Smart Crop Production in Climate Change Scenario

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Climate change is a major theme of discussion nowadays everywhere. Climate change is not a one-day matter but gradual changes have been noticed. The changes are rainfall pattern, rainfall intensity, cloud burst, unpredictable floods in non-flooding areas, increase in temperature as well as drought. For farmers, it is very unpredictable matter as they have to go for seasonal crops and depends on climate only. As most of the area in India are rainfed.

In rural areas of developing countries, more than 70% of the population still depends on agriculture. However, economic crises, unscientific land allocation and climate change issues have hindered attempted gains in agricultural productivity and related rural development outcomes. Technology-driven breakthrough has usually pushed agriculture to the brink of another development that can affect not only plant diversity and yield, but also climatological and socio-economic outcomes. The concept of sustainable agriculture has become increasingly popularized as research and farming communities believe that productivity with environmental and social consequences need to be judiciously balanced. Agriculture of developed nations has practically benefitted of this concept worldwide during the 1990 s. In order to be successful worldwide, extensive research must be conducted not only for large-scale farms in developed nations but also for small-scale farms in developing nations.

As we know greenhouse gas is the major factor of climate change. Due to increase concentration of concentration of greenhouse gas in the atmosphere, due to increase of human activity that led to enhanced greenhouse gas effect. Resulted increase heat on earth's surface.

Climate change has many effects on agriculture crop production that led to threat to food security against increased population. Agriculture on the other hand also one of the contributors of greenhouse gas (CO_2, N_2O, CH_4, CFCS).

In present scenario of agriculture, needs both adopt to the climate change effect and also has to reduce the GHG emissions via different ways. Due to climate change so many effects have been found in production of crop, adaptability of different varieties. So, adoption mechanism has to adopt to cope with the adverse situation.

Climate smart agriculture is an action to meet the changes of climate change to get the agricultural product to meet food security. The related factors of climate change adaptation, mitigation and productivity, and increase in income are the factors that depend on each other.

Many climates resilient measures have been worked out by scientists, and researchers as climate-smart agriculture.

For every good production quality of seed is important along with other types of planting material. In this case seed delivery system and agricultural extension system should be strengthened.

The technologies for climate smart agriculture are- the use of quality seeds and planting materials, integrated pest management, sustainable mechanisms, improved water use & management, sustainable soil, and land management, biodiversity management, and technology for decision-making. As per FAO (2011), using quality seeds and planting materials, including rootstock and scion combinations, of well-adapted varieties is good agricultural practice and is climate-smart. Choosing crop species and varieties adapted to the prevalent or expected impacts of climate change for the given region and farming system is the most economical and environmentally friendly means of safeguarding crops against abiotic and/or biotic stresses, such as climate-driven extreme weather events and upsurges in pests and diseases. Useful traits include time to ripening, early and late maturity, blooming, and resistance to pests and diseases.

Promoting intra- and inter-specific diversity over space (e.g., intercropping, using crop variety mixtures) and/or time (e.g. crop rotations) increases the stability of crop yields. Crop associations and rotations designed for specific adaptation goals use cover crops to partially or entirely replace mineral fertilizer inputs, and/or mechanical soil tillage. In climate-smart systems, the main function of cover crops is not necessarily seed production. Cover crops need to be terminated when appropriate to achieve the agronomic goal they are designed for. Growing a single crop, using a mixture of appropriately chosen genotypes of a given species, such as a mixture of high-yielding hybrid varieties and traditional varieties, increases the producer's resilience in the face of climate unpredictability. Growing annual crops (e.g. leguminous crops) in the rows between perennial crops requires the accurate selection of species to avoid competition for water in the most vulnerable phenological stages.

The proper interpretation of reliable seasonal forecasts allows farmers to select crop varieties and to adapt crop calendars to new temperatures and rainfall patterns, plan the timing of husbandry operations, such as irrigation; pruning to avoid damage from heat or moisture; fruit thinning to balance excessively high rates of fruit set and reduce competition for developing fruit in case of excessive flowering; protecting early bloom from late frosts through short-term interventions. Implementing soil and water conservation techniques or in situ water conservation (e.g. soil mulching, rainwater harvesting) enhances crop productivity.

Inducing flower by spraying or by irrigation is a short-term intervention to break dormancy when natural climate phenomena for breaking dormancy are absent. Shading and/or painting trunks decrease the effect of excessive sun and heat. Misting helps control both freezing temperatures and heat.

Measures aiming at preventing crop losses may include: Selecting species capable of resisting specific extreme weather conditions (e.g., root and tuber crops in cyclone-prone areas) or species with short growing cycles from seed to yield.

Protecting crops with: mulch of different materials and colours, for controlling weeds and reducing evapotranspiration; nets, for bird control, insect proofing, hail protection and shading; floating mulch for protection against late frost and insects

Different submergence-tolerant rice varieties like Ranji Sub 1, Swarna Sub 1, Bahadur Sub 1, Cheherang Sub 1, IF 64 Sub 1 etc can cope the resilience of climate change. Just like that the white cabbage variety is also suited to adverse climatic condition.

Increasing efficiency in fertilizer use through site-specific nutrient management practices that optimize the use of existing soil nutrients while filling deficits with mineral fertilizers.

Using conservation agriculture improves soil health, allows the soil to grow both at the surface and at depths, and improves water retention.

