



Sustainable Agriculture: A Framework for achieving UN Sustainable Development Goals (SDGs) in Indian Agro-climatic Region

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ABSTRACT

Sustainable Agriculture is a crucial role play in human food and health security because it provides rich nutritious food vitamins, minerals, antioxidants, fiber and other beneficial compounds. It can help to minimize diabetes, obesity, disorder and cardiovascular disease. In present concern in rapidly climate change, soil health issues and rising health trouble are key conflict to food and nutritional security in globally. Sustainable Agriculture provides suppress these challenges align with the Sustainable Development Goals (SDGs). The SDGs were taken-on all United Nations (UN) Member Countries in 2015. These are 17 SDGs highlight zero hunger, good health, climate action, life on land that can be achieve by 2030. These highlights exclusively connect between environmental, economic and social aspects. Agriculture Practices such as Organic and Natural farming, Integrated Weed Management (IWM), Integrated pest management (IPM), climatic resilient variety, water-efficient irrigation and climate-resilient technologies amplify productivity without harming ecosystems. This article discusses the concept of sustainable Agriculture, its role in human health and nutrition, linkage with SDGs and future strategies for strengthening agriculture-based sustainable food systems in India.

Keywords: Diversification, Environment, Human well-being, SDGs, Sustainable Agriculture, Nutrition security.

1. Introduction

Indian Agriculture occupies a unique position in Indian agriculture because it connects directly with human nutrition, health and livelihoods. Cereals, Pulses, Fruits and medicinal plants are essential for a healthy and productive life. In India, Food grain 376.5 million tonnes, Rice production (154 million tonnes) and Wheat production (120 million tonnes) output for 2025-26 (Anonymous 2025-26). It has made remarkable progress in agriculture production in recent years. The globally population are continuous rising become a major challenge of food insecurity, loss biodiversity and worry about limited resources. Further malnutrition, lifestyle diseases and environmental degradation continue to rise. One of the major reasons is the unsustainable way food

is often produced. Excessive use of chemical fertilizers, pesticides and water has degraded soils, polluted water bodies and raised serious food safety concerns. Under these conditions, sustainable agriculture has emerged as a practical and timely solution. It aims to produce nutritious food, protect natural resources and improve farmers' incomes at the same time. Globally population will gain 9 billion in year 2050 (FAO, 2017).

2. Geographical Dimensions

India Geography has much diversified nature which are various types found in different-different regions. It is mainly divided 15 agro-climatic zone by the planning commission on 1988. Which classification on the bases

of soil, Climate, physiography and length of growing period. Hence, every agro-climatic zones are faced several problems like shifting cultivation, floods, water

scarcity, Flood, waterlogging condition, riverbank erosion, ground water depilation, drought etc.

Table 1.1 Problems and Sustainable practices in Agro-climatic zone

No.	Agro-climatic Zone	Major Location	Major Problems	Sustainable Practices
1.	Western Himalayan Region	J&K, Himachal Pradesh, Uttarakhand	Soil erosion, landslides, water stress	Terrace farming, agroforestry, soil conservation, rainwater harvesting
2.	Eastern Himalayan Region	Sikkim, Arunachal Pradesh, parts of Assam & West Bengal	Jhum cultivation, soil erosion, landslides	Agroforestry, terracing, integrated farming, conservation agriculture
3.	Lower Gangetic Plains	West Bengal	Floods, waterlogging, salinity	Drainage, flood-tolerant crops, crop diversification, raised-bed farming
4.	Middle Gangetic Plains	Bihar, eastern Uttar Pradesh	Floods, waterlogging, soil fertility decline	Rice–pulse diversification, drainage, integrated nutrient management
5.	Upper Gangetic Plains	Western & central Uttar Pradesh	Groundwater depletion, rice–wheat monocropping	Crop diversification, micro-irrigation, conservation agriculture
6.	Trans-Gangetic Plains	Punjab, Haryana, Delhi, parts of Rajasthan	Groundwater depletion, stubble burning, soil degradation	Direct-seeded rice, crop diversification, residue management, drip/sprinkler
7.	Eastern Plateau & Hills	Jharkhand, Odisha, Chhattisgarh, West Bengal	Soil erosion, low irrigation, poor soil fertility	Watershed management, agroforestry, pulses/millets, organic amendments
8.	Central Plateau & Hills	MP, Rajasthan, Uttar Pradesh	Drought, rainfall variability, soil erosion	Watershed development, drought-tolerant crops, conservation tillage
9.	Western Plateau & Hills	Maharashtra, MP, Rajasthan	Drought, water scarcity, soil erosion	Drip irrigation, watershed management, pulses/oilseeds, mulching
10.	Southern Plateau & Hills	Karnataka, Telangana, Andhra Pradesh, Tamil Nadu	Drought, groundwater depletion, soil degradation	Micro-irrigation, millets, rainwater harvesting, soil-water conservation

