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Climate Change Adaptation Strategies for Sustainable Agricultural Production: Challenges, Opportunities and Future Perspectives

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INTRODUCTION

Climate change is the global issue that may reduce the income level, sustainability by influencing agricultural production, livestock production, trees and commercial aquatic species. Climate change and factors related to climate change increases food insecurity and inequality through abiotic influences like drought, salinity, high temperature and submergence. Across the abiotic factors, drought and salinity are the two major threats affecting poorer households, rural farming community, small and marginal farmers (Gbobaniyi, et al., 2014). Adaptation and natural resource management is the durable step under such vulnerable climatic situation. In rural commodities, several attempts have been made for the sustainable development by adopting the natural resource management strategy. Furthermore, development of projection strategy to reduce the effect of climate change through renewable surface water by saving natural water resources and storage of rain water for the agricultural and livestock production. This is one of the best strategies for used of water from natural resources and rainfall. On an estimate provided by IPCC (2012), the severe condition of drought will have to intensify by at least 25 countries of the world by saving water reservoir and natural water resources. In most of the regions like Central North America, Mexico and Central America, Northeast Brazil and Southern Africa such type of strategy have been employed to get rid of drought like severe situation. In addition, reduction in the rainfall particularly in the semi-arid and arid region will translate into a much larger reduction in river runoff. On an estimate, it has been observed that 13 percent of the water reduction due to low rainfall has been retained by saving 34 percent of the water.

Therefore, convergent research results from globally consistent, multi-model climate change assessment for major crops with explicit characterization of uncertainty (Frieler, et al., 2015). Such types of uncertainties may show that climate change will fundamentally alter global food production patterns. Negative crop productivity impacts from climate change for wheat, rice and maize–everything else being equal given present-day agricultural areas, levels of management and technology–are expected in low latitude and tropical regions, even at low levels of warming.

2. Causes of climate change

Several types of abiotic threats influencing crop production, livestock production and economic standard of the peoples are the major cause of the climate change. Most of the climate change in many countries due to human-induced actives. Increased temperature due to global warming and human-induced activities gives unwanted and serious results in terms of coastline inundation, oceanic salinization, erosion are the consequences of sea level may influencing the global food security and economic status (Faroque, et al., 2013). These anthropogenic causes reduce the crops productivity by affecting the agricultural inputs and natural resources related to agriculture system. In most of the areas where climate change affects crop productivity and livestock production and may be projected to upsurge the land menace from drought and heat both.

The impacts of climate change are not similar in district to district or within district on different blocks. So, the measurement of climate change impact is very critical and problematic issues. However, diversity in the impact of climate change become conscious over time is extremely context-specific. Measurement of climate change impact needs accelerated and advanced technologies to develop accuracy in the impact reports. Thus, development of framework and dedicated team to observe the diversity in the climate change impact may provide strategic idea for preparation of correct report. Several models and framework ideas has been designed in the observation of the impact of climate change. However, one of the major components of the climate change is drought caused by water deficit are not judge by single parameter because drought is one of the multidimensional stress affects crop growth and development at each stage (Nikulin, et al., 2012).

3. Impact of climate change on agriculture

Agriculturally important crops like rice, wheat, maize, chickpea, sorghum, oils yielding crops, vegetables needs seasonality for proper growth and satisfactory yield. The vulnerability in agricultural system in context to successful crop production, three important factors is responsible exposure, sensitivity and adaptive capacity of system. Some arid and semi-arid zone where drought-prone area developed due to low rainfall and lack of water reservoir may be utilized using short duration crop cultivars and low water requiring crops for strategic sustainable agriculture development. Important physiological traits are also considerable parameters of the crop production under drought and water deficit condition (Clements, et al., 2011). Physiological traits like waxy leaves, sunken type stomata, small leaf area, leaf orientation towards sun, deeper root system may also decrease the water loss through evapotranspiration, transpiration and guttation.

Some issues related to biotic stress like insects, pests and diseases are also come into existence for damaging crops are due to climate change. Because some abiotic factors generated due to climate change are provide favorable condition for the survival of pathogens and pests. Climate change also affects soil fertility, nutritional status of the soil, dissolved minerals and long enough to cause soil salinity. Soil salinity is one of the major problems for crop production mainly caused by two climatic factors such as high temperature and water deficit condition (NAAS, 2013).

