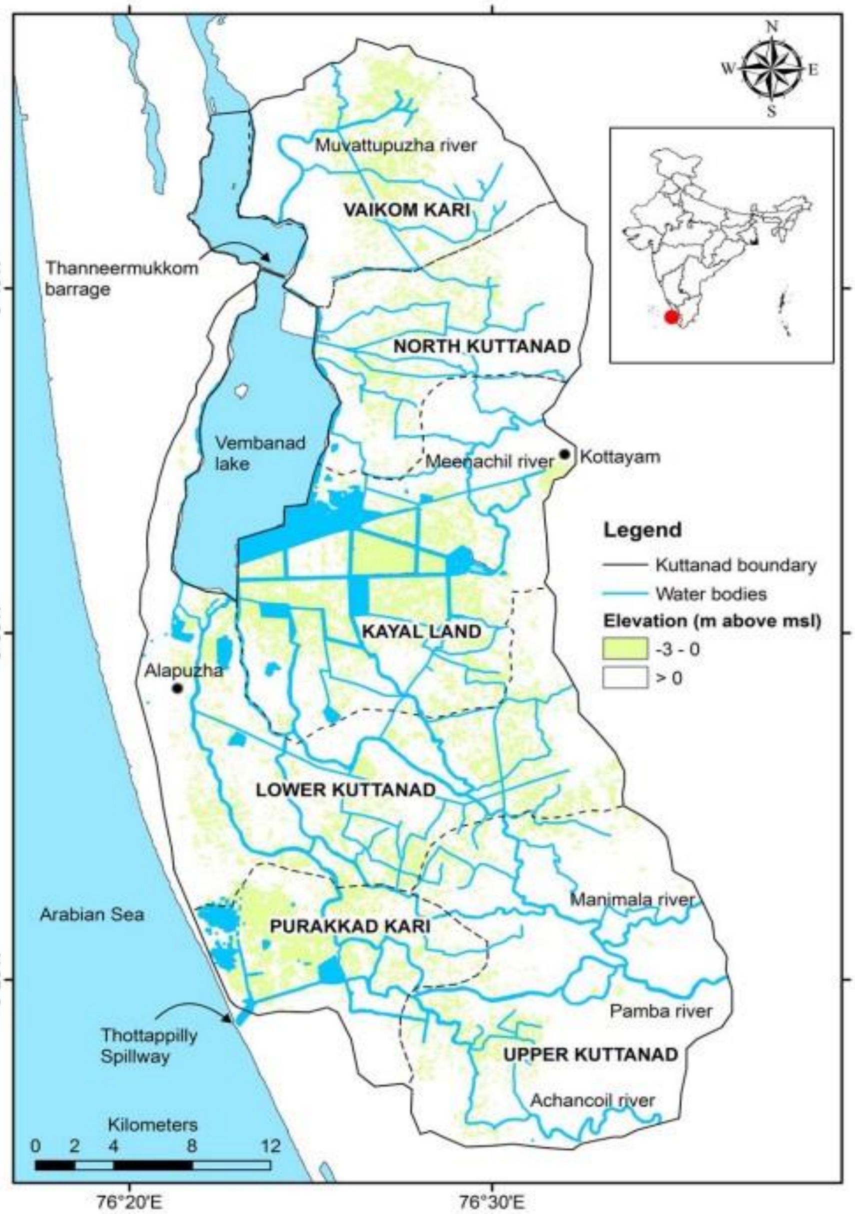

Figure 1. The study region showing below sea level paddy land tracts

III. 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. The paddy fields were left fallow in between seasons so that the earth could restock its fertility. They only grew one crop each year. Thus, in order to mitigate climatic variation and natural disasters, farmers in Kuttanad must combine traditional farming methods with climate smart farming methods.

IV. CONCLUSION

Farmers are dealing with the effects of climate change. Food security is a key worry in today's globe due to a growing population. Adopting climate resilient farming practises is critical, and climate smart agriculture is a better option in this regard. It would boost productivity and lessen the negative consequences of climate change while requiring less knowledge and resources from the farmer. Though assimilation 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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