

The Agriculture and Environment Nexus in the Context of Indian Economy

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I. INTRODUCTION:

Agriculture plays a crucial role in the Indian Economy as it provides livelihoods for a significant portion of population and contributes to food security. Agricultural growth has a multiplier effect on the entire economy of the country as it has close linkages with other economic sectors. India is said to be global agricultural power house. It is the world's largest producer of milk, pulses and spices and has the world's largest cattle herd (buffaloes) as well as the largest area under wheat, rice and cotton. It is the second largest producer of rice, wheat, cotton, sugarcane, farmed fish, sheep and goat meat, fruit, vegetables and tea. The country has some 195mha under cultivation of which some 63 percent are rain fed (roughly 125 mha) while 37 percent are irrigated (70 mha). In addition forests cover some 65 mha of India's land.

Although in the past years, Indian agriculture has made a significant progress but currently it faces many challenges. Its share in India's Economy has progressively declined to less than 15% due to high growth rates of the industrial and service sector. Because of stagnation of net sown area, plateauing yield level, deterioration of soil quality, reduction in per capita land availability etc. the agriculture sector is not performed well in current time. Moreover changes in the environmental situation putting pressure on agriculture affecting its sustainability.

Green revolution remains the most defining phase of Indian agriculture in the last century. It was an input intensive and technology focused approach helped India meet self-sufficiency for cereal needs and avert potential famines. Instead of these advantages, it has some long-term adverse environmental impacts. For example degrading topsoil, declining groundwater levels, contaminating water bodies and reducing biodiversity. Modern agriculture practices are known to significantly contribute to global climate change, primarily through the production and release of greenhouse gases such as methane and nitrous oxide. There is a great concern for the emission of methane and nitrous oxide because of their high global warming potential. So, agriculture is both a contributor and a victim of climate change on environmental change. Therefore a feasible strategy has to be adopted so that it seeks to strike a fine balance between the need for food production and the protection of ecosystems within the environment.

II. EXPLANATION –

D) Green Revolution and Its Impact on Environment

The green revolution was launched under the guidance of geneticist Dr. M.S Swaminathan which was started around 1960's. The green revolution led to high productivity of crops through adopted measures such as 1) Increased area under farming, 2) double cropping 3) adaptation of HYV of seeds 4) highly increased use of inorganic fertilizers and pesticides 5) improved irrigation facilities and 6) improved farm implements and crop protection measures.

The impacts of green revolution on environment are as follows--

1) Impacts of Pesticides: Although the uses of pesticides has contributed a lot of economic gains it is found that a significant amount of pesticides is unnecessary in both industrialized and developing countries. The average amount of pesticides uses is far lower in India than in many other countries; there is a high pesticide residue in India. This causes a large amount of water pollution and damage of the soil.

2) Water Consumption:- The crops introduced during the green revolution were water-intensive crops. Most of these crops are cereals and almost 50% of dietary water footprint is constituted by cereals in India. Since the crop cycle is less the net water consumed by these crops is also really high. The introduction of canal systems

and irrigation pumps sucked out water from the groundwater to supply the water-intensive crops, such as sugarcane and rice. Punjab is a major wheat and rice cultivating area and hence it is one of the highest water depleted regions in India. It is predicted that Punjab will have water scarcity in a few years.

3) Air Pollution :- In the heartland of the green revolution Punjab farmers are burning their land for sowing the crops for the next cycle instead of the traditionally practiced natural cycle. The next crop cycle arrives very soon because of the crop cycle is of short duration for the hybrid crops introduced in the green revolution. This contributes to the high amount of pollution due to the burning of agricultural waste in parts of Punjab. This kind of cultivation can lead to the release of many greenhouse gases, such as carbon dioxide, methane, nitrogen oxides etc.

4) Impacts on soil:- There was a repetition of the crop cycle for increased crop production and reduced crop failure, which depleted soil's nutrients. The application of pesticides and fertilizers led to an increase in the level of heavy metal especially Cd (cadmium), Pb (lead), and As (arsenic) in the soil. Weedicides and herbicides also harm the environment. The soil pH increased after green revolution due to the usage of these alkaline chemicals. The practice of monoculture (only wheat-rice cultivation) has a deleterious effect on soil properties which includes migrations of silt from the surface to subsurface layers and a decrease in organic carbon content. The effects of the green revolution are persisting. The green revolution, which was beneficial in ensuring food security, has unintended but harmful consequences on agriculture.