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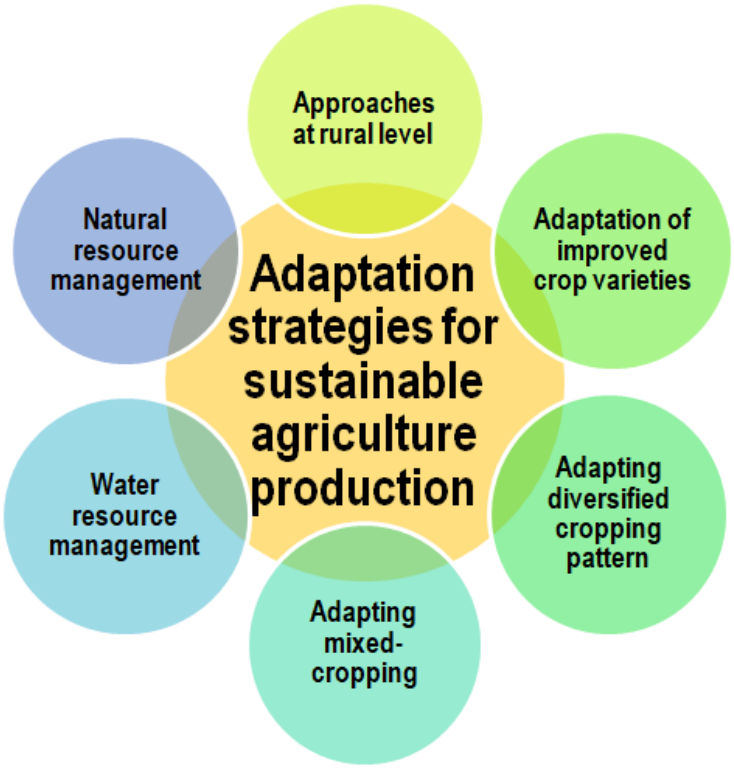
4. Resilience development towards agricultural system

Resilience is the degree of adaptation under which crops are surviving and complete their life cycle to give satisfactory yield. Global agricultural system needs more intensification to develop resilience in the current situation of climate change and global warming. In many crops, improved crops cultivars has been developed by identifying genes and QTLs associated with abiotic threats like drought, salinity, submergence, low temperature tolerance. Management in the crop production strategies and agronomical practices may also provide strength in the development of residence in the drought-prone area. Post-harvest management is another considerable practice especially in the like stock and fodder production under acute environmental condition is one of the suitable resilient strategies. Strategic animal breeding for with low requirement of fodder may build resilience in contest to livestock production (Nikulin, et al., 2012). In addition to development of resilience, genotype-by-environment interaction, genetic variability, lower heritability can alter the adaptation mechanism for fulfillment of the gap between resilience and climate change.

5. Adaptation strategies for sustainable agriculture production

Adaptation is one of the important strategies for the development of sustainable agriculture under the climate change scenario. Several policies and framework have been standardizing to optimize the sustainability under acute climate change condition. Another important of adaptation is to implementations of the strategies of policies and parameters of framework. Most of the strategy of adaptation is associated with natural resource management like reforestation, recharge of water reservoir, development of energy and biological diversity. Therefore, the natural resource management provides strength to the sustainable development system by adaption. Another important thing is to revision of the agricultural production system according to the situation of regional climate change (Nikulin, et al., 2012).



Rural area is most affective spot under climate change. Several phenological changes have been observed in rural area and farming communities (Anonymous, 2010). Most farms and farming community are affected and they need to adapt for sustainable agriculture and livestock production. Sustainability can be develop in rural climate to adopt sustainable environmental safely developed framing practice, which are economically viable and conserve natural resources by shifting to pre-existing less effective environmental threatening system. Long-term sustainable development at farm and farming community level can be achieve through several management practices with potentiality to reduce the losses occurring at farm level. Development of conservation agriculture system by restoring natural resources like reforestation, recharging water reservoir, and by developing local agro-ecosystem may give long-term higher crop productivity. Conservation agriculture system may also provide opportunities to build-up strong base for the livestock production (Shetty et al., 2013).