11.	East Coast Plains & Hills	Tamil Nadu, Andhra Pradesh, Odisha, West Bengal	Cyclones, floods, salinity intrusion	Salt-tolerant crops, drainage, mangrove protection, crop diversification
12.	West Coast Plains & Ghats	Kerala, Goa, coastal Karnataka, Maharashtra	Heavy rainfall, soil erosion, landslides	Contour farming, terracing, agroforestry, cover crops
13.	Gujarat Plains & Hills	Gujarat	Drought, salinity, water scarcity	Drip irrigation, rainwater harvesting, salt-tolerant crops, watershed management
14.	Western Dry Region	Western Rajasthan	Desertification, drought, wind erosion, water scarcity	Drought-resistant crops, shelterbelts, rainwater harvesting, agroforestry
15.	Island Region	Andaman & Nicobar, Lakshadweep	Sea-level rise, salinity, cyclones, soil erosion	Mangrove/coastal protection, salt-tolerant crops, agroforestry, rainwater harvesting

3. Concept of Sustainable Agriculture

Sustainable Agriculture is system of agriculture that contest of the present need of food and nutrition fulfilled without inadequate effect on future generation with retain soil and environmental health. It is about an uplift biodiversity and encourage sustainable living and food productivity (Alexandra, 2022).

It is using of better use of resources and practices encourage sustainable farming. Diminishing dependency on chemical inputs and promote eco-friendly alternatives for safe Flora and fauna. Soil fertility maintains including practices such as Integrated Nutrient Management (INM), Organic compost, biofertilizers, organic mulching, crop diversification and precise irrigation. Farmers are adopting climate resilient varieties as well as contingent climate strategies to mitigate sudden weather-related issues like delay monsoon, drought or flood.

4. Role of Sustainable

4.1 Human Well-Being

Agriculture a basic fundamental key role in human to required for growth and development. It provides cereals, pulses, fruits, vegetable, milk and other food products which provide carbohydrates, protein, minerals, vitamins and antioxidant. Grains are highly rich vitamins, minerals and dietary fiber. Green leafy vegetables supply minerals like iron and folates. In fruit is Mango highly rich in vitamin A and Amla in vitamin C. Regular consumption of grains, pulses, fruit and vegetables uplift to prevent nutrient deficiencies. It is minimizing health

related disorder and disease. Several disorder viz. anemia (iron deficiency), osteoporosis (Ca deficiency), goiter (iodine deficiency). So, abundant amount of minerals are very important in our daily diet. These are only fulfilled by regular consumption of nutrient rich diet. Through this we will stay away illness (Lykogianni et al., 2021)

4.2 Environmental Well-Being

Sustainable is an emphasizes natural resources utilization in a responsible manner however maintaing ecological balance. It is managing healthy, resilient and biodiversity balance which support sustainable development. This combination will be provided to favorable microbial activity in soil health. Mulching is reduced evaporation on ground surface level and add on organic carbon (Niranjan et al., 2023). Integrated pest management (IPM) to uses of nature-based pesticide Neem oil (Azadirachtin) for white fly, thrips and caterpillar as well as bio pesticide Beauveria bassiana, Metarhizium anisopliae, Bacillus thuringiensis for control caterpillar in crops. Bio Fungicide Trichoderma harzianum to be suppress growth of many types of disease. Environmental well-being means in agriculture like various comprehensive practices encourage soil health, reduce food waste and integration of crops, the quality for farming (Karaka & Ince, 2023).

5. Sustainable Development Goals (SDGs)

United Nations (UN) formation of SDGs in 2015 for “A blueprint of Peace and prosperity people and the planet, today and for future”. The agenda of achieving 17 Goals

in 2030. Sustainable Agriculture aligns closely with 5 Goals global development priorities. Its contribution to the Sustainable Development Goals is measurable.

5.1 SDG 2 - Zero Hunger

Its aim is to end malnutrition and hunger, mainly in children by 2030. Worldwide children are affected around 155 million chronic malnutrition therefore children's growth and development stopped. Hence, increment in disease and death (United Nation report 2015). Agriculture increases availability of diverse and nutrient-rich foods. It is increasing productivity via. developing high yielding variety and adopted intercropping cropping system. These practices ensure stable production and reduce hunger and malnutrition.

5.2 SDG 3 - Good Health and Well-Being

The agenda of achieving universal health covering men and women for minimizing maternal mortality, reduces road injuries significantly uplift to life expectancy. Safe and nutritious food supports healthy lives. Reduced chemical residues lower health risks for both consumers and farm workers.