II) Modern Agriculture And It's Impact On The Environment:-

Indian agriculture sector is a significant contributor to greenhouse gas (GHG) emissions. As per the third Biennial Update Report submitted by the government of India in early 2021 to the United Nation's Framework Convention on Climate Change (UNFCCC) the agriculture sector contributes 14 percent of the total GHG emissions (energy 75.01 percent industrial process and product use 8 percent, and waste 2.7 percent as per 2016 data).

Within the sector, 54.6 per cent of GHG emissions were due to enteric fermentation, followed by 17.5 per cent from rice cultivation, 19.1 per cent from fertilizer applied to agricultural soils, 6.7 per cent from manure management, and 2.2 per cent due to field burning of agricultural residues. Therefore, effective mitigation measures and appropriate adoption technologies must be taken to reduce GHG emissions from the agriculture sector.

A study by the International Maize And Wheat Improvement Centre (CIMMYT) pointed out that India has the potential to cut 18% of its annual greenhouse gas emissions from the agriculture and livestock sector. The study estimated that 50 per cent of this reduction could be achieved by implementing these three measures-

- (a) Effective use of fertilizer
- (b) Adaption of zero-tillage
- (c) Management of water used to irrigation paddy

Here the zero-tillage also called No-till agriculture, is a cultivation technique in which the soil is disturbed only along the slit or in the hole into which the seeds are planted, the reserved detritus from previous crops covers and protects the seedbed.

There are several potential approaches to reduce GHG emissions from agriculture that have been tested at experimental scale. These need large scale testing from the mitigation perspective and their cost benefit assessed at a larger scale. The key approaches for mitigation are:-

- a) controlling production, oxidation and transport of methane from paddies by the practice of mid-season drainage or alternate drying instead of continuous flooding is required. Research shows that such a practice does not lead to any significant reduction in crop production.
- b) Application of nitrate fertilizers in aerobic conditions and ammonium fertilizers in wetland crops help reducing the nitrous oxide emission. The use of nitrification inhibitor, particularly the low cost locally available plant derived materials, such as neem cake is a good option to mitigate nitrous oxide emission from soil.
- c) Improved management of livestock diet through the use of improved feed additives, substitution of low digestibility feeds with high digestibility ones, concentrate feeding etc. could lead to reduce methane emission.
- d) Different types of approaches to increase soil carbon, such as organic manures, minimal tillage and residue management should be adopted. Resource conserving technologies restrict release of soil carbon thus mitigating increase of CO₂ in the atmosphere.
- e) By using better designs of machinery, increasing fuel efficiency in agricultural machinery, commercialization of wind and solar power potential and use of laser levelers could lead to improvement in the efficiency of energy use in agriculture. All these results in helping mitigation.
- f) Changing land use by increasing area under bio-fuels, agro-forestry could also mitigate GHG emissions. This however, may have trade-off with goal of increasing food production.

III) Effect Of Environment On Agriculture

Cultivation practices are completely based on climatic situations. In the last three decades climate change is perceptible through a rise in all India mean temperature and increased frequency of extreme rainfall events. This causes fluctuation in production of major crops in different years. Impact of climate change on Indian agriculture was studied under National Innovations In Climate Resilient Agriculture (NICRA). The impact of climate change on agriculture in India are as follows:-

Crops :- A higher frequency of extreme weather events like floods, draughts and heat waves can reduce the overall crop yield and lower the quality significantly. High temperature encourage weeds and pests that eventually leads to reduce crop productivity. Changes in rain patterns also negatively affect crop productivity.

Water Resources :- When water precipitation levels are extremely low, it can lead to drought like situation. But due to global warming, the glaciers in the Himalayas melts and it may lead to increase water levels in the Ganges and the Brahmaputra rivers. In the long run, this would increase the availability of freshwater considerably. A significant increase in run off is projected in the wet season that may lead to increase in frequency and duration of floods and also soil erosion. However the excess water can be harvested for future use by expanding storage infrastructure.

