



A Need of Climate Smart and Sustainable Agriculture in India

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According to greatest ecologist Allan Savory "The meaning of agriculture is not only the crop production but also production of food and fibre from the natural resources like land and water. Agriculture is the foundation of civilization and stable economy of a nation". India is a developing country and agriculture is the back bone of our nation. Hence, the growth of India depends on the growth of agriculture and its allied sectors. But, there should be sustainable growth of agriculture otherwise, it may impact negatively to the nation. The agricultural growth means increase in productivity and the productivity of agriculture depends on the types of inputs given to the agriculture. The optimum productivity of agriculture mainly depends on the very basic inputs such as seeds, irrigations, fertilizers and mechanizations.

In India, climate plays a vital role in agriculture. The uncertainty of climate is responsible for the fluctuation of the growth rate of agriculture and its allied sectors. Because, about 50 % the cultivated lands are rainfed in India. The soils of the rainfed areas are alluvial with less fertile, low moisture holding capacity, salt affected and susceptible to erosion. The weather of these areas is erratic with uncertain and low rainfall (500 mm or less/ year) coupled with delay in onset of monsoon and early cessation of rain which leads to prolonged dry spells. The farmers of these areas are mostly practiced conventional farming with lack of modern technology, infrastructures and crop inputs. Further, the climate change has greater effect on the agriculture productivity and farmer's income. The impact of climate change on agriculture is felt during the extreme cases of temperature and rainfall. The climate change can be felt when temperatures are much higher, the quantity of rainfall declines significantly and the number of dry days is more than the normal. According to the economic survey of India, rainfed areas are more adversely affected by climate change than the irrigated areas. And the loss of production of food grain in case of rainfed area is approximately two times more than irrigated lands. Hence, due to lower production of agriculture, it lowers down the income

of farmers from agriculture. It has observed that the climate change itself lower the income of farmer about 15 to 18% on an average, but, in rainfed area it varies from 20 to 25%. The studies of climate change in India predict that, temperatures are may rise by 30C to 40C by the end of 21st century. If this prediction will true, then, about 12% of the farm income will reduce with potential losses of 18% to the annual revenue. This is one of the examples of unsustainable agriculture and the effects of this can be visible in terms of alleviation of poverty and poor living standard. The effects of climate change can be minimised by introducing and facilitating drip and sprinkler irrigation system to the infected areas. So that, India can grow more crop from single drop of water. Hence, it is required to develop certain options to maintain the sustainability of the agriculture.

The gift which Indian people have got from Green Revolution is the self-sufficiency in food production. The excessive use of chemical fertilizers and irrigation with high yielding varieties (HYVs) of seeds help us to become the self-sufficiency in food production. As population is increasing, the available cultivable land is getting fragmentation i.e. land holding capacity of farmers is decreasing. It has seen that nearly half of the farming communities have 0.01 to 0.04 hectares of land as their own. Hence, to produce more food grain the available cultivated land is overused and exploited. Earlier the traditional system of cultivations such as intercropping, mixed cropping and crop rotation were practiced, but, now the monoculture cropping system becomes predominant, which leads to soil infertility. Because, the same fields are used for 2 to 3 times to produce similar types of crops per year without rest. This system of cropping pattern helped to higher production and greater profits than the conventional farming, but, failed to sustain for long time.

The meaning of sustainable agriculture is to proper manage of agricultural inputs for a particular crop to improve the productivity without losing the soil fertility and damage to the environ-

ment. So that, it can run for a longer duration. The sustainability in agriculture is the most important task now a days, demand for food is going to be increased as there is continuous increasing rate of population. It has seen that, food grain increment rate is 1.5 % whereas, population growth rate is 1.9 %. Hence, there will shortage of food in near future. According to United Nations Development Programme, the national food security, upgrading the living standard of farmers and conservation of natural resources like soil and water is the sustainability development.

Today, it is necessary for a marginal farmer to divert agriculture through different cropping systems. However, the diversion of cropping system depends upon the agro-climatic factors such as soil types, quantity and commencement of rainfall in that particular region. It is sure that, by adopting double cropping, intercropping and mixed cropping, profit of farmers can be increased as the land use efficiency will increase. But, it needs the cost effective modern technology and infrastructures. Hence, it is important to develop a low cost technology to meet the financial burden of the marginal farmers. Sustainable agriculture can be achieved by coupling various traditional and modern methods of cultivation. In future, the sustainable agriculture can be achieved, provided, farmers should be encouraged to adopt proper technologies and not to drop crop cultivation particularly in dry land area.

