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Review Article

Rigid transformation of Indian agriculture in changing climate

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India is one of the most population countries of the world. Indian agriculture under the climate change conditions is continuously support to feed the 1.42 billion populations because of largest agri-regions (20), different climates (15) and soil types (46 out of 60) of the world. The climate change is great challenge all over the world but in these situations, India is largest producer of many agricultural commodities as milk, tea, pulses, spices, jute, cashew and second major grower of cereals as rice, wheat and oilseeds, sugarcane, cotton furthermore, second in horticultural crops like fruits and vegetables and major producer of banana and mango. But the population is increasing at fast rate so counter it, there is need the rigid transformation of Indian agriculture in the era of climate change. In this article discussed the strategies or approaches for the transformation in Indian agriculture as suggested by different experts at scientific basis.

Keywords: *climate change, challenges, Indian agriculture, population, transformation*

Introduction

India has rich natural resources particularly second largest in agricultural land and globally has 20 agro-climate zones with 15 climates and 46 soil types. India is the world's biggest producer of milk, tea, pulses, spices, jute, cashew and second major grower of cereals as rice, wheat and oilseeds, sugarcane, cotton furthermore, second in horticultural crops like fruits and vegetables and major producer of banana and mango. Being a largest grower, it has remarkable impact on people and environment so in the span of climate change and population increase (Raj & Das, 2023); there is need of sustainable agriculture in the form of innovative approaches for agricultural technologies and policies. Indian Agriculture needed transformation changes to decrease the emission of greenhouses gases by improving the soil, water and residues management, controlling the wastage of food, improving biodiversity at farms and exaggerate the carbon sequestration by sustaining the level of food production and services of ecosystem.

This article developed and presented keeping in view the significant impact of present agriculture on people and environment of India. The author is from the Punjab Agricultural University, Ludhiana, Punjab (India) and served as senior agronomist in the teaching, research and extension in the field of agronomy. In the research worked on crop production, conservation agriculture, cropping systems and medicinal plants for developing technological recommendations of cultivation of crops. Indian agriculture is under transformation from the last long time keeping in the ever increasing population and environmental changes that impact on the cultivation of agricultural crops and human. Therefore, this article has vital significance to aware about the transformation in Indian agriculture. The literature and related information were collected from internet for developing this article.

Reduce greenhouse gas emissions

Greenhouse gases emission increased from agriculture by rice farming (Maraseni et al., 2018), nitrogen fertilizer and energy use, livestock and dairying. There is difficult to reduce the emission in respect of traditional technology application in their production. However, the possibilities in mitigation level are higher as compared to others because not considered all the possibilities in the analyses for the increase in productivity and success chances of innovative practices. Pathak (2023) reported that greenhouse gas (GHG) emission 14% come up from the agriculture sector in the country. This emission from agriculture can be realized by sustainable land management, increasing efficiency and performance of the system. In India, studies observed that methane production can be decreased about 40-50% from the fields of lowland rice with water management practices (means use of less water compared to continuous standing water in the fields), sowing short span of varieties and application of modified form of urea (neem-coated) indicated to leaf colour chart (LCC) and soil health card (SHC). Direct seeding of rice can decrease 70-75% methane emission, where water not allowed for continuous standing in the fields. In agricultural soils carbon sequestration can be enhanced with the use of balanced nutrition, crop waste and organic manure. Currently, India is pledged for decreasing emission of greenhouse by 45% up to 2030 and successfully to be achieved the target of net zero emission by 2070. Gupta et al. (2021) recorded the greenhouse gases (GHGs) as carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) are produced by agricultural soils. Rice cultivation is a main concern of researchers that is produce the menacing and long lived greenhouse gases as N_2O and CH_4. It has been reported that rice fields emitted globally CH_4 and N_2O about 30 and 11%, respectively. Therefore, it is imperative to establishing concurrent validity of N_2O and CH_4 fluxes of these gases from the fields of rice and to establish the mitigation approaches for reducing the oncoming climate change. By changing conventional management of crops have a remarkable effect on decreasing emission GHG from fields of rice. However, Chataut et al. (2023) recorded the requirement of food is presently more than earlier, it could be due to the increase global population that resulted in the area is diverted from grassland and pasture for cultivation of agricultural crops. The agricultural intensification needs more energy and excessive use of chemicals and organic materials for production of agricultural food. Similarly, the GHGs production is also raised proportionately of CO_2, N_2O, and CH_4 that is fiasco owing to climate change. In spite of the less emission of these gases as compared to CO_2, but their contribution is larger in global warming. Whereas, Laborde et al. (2021) reported that food production is significantly influenced by climate change and their contributors. However, the total GHGs emission globally considered mainly from changes in land use and agriculture. Agriculture supported by the government worldwide with US$600 billion/year, it has been found that support has little effect on increasing global greenhouse gases emission from production; partly it is not systematically unfair for higher emission, and partly use of support for trade security decreases requirement for some higher emission of gases by increasing input prices. For significantly decreases greenhouse gas emissions from agriculture while protecting food security so needs a higher broad based update in operation support to consumption and production of agriculture.

