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Climate Resilience:-A Way Forward to Mitigate the Harsh Effect of Climate Change

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Climate change is the longing change in the normal distribution of weather pattern which poses ill impact towards ecology and persist for long periods. It is an established fact that climate change is bombarded by greenhouse gas (GHG) emission. Agriculture is both a target on one hand and a contributor on another side to climate change. The second highest source of GSGs emission is due to the use of chemical fertilizers, pesticides, enteric fermentation, transplanted rice cultivation etc. Adverse impacts of global warming include reduced crop quantity and quality due to the reduced growth period following high levels of temperature, reduced sugar content and increase of weeds, diseases and harmful insects in agricultural crops. Climate resilient agriculture increases the capacity of the system to cope back in such a way that it doesn't go back to the previous situation. Resilient agriculture is a new term but this adaptation is present in the nature from time immoral, but the problem is rapidity of the climate change. These changes are so fast that nature isn't able to synchronize with this. Climate change can be natural i.e., due to continental drift, volcanos, ocean current etc or anthropogenical due to urbanization, industrialization, burning of fossil fuel, deforestation etc. The basic element required for sustainable and effective development in agriculture is ensuring that investments should be based on evidence about past and future climate risks.

Climate resilience is a key concept of climate risk management and it refers to the ability of an agricultural system to predict and prepare for, as well as adapt to imbibe and recover from the impression of changes in climate and extreme weather conditions. Resilience can be improved by implementing short and long-term climate mitigation and adaptation strategies, as well as ensuring clear and evident participation of multiple factors in decision-making and management systems. Mostly the hydro-meteorological hazards are slow in their onset, such as changes in temperature, rainfall and snowfall resulting in long-term changed temperature, precipitation patterns and therefore agricultural droughts. On the other hand, some meteorological changes occur more suddenly, such as storms and floods. Both these hazardous scenario's require robust and quick risk preparedness for the assessment of climate risk. Climate risk is based on the exposure to climate hazards, vulnerabilities and the adaptive capacity of the agricultural, social, and ecological systems. The practices where climatic hazards need attention for resilience are organized as follows: crops, livestock, forestry, fisheries and aquaculture. The most suitable climate resilient practices will depend on the hazardous risks, evident exposure and expected vulnerability observed during the climate risk screening process. There are some agronomic measures which needs to be adopted for effective resilience against the climatic risks. The effect of climate change can be reduced by implanting program like weather based agro-advisories, crop variety selection, efficient cropping system, water harvesting for conserving water resources, effective and strategic planning.

Minimum tillage system: Soil tillage practices have a clear impact on the physical properties of soil and the greenhouse gas emission. By disturbing the soil extremely very less, the farmers can conserve labor as well as fuel costs, reduce soil erosion and preserve essential nutrients. No-till also increases the accumulation of soil organic carbon, thereby resulting in sequestration of atmospheric carbon dioxide. It has been recorded that a significantly higher net global warming potential under conventional tillage systems which is 6–31% higher than zero tillage systems (Mangalassery, *et al.* 2014). According to the environmental protection agency, 2009, no-till system can save 35 liters for land preparation, one liter diesel contains 0.74 kg C and emit 2.67 kg, so through this no-till system, global worming potential of a particular system can be reduced.

Selection of heat tolerant crops/varieties: The cultivation of crops like pearl millet and sorghum enhance yields in areas where temperatures are expected to exceed certain thresholds that are harmful to existing cropping systems.

Short duration varieties: This reduces the effect of heat stress at key phenological phases viz germination and flowering and improve final yields and impedes plants exposure to heat by shortening the growing cycle and thus the total water requirements during the growing season will be lessened.

Normalizing crop calanders: The optimal crop calendars should be framed on the basis of historical climate data and seasonal forecasts, support decision-making, avoiding heat stress conditions at crop's sensitive phenophases and increasing yields.
Plantation of windbreaks: Rows of trees can protect crops by breaking strong winds, reducing soil erosion, increasing crop yields, and protecting livestock and crops from heat and cold conditions.

Crop management practices: Weeding and defoliation reduce soil water losses from plant transpiration. Cover crops reduce soil erosion by increasing soil organic matter, water, air, nutrient availability and breaking the soil into small fragments can prevent the loss of land moisture by evaporation. Hydroponics with re-circulating water systems can reduce water losses and covering the soil with crop residues in combination with no-tillage reduces the exposure of crops to heat-stress conditions. It also increases soil moisture by reducing direct soil evaporation.

Custom hiring of machinery used in agriculture: At village level land fragmentation is a major problem, so community farm machinery hiring reduces the environmental pressure due to reduced use for cultivation practices. The Community managed custom hiring centres needs to be setup in each village to access farm machinery for timely sowing. This is an important intervening to contract with variable climate like delay in monsoon, inadequate rains during crop growth period.

Cultivation of drought tolerant crops: Crops with low water requirements like sesame, millet, sorghum etc can reduce evapotranspiration losses during photosynthesis by rapidly closing their stomata and maintaining leaf water potential and photosynthetic rate. Enhance food production during the dry season when food insecurity levels are highest.

Carbonation of soils: Soil organic carbon management is an important factor for achieving the resilience to climate change. Increasing soil carbon storage can enhance infiltration, fertility and nutrient cycling, reduces the wind and water erosion, minimize compaction, increases water quality and environmental sustainibility. Enhancing the carbon sequestration through residue management, eliminating fallows by permanent plant cover, diversified crop rotation particularly with legume crops, agroforestry etc. Retention of crop residue without burning lead to add some carbon to the soil, 1 tonne of rice residue burning emit 1515 kg CO_2, 0.4kg SO_2, 2.5kg CH_4, 92kg CO, 3.83 kg NOX and non-methane volatile organic compound (Andreae *et al.* 2001) which can increase the ill-effects of the climate change. For retention of CO_2 in the soil, C:N ratio is important so the N source from the legume plays a pivotal role to control the Carbon sequestration. Agroforestry is a great option for re-carbonization through global carbon sequestration and the long-term storage of atmospheric carbon dioxide. In agroforestry systems the carbon stored in soil ranges from 30 to 300 Mg C/ha up to 1m (Nair *et al.* 2010).

Contingency crop planning: The erratic rainfall pattern is the main reason to planning for alternate cropping and cultivator to suite the resource endowments of rainfall and soil in a given location (Reddy, 2019). In rainfed areas, early showing of crop with the onset of monsoon is the established practise for obtaining maximum yield. Generally re-sowing, thinning the crop, removing the alternate crops, dead furrow, 2% urea application or KNO_3 or DAP application, growing storm resisting crop like ginger, pineapple etc are some of the contingency cultivation practices to combat the risks of climate change.

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