Identification of suitable crop cultivars under the era of climate change is one of the important steps of adaptation for sustainable development in the agriculture system. Selection of suitable crop varieties like short duration, early maturing, deeper root system are able to sustain under draught and low rainfall condition is one of the measurable strategy of adaptation under climate change scenario. In many crops, several varieties have been identified for sustainable crops production under the stressed conditions. Particularly in cereal crops such as rice, wheat, maize, sorghum, and barley several cultivars having tolerance when subjected to abiotic stressed conditions like drought, salinity, and submergence. Crop improvement era initiates crop improvement by conventional and molecular breeding strategy. Several genes and QTLs have been identified and introgressed into crop cultivars for the development of resilience for both biotic and abiotic stresses. In may crops drought and salinity tolerant genes and have been identified on the various chromosomal location and introgressed into susceptible crop cultivars for development of resilience (Faroque, et al., 2013).

Today farming community grown same crop on the same land and harness the natural resources. Such type of mono-cropping invites climatic risk up to long period may be severely impacted. In the particular region where mono cropping prominent, the attack of biotic threats like insects, pests, and pathogens are more because of the availability of long-term favorable environmental condition for this threats. Crop diversification is not new practice of agriculture production system. Change is the cropping pattern by adapting the diversified cropping system may be beneficial in the era of climate change (Lakhran, et al., 2017). Therefore, adaptation of diversified cropping pattern may protect natural diversity, agro-ecosystem in response to climate change.

Mixed cropping is the oldest system of crop production in undeveloped countries where agricultural resources are limited. Mixed-cropping would not 100 percent profitable but it insures the satisfactory profit under water deficit condition and other stress. Poor and marginal farming community of undeveloped countries were used the mixed cropping system like pigeonpea, sesame, sorghum in summer season, and chickpea, pea, linseed and mustard in winter system. However, in the era of climate change such type practices of crop production are needful. In many countries policies and guidelines have been standardize for mixed-cropping pattern to tackle the issues related to climate change (Cameron, et al., 2015).

Sustainable livestock production is the second most important wings for the farming commodities for gaining income by selling animals, milks, meats during the acute climatic situations for development of sustainability. By products of livestock's like animal residue, crop residue, and dung as manure can be used efficiently on farm with dual advantage of its better utilization as well as reducing external

inputs use may also enhance environmental sustainability (Meena, et al., 2016).

Agriculture production including crops and livestock is directly depends on the water and natural resources. River, canal, ponds, lakes, and wells are major water resources particularly in the rural areas where crops and livestock productions are directly depend. Other natural resources like grassland, forests, and agroforestry system are the second most important natural resource on which most of the livestock productions are depends. Human-induced activities, such as destroying water reservoir, deforestation, conversion of grassland and wasteland, industrialization, urbanization are threaten the water and natural resources. Fisheries are another important source of income generation in the rural communities is also influenced by destroying natural water resources (Shetty, et al., 2013).

Under steamed climate change and drought, irrigation water conservation using drip, sprinkler and other moisture conservation technologies like trickle irrigation, mulching may also provide sustainability for crop production. Soil conservation by improving soil fertility and physical status of the soil may also useful practice for sustainable agriculture development. In context to long-term soil conservation, crop residue retention, and sensible legume based crop rotation have been proven to develop sustainable agricultural production system (Hobbs, et al., 2008). Long-term moisture conservation in soil by green manuring, composting, and by dense cropping enhance the agricultural productivity under climate change scenario (Brinkman and Sombroek, 1996). In addition, development of agro-ecosystem by restoring natural resources and crop production components can retain the long-term crop production.

CONCLUSION

Considering climate change scenario, it needs more efforts in coming years for sustainable development. Several policies have been made by government, private sectors and NGOs for development of sustainability in the ecosystem and many of them are implemented in required areas. Scientific communities are also working in context to development of sustainable system for the farming communities through improved farming system, varietal improvement against abiotic stress. In addition, the considerable needs are required to increased focus on regional studies of impacts and adaptation to climate change in agriculture sector. In most of the countries of the world, agricultural and livestock production are facing problem in food production sustainably to feed a growing global population with least external inputs.

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