Soil testing and managing soils

The aim of better soil management is essential to meet basic requirement of plant growth (psu.edu; yara.in). The soil is a physical medium and provides nutrients, water, oxygen, and permits seeds to grow, shoots to come forth and like to go for the sunlight and roots to appear and grow downward and become strong. Soil testing is important to deal with soil ability for plant growth (psu.edu). It gives very critical information about quantity of nutrients like phosphorus, potassium, magnesium, calcium, pH (for acidity and alkalinity) and organic matter of soil. Nitrogen is primary nutrient, which is found deficient and is not tested directly in all tests of soil. This is due to the nitrogen quantity and different forms influenced by soil type, amount of water in soil, temperature and living components (micro fauna, macro fauna and micro-organisms) so single test does not supply essential and required information (psu.edu). Soil testing is essential for managing soil fertility and adds the nutrients for growth of crops. For the adding organic matter needs to add composts and manures with the nutrients to the plants. The conservation practices of no tillage, minimum tillage like others crop rotation, mulching, cover crops are followed for better plant growth (psu.edu).

Crop residue management

Kumar et al. (2023) recorded that crop wastage significantly provides help and support to the agro-ecosystem services. The scientific cultivation of improved high producing varieties for agriculture production enhanced the crop waste and challenging to overcome its issues of management. The crucial time after the harvest of rice and wheat sowing and harvesting of sugarcane and poor use of some crop waste as animal feed encourage its burning particularly in developing nations like India. Under the situation climate change, the continuous practice of burning crop waste creates the problems for sustaining production systems and keeping the natural resources in good conditions. The essential elements upon burning of crop wastage are lost and changed into harmful particulate which cause air pollution. If the crop wastage is managed with scientific way it can be used to improve the soil fertility and industrial feedstock.

Food wastage

Priya et al. (2023) the Food and Agriculture Organization (FAO) reported that India had the maximum malnourished population of the global during 2020. The problem of world starvation was further becoming more severe due to the pandemic of COVID-19 (WHO, 2021). In 2019, the food waste was recorded 931 million tons, out of this 61, 26 and 13 % from households, food services and retail, respectively. The further reported that 50 kg food waste produced per capita/year by Indian households accounting about 68.77 million tons annually (Food Waste Index Report, 2021, by United Nations Environment Programme (UNEP) and The Waste and Resources Action Programme (WRAP). This study for food waste found that the wrong calculations in food formation, food in appropriation and reduction in Indian original local value system. It also observed suitable solutions for managing or gets rid of food wastage and find out the alternate ways of producing and consuming and increasing the family food culture. In India, the post harvest losses in 2014 as the extent of Rs. 926.51 billion (USD 15.19) but the grossly underestimated the food loss and waste. As per the 2020 Global Hunger Index, India stands at 94th position out of 107 nations. This amount of food loss and waste indicates that need to improve availability food, increase income, reducing the pressure on natural resources and decreasing greenhouse gases (wri.org)

To decrease food waste and support to sustainability (totalfood.com), follow the below tips:

1. Perfect shopping and food stock at the level of household
2. Proper management of food use and order in restaurants
3. Storing and food managing techniques for retailers
4. Targets and quantify food waste and loss at entire levels
5. Encouraging cold food chains sustainably to adapt the changing of climate

Biological diversity

Dar et al. (2022) reported that the different types of biological diversity of India under various climatic regions coupled with different types of ecosystems. India is considered as mega-biodiverse country in the global 17 megadiversity zones. In spite of this, India has only 2.2 per cent geographical land of the world and stands for 12 per cent species of the world. The total global species of 12,44,360, India represents 1,50,170 species with 12th rank of the world. These consist of species 1,01,167 animals, 49,003 plant and fungal etc. The thick network preserved of the country has conservation, wildlife, community and national parks protected areas with a total of 1,1,921 km^2 which is 5.03 per cent of the gross area of the country. There is need to documentation of daily observation of local environment and biodiversity for the knowledge of local population about animals, plants, wild and domestic, its record may have the traditional knowledge of different species.

Carbon sequestration

Kumara et al. (2023) advocated that Indian agriculture sector make sure food and livelihood protection to the large rural population because there is serious risk to agricultural sustainability from negative impacts of climate change. Sustainable cultivation provides very considerable advantages and support to control the effects of climate change than the traditional and conventional technologies. They found the highest carbon sequestration (+41.28%) with the use of biochar so it was the successful practice in medium fine textured soils for maize-wheat and legume cropping sequence. It was also observed the favourable time, irrigation, rainfall, and humid sub-tropical climate were very effective factors, which impact significantly on carbon sequestration. This study also reported that a certain level of carbon sequestration feasible at a particular area being a dynamic process. They also recorded that all the highly produced methods that increase carbon sequestration was practically favourable and profitable economically and carbon sequestration with the sustainable management of crops to control the climate and natural resources.

Conclusion

Changing climate impacts the crop productivity drastically and reducing food production. To feed the growing population, it is inevitable to reduce the emission of greenhouse gases from the agricultural land by reducing the application of inorganic fertilizers. The soil testing will guide the proper management of crops with required amount of fertilizers by avoiding excess. Carbon sequestration is another important process and remedy for the climate management. Furthermore, reduction postharvest wastages and food wastages could help us to manage the food security in the future.

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