Minimizing mechanical soil disturbance continuously over time prevents and soil compaction, slows the mineralization of soil organic carbon, increases the effectiveness of rainfall, curbs soil erosion and reduces the risks of waterlogging. The year-round seeding of fields in crops/mulch, if water availability permits, protects the soil from erosion and compaction, and keeps important nutrients, especially nitrogen and phosphorus, on farmers' fields.

Most nutrient losses occur during the period between seeding and the development of a dense canopy; and after harvest when there is no crop on the field.

A diversified and intensive crop rotation is one that: eliminates fallow periods where possible; returns crop residues to the soil with an average carbon-to-nitrogen ratio in the 25-30 range; improves the soil and responds to specific needs related to agronomic practices (e.g. improved soil compaction) and water management either through improved drainage or reduced evaporation.

Integrating nitrogen-fixing perennial woody species (e.g. *Cajanus cajan* or pigeon pea) and trees with annual crops increases soil fertility, produces biomass and reduces soil erosion. This practice also sequesters carbon and redistributes the carbon to deeper soil layers. Integrating multipurpose crop varieties, whose biomass can be used in a range of combinations for food, biofuel, feed, and/or fibre, can improve the functional and productive management on the farm and be climate-smart. Examples of multifunctional crops include living fences that can provide food and feed and serve as windbreaks.

Crop water productivity is improved by implementing good agronomic management decisions and practices such as selecting crop varieties that are drought tolerant and/or have a higher water productivity (i.e., that deliver more yield per liter of water); adjusting cropping calendars; encouraging deeper rooting of crops; using conservation agriculture for higher water retention; and mulching.

Implementing soil and water conservation techniques (e.g., soil mulching, shading, rainwater harvesting, using fences or windbreaks to reduce evaporation) enhances crop productivity.

Integrating feed for livestock from annual crops with perennial feed, particularly from deep-rooting legumes, promotes soil health and provides additional quality forage during dry periods. It also improves the quality of the diet of ruminants, reducing methane emissions from enteric fermentation.

In irrigated systems, increasing the efficiency of irrigation (e.g., through deficit irrigation, precise water applications, high-efficiency pumps), reducing water losses and improving water allocation and the management of water demand, optimizes yields per volume of water applied, reduces greenhouse gas emissions and brings about gains in energy efficiency, mainly in the use of fuel.

For increases in the quantity, frequency, and intensity of rainfall, the following practices reduce or avoid damage to roots from waterlogging: Improving drainage.

In the case of biodiversity management, growing "a genetically diverse portfolio of improved crop varieties, suited to a range of agro-ecosystems and farming practices, and resilient to climate change" is a validated means for enhancing the resilience of production systems (FAO, 2011). When confronting abiotic changes (e.g. shifting rainfall and temperature patterns) and biotic disturbances (e.g. pest infestations), the level of existing biodiversity can make the difference between a stressed agricultural ecosystem and a resilient one.

The diversification of crop systems can take many forms, involving different crop species and/or varieties (intra- and/or inter-specific diversification), different spatial scales (landscape, farm, individual fields and/or crop) and different time frames.

In case of Integrated Pest Management, climate change will affect the spread and establishment of a wide range of insect pests, diseases and weeds. Integrated pest management is an ecosystem approach to crop production and protection. It is based on the careful consideration of all available pest management techniques. Integrated pest management involves the use of appropriate measures to discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified; reduce or minimize risks to human health and the environment; and disrupt as little as possible the agricultural ecosystem. As the climate changes, national regulatory, policy and institutional frameworks must be strengthened to enable the adoption of integrated pest management practices on farms and in rural communities. In particular, frameworks should support farmer training in integrated pest management; maintain the surveillance systems, including those used in community groups, that are used to detect and report changes in the behaviours of pests and natural enemies; develop appropriate quarantine procedures to prevent the entry and establishment of plant pests; and formulate appropriate management strategies to respond to potential outbreaks. Other important elements of any strategy to promote a shift to resilient crop production systems include phytosanitary frameworks and measures that can facilitate the creation of markets for sustainable products; and the transparent collaboration among policy makers, industries and farmers on the national registration processes for the most appropriate pesticides to a climate-smart approach (FAO & INRA, 2016).

Sustainable soil and land management for increased crop productivity where at the landscape level, reducing land-use change by carefully limiting the need to expand cropland and grazing land can reduce emissions and increase the capacity of the soil to store carbon.

At the field level, increasing productivity allows to grow more from the land already under production. This eliminates the need to open new land for agriculture and helps reduce the emissions associated with agricultural expansion. Soil protection can be achieved by practicing direct seeding in combination with the sustainable management of crop residues and within a broader framework of integrated soil fertility management.

Sustainable mechanization where the availability of appropriate machinery to carry out sustainable crop management practices increases productivity per unit of land. It also increases efficiency in the various production and processing operations and in the production, extraction and transport of agricultural inputs, including coal and oil.

Technologies for decision-making where developing simple and robust scientific tools that can guide the decision-making of farmers on a seasonal and long-term basis is essential for planning strategies to address climate change.

In terms of risk management, some of the most relevant technologies relate to weather forecasting and early warning systems. The improved timing and reliability of seasonal forecasts and hydrological monitoring enables farmers to make better use of climate information, take pre-emptive actions and minimize the impact of extreme events (Faurès et al., 2010; Gommes et al., 2010).

Conclusion

Crop production in climate change environment is therefore inclusion of many technologies than normal crop production practices. Farmers have to be award to know the technologies in proper way so that they can be able to cope with adverse climatic situations. FAO has played a great role in the climate-smart agriculture by providing many more informations.

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