There are certain modern methods of cultivation are available in agriculture those can help to achieve sustainable agriculture as well as reduce the effects of climate change. Some of these methods are mentioned below:

- I. Hydroponic and Aquaponics
- II. Biochar
- III. Organic farming
- IV. Hydrogel

Hydroponic and Aquaponics

Hydroponic is a method of cultivation in which soil is not required as a medium to grow plants. In hydroponic the media may be liquid or soil less (coconut coir, sponge, rockwool etc.). It can be practised in closed green house or outdoor system. The hydroponic system of cultivation can be classified as flow through, re-circulating, non-circulating, water only and media systems. In closed system plant can grow round the year as well as during abnormal weather conditions such as extreme drought or cold inside greenhouse in control manner. In this method water can be conserved and used in efficient manner. As soil is not required to grow crops,

this method of cultivation won't affect the soil adversely. If there is space limitation, one can grow plants in tier. Hence, more food production per unit area can possible. Here, the required nutrients for plant growth are supplied along with water. The additional nutrients may not require if fishes can be grown along with plant in fish tank. The circulating water from the fish tanks can be used for plant growth which is full of nutrients. This type of cultivation is known as aquaponics. The initial investment is more to develop the infrastructure in hydroponic system which is the only disadvantage. But, once the setup is completed, it can be used for long time with minimum water and no soil. Hence, it can solve the problem of food production with land holding constraints of marginal farmers as well as it is a sustainable way of cultivation. It won't do any harm to the environment.

Biochar

Biochar is one of the bioproducts obtained from heating biomass in a closed system under limited supply of oxygen and it is rich in carbon content. There are various thermochemical technologies are available to produce biochar from biomass i.e. pyrolysis, gasification and hydrothermal conversion. The biomasses used to produce biochar are crop residue, manures, timbers, forest residues and green waste. As biochar is rich in carbon it can be used as soil amendment to help in carbon sequestration and to boost the quality of soil. Using biochar as soil amendments can benefit both to environment and agriculture by reducing bio-waste, producing energy, improving quality of soil, sequestering carbon, increasing crop yield etc. Hence, use of biochar as soil amendment is one of the innovative and highly promising practices for sustainable agriculture.

Organic Farming

Organic farming is to produce agricultural product without using synthetic fertiliser, chemicals, pesticides, growth regulators and livestock feed additive. To meet the food requirement of the growing population, there is a trend to excessive use of chemical fertilizer, growth regulators, pesticides and insecticides. There is no doubt; food production will increase by using these additives to the plant and soil. But, there will be tremendous ill effects on human health as well as to the fertility of soil. Hence, to sustainable agriculture, one should go for organic farming. Though, the cost of these organic farm products are little bit high, but, it has long term benefits in terms of soil and human health. The Govt. of India should encourage more to the farmers to grow organic products by providing certain incentives or subsidies. The locally available raw

materials can be used to produce compost such as manure, straw, green materials etc. The soil fertility is decreasing day by day not only by using chemical fertilizers, but also, in the arid tropic area, due to climate and geological changes. High temperature helps soil organic matter to be oxidised. Hence, due to low nutrient contents, these soils are more vulnerable to overexploitation. The use of organic farming can reduce these ill effects of climate as well as the soil pollution by chemicals and will help to sustainable agriculture.

Hydrogel

The conservation of soil and water is the most important factors to achieve sustainable agriculture. It has seen that the distribution of rainfall is not uniform across the geographical areas. The rainfed lands suffer lots of problem due variation in rainfall. Due to climate change, the pattern of rainfall is also getting affected. Hence, it is essential to conserve water, so that, it can be used when it is required. Water can be conserved in-situ by using hydrogel. During the growing period of crop if water will shortage in the field, crop can extract the water from the hydrogel. Hydrogels are the super absorbent polymer (SAP). There is extensive research work has carried all over the world particular in Iran, china, USA and Europe to develop SAP, that can increase the water holding capacity of soil and increase crop yield. SAPs are hydrophilic networks which can absorb and retain large quantity of water or aqueous solutions. The invention of SAP is the gift to the agriculture, particularly to the rainfed agriculture to make sustainable agriculture. SAPs are generally sugar like hydroscopic structure that can be mixed with soil as amendment. They can absorb and hold water more than 400 times of their own weight. Studies has been seen that using of hydrogel in agriculture increases the water holding capacity of the soil, reduces the use of chemical fertilisers, pesticides, increases the yield of crop, and increases the irrigation frequency and water use efficiency. As water stores near to the root zone, it can reduces the stress to the plants during long dry spells. The application rates of hydrogels are varying with soil types. The average doses to reduce water stress and to increase irrigation frequency is 2.25 to 3 g/ kg of soil. The use of hydrogel in the agriculture field will not cause any adverse effects to the soil as these are biodegradable by aerobic or anaerobic microbiological activities. It has observed that it can degrade 10 to 15 % per year to the form of water, carbon dioxide and nitrogen. Hence, it has zero bioaccumulation potential. To achieve sustainable agriculture, the role of hydrogel is much more than it has stated above.

Hence, using hydroponic, biochar, organic farming and hydrogel in agriculture has practical proposition for climate smart and sustainable agriculture, provided adequate attention should be provided to facilitate these technology to the farmers. It is the urgent need to involve more and more scientists as well as extension workers to identify the thrust areas of research to develop an eco-friendly climate smart and sustainable agriculture technologies.

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