Soil:- Changes in climate conditions are causing the quantity and quality of organic matter content in the soil to reduce. An increased percentage of carbon dioxide in the ambient air leads to crop residues with a higher C:N ratio. A higher C:N ratio can negatively affect the rate of decomposition and nutrient supply. Also, frequent variation in precipitation levels and wind intensity can alter the severity, frequency and extent of soil erosion which is definitely not good for the health of soil and crop.

Livestock :- Climate change has pronounced effect on feed production and nutrition of livestock. Increased temperature results in enhanced lignifications of plant issues and reduced digestibility. Climate change is likely to aggravate the heat stress in dairy, animals adversely affecting their reproductive performance.

The effects to combat climate change will have to focus on mitigation and adaptation efforts across all sectors. For a country like India, the task will be to ensure increased production without increasing the environmental footprint of agriculture by enhancing knowledge and skills of farmers

IV) Govt. Of India Initiatives For Climate Change Adaptation

The missions that are adopted by government of India aiming to combat global warming and for climate change adaptation. These missions implemented package of several technologies developed by the ICAR (Indian Council Of Agricultural Research) . some of these missions are described below -

National Mission On Sustainable Agriculture (NMSA) :- The Mission was structured under the National Action Plan On Climate Change (NAPCC) and made operational during 2014-15 . It aimed to synergize resource conservation, enhancing on restoring the soil fertility etc. Integrated Farming System(IFS) integrated animal component and Water Use Efficiency (WUE) is adopted specially in dry lands on rain fed agriculture areas.

Pradhan Mantri Fasal Bima Yojna (PMFBY) :- The scheme was introduced on 14th January, 2016 in order to reduce the agricultural distress and farmer's welfare without affecting substantial hikes in the Minimum Support Prices (MSP) on agricultural produces during monsoon fluctuations on any other natural calamity by providing full insured amount on crop losses.

Green India Mission (GIM):- The Mission was started in February, 2014 and outlined under NAPCC. The main objective of the Mission was to protect, restore and enhance the diminishing forest cover in India and to fight climate change with adaptation and mitigation measures.

National Action Plan on Climate Change (NAPCC) and State Action Plan On Climate Change (SAPCC) :-The NAPCC was released on 30th June, 2008 in order to create awareness among public, govts, agencies, industries, scientists and the society on the risks posed by global climate changes. It pulls all the existing government's national plans on energy efficiency agriculture, renewable energy, water and others. The SAPCC have enlisted climate adaptation and mitigation strategies aligned with eight national missions under NAPCC.

Agricultural Contingency Plans and National Innovations on Climate Resilient Agriculture (NICRA) :- Agriculture Contingency Plans are technical documents compressing integrated information on field crops, horticulture, poultry, fishery, livestock and technological solution for all weather related problems for the respective farming activities. NICRA is a Network project of the Indian Council of Agricultural Research (ICAR) started in February, 2011 with the objective of enhancing resilience of Indian Agriculture to adverse climate changes by adopting innovative technologies.

National Adaptation Fund :- The National Adaptation Fund For Climate Change (NAFCC) is a Central Sector Scheme which was set up during 2015-16. The overall aim of NAFCC is to support concentrate adaptation activities which mitigate the adverse effects of climate change. The projects related to adaptation in sectors such as agriculture, animal husbandry, water, forestry, tourism etc. are eligible for funding under NAFCC. The National Bank for Agriculture and Rural Development (NABARD) is the National Implementing Entity (NIE). Technologies generated by ICAR and State Government Universities are being implemented in coherent package to develop resilient capacity of vulnerable regions in India.

Along with the missions discussed above, National Adaptation Fund for Climate Change (NAFCC) Paramparagat Krishi Vikas Yojana (PKVY) National Livestock Mission, Neem Coated Urea, National Action Programme to Combat Desertification etc. are also implemented by Govt. of India as initiative for climate change adaptation.

In the face of increasing extreme climate events such as acute and frequent droughts, floods, desert locust attacks etc. the sustainable agriculture become so vital as it offers a much needed alternative to traditional input intensive agriculture. Sustainability in agriculture means that the land and resources that are being used for agriculture today are passed on to future generations in a sustainable way so that they can continue farming and have food security. India has already adopted different policies in order to make sustainable agriculture a success. Besides these, the following strategies may also help to scale up sustainable agriculture in India—

i) The focus on knowledge exchange and capacity building among farmers and agriculture extension workers on SAPs has to be increased.

ii) Through long run comparative assessment (between resource intensive and sustainable agriculture) in view of changing climate to inform long term resilient approaches to nutrition security; it may help in support rigorous evidence generation.

iii) Broadening perspective of stakeholders across the agriculture ecosystem in order to consider alternative approaches; as they are only exposed to resource intensive agriculture for the last six decades. A suite of strategies spanning evidence driven narratives to on ground field visits would help.

iv) Adopt transition support plans helps to attend short term transitional support to those who would get adversely impacted by a large scale transition to sustainable agriculture.

v) The data and information collection on sustainable agriculture practices should make visible in the prevailing agriculture data systems at the national and state level. On the absence of reliable data, it is difficult to ascertain the scale and extent of sustainable agriculture in India.

III. Recommendations –

1) There should be enhance investment in water storage and efficient water use technologies. Differential and better incentive mechanisms should given to the farmers and practitioners who practice Good Agriculture Practices (GAP) related to water and fertilizer saving, residue recycling and integrated farming systems. Having taking into consideration the changing rainfall patterns and decreasing irrigation water availability, there should be make investment in technologies that allow aquifer recharge and drip and sprinklers to increase efficient use of available water.

2) Strengthening research on development of adverse climate tolerant genotypes and land use systems may help in ensuing adequate food production. Biotechnology and modern tools of information technology, space technology and communication have great role to play in this.

3) Value added climate risk management services has to be provided to the farmers in the form of reliable weather forecasts and associated agro-advisories should be provided for the farmers in different agro climatic regions. Establishment of early warning system for emerging climate risks such as drought, floods, heat and cold waves and for pests and disease outbreaks are desired.

4) If agriculture has to provide environmental services i.e. the resource conservation (carbon, water, energy), then this will require farmers' additional time, energy, costs. Therefore the government should provide financial incentives to farmers.

5) Global climate changes affects food and livelihood security of millions of poor farmers and landless in the developing countries who have not contributed significantly to the emissions. Therefore international climate change negotiations should focus on mitigation of greenhouse gas emissions from industrial and other sources.

6) National adoption fund sponsored projects need to be region specific package of climate adaptive technologies implemented under these projects should be monitored by the experts and needful guidance to be taken periodically for better implementation.

7) Quantification of impacts should be made mandatory in the project sanctioning mechanisms. With such strategies, the much needed level of agriculture sector growth along with environmental sustainability can be attained.

IV. CONCLUSION

Global Climate Changes and increasing climate variability are likely to exert pressure on agricultural systems and may constraint attainment of future food production targets. Extreme temperature and its erratic events disrupt the activities of all the existing lives on the planet by means of severe damage or loss. Assessment of the impacts and a comprehensive understanding of the benefits of adaptation options over combating the uncommon incidents of climate change is pivotal in the current scenario to sustain life. To maintain ecosystem health and services under variable, unpredictable or unknown conditions, there is a need of more resilient systems, decentralization participatory research and breeding networks. At the same time increased involvement of the many stakeholders and scientists from outside plant pathology shows the importance of considering trade offs with other objectives. Increasing diversity would be in favour of a land sharing approach, but may be relevant also to land sparing sceneries (e.g. at the margin of fields), depending on the spatial and temporal scale and the type of diversity (genetic, species, species turn over, ecosystem) considered.

In order to adopt sustainable agriculture practices organic ways of farming is required. Similarly alternative agriculture techniques, such as intercropping, Zero Budget Natural Farming (ZBNF) with essential principles involving the enhancement of nature's process and elimination of external inputs can be practiced. At the budgetary level, significantly increase allocation to sustainable agriculture enabling its evidence backed scale up across the country. Above all of these, the national policy should focus from food security to nutrition security and yield to total farm productivity. It would help recognize the critical role that sustainable agriculture could play to ensure India's nutrition security in a climate constrained world.

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