5.3 SDG 12 - Responsible Consumption and Production

It is strengthening global food production and consumption chain for reduces food losses include post-

harvest losses in agriculture commodities. According to Food and Agriculture Organization (FAO) said, globally 14 percent food lost (The State of Food and Agriculture 2019). Encouraging Framework to reducing food losses to adopt better framework supply chain management globally. Focus ensures sustainable production, efficient resource use, reduced waste and eco-friendly practices promote responsible production systems.

5.4 SDG 13 - Climate Action

Climate action is very urgent action because its impact already rose 1.2°C level global warming which stimulus melting glacier (Pathak et.al, 2022). Minimized use of carbon uses but increasing uses of wind, solar and other type of renewable energy for generating electricity. Modern agriculture focuses on generate significant role of crop residues, animal waste and food-processing. Precision nutrient management system adopted in climate-smart agriculture practices improve resilience and reduce emissions.

5.5 SDG 15 - Life on Land

The UN Assembly declared maintain economic, social and environmental coordination. So, increasing overall forest production that affect degraded land. Growing diversified and indigenous plants also provides habitat for pollinators, birds and beneficial insects. Biodiversity conservation and soil restoration protect terrestrial ecosystems.



6. Key Sustainable Agriculture Practices Supporting SDGs

6.1 Organic and Natural Farming

Organic farming to be define as use of organic inputs such as farmyard manures, compost, vermicompost,

green manures, biofertilizer and biopesticide rather than synthetic compound. Natural farming is a traditional farming system method involves Jeevamrit, Beejamrit,

Neemastra and Brahmastra to be used for managing pest & disease infestation. This farming method emphasize to build favorable micro climate in soil (Rhizosphere) which in case microbial growth for maintain soil fertility and productivity (Sharma, 2023). Its practice can minimize farmers agriculture input cost and strengthen output production as well as managing biodiversity on persisting on land. Efficient use of natural resources amply beneficial insect predator (ladybird beetle), Parasitoid, microbes to maintain ecological cycle.

6.2 Water-Efficient Irrigation

Earth occupied about 96.5% salt water. Only 2.5% is fresh water and most frozen in ice form which can be further utilized in efficient manner. Climatic change to be uncertainty precipitation result of adversely impact ground water recharge that mostly water consumption in agriculture sector for crop production and livestock. So, adopt precise irrigation system to overcome these challenges. Drip irrigation, sprinkler irrigation and smart soil sensors technically use in precise and efficient manner and efficiently which save 70-80% water. Addition rainwater harvesting technology and farm ponds to be collect runoff water for contingent uses for irrigation and other uses.

6.3 Soil Conservation

Detachment, transportation and deposition of soil from one side to another side due to wind and water are known as soil erosion. It is losses of soil fertility and productivity which is very important issue for future farming. So, soil conservation is mainly important to conserve soil and retain fertility. Important practices are mulching and cover cropping use for plains areas. Contour and Terrace farming are cuts to hills form of steps across the slop for hilly areas. These practices are brought down soil erosion and land degradation. In additional conserve soil moisture minimizing number of irrigations rather than high demand of water.

6.4 Multiple cropping system

Growing of two and more than crops together in a respectively manner same farm field is known as Intercropping. Viz. Wheat + mustard, Maize + greengram, ground + pigeonpea, sorghum + pigeonpea. Relay cropping system a growing of two or more crops before first crop harvesting, sowing second crop hance four crop in yearly. Multistorey system more than plant in different Hight like coconut + Black pepper + cocoa +Pineapple (Zhang et al., 2022). These are practices to influences high production in a limited land uses for global food security.

6.5 Conservation Agriculture

Conservation agriculture farming that goal to enhance crop production balance with soil, water, biodiversity and environment. It is emphasis reduced soil erosion,

reduced farming cost, conserve soil moisture, improve soil fertility, diverse microbes' population, improve soil structure rather than high-cost input and degraded soil degradation (Pittelkow et al., 2015). Practices like minimum tillage or no tillage, maintain crop residues are significant role play in sustainable environment. Avoid heavy uses of machinery and minimum disturbance of soil.

6.6 Crop diversification

Crop diversification is a shifting towards Changing cropping pattern in sequence which are adopted without repetition of same crops in whole of year. Key principle of crop diversification is very significantly role plant in soil diversification such as physical, chemical and biological condition. Soil's cation pH, Ec, Cation exchanging capacity (CEC), mineralization, microbes' growth, are nutrient availability directly affect soil health. Thumb rule is crop changing to cereal, pulses, oilseed and other family crop in an alternate align i.e. Wheat-gram-greengram in one year (Li et al., 2019).

6.7 Integrated Farming System

Integrated farming system (IFS) is combination of more than enterprises such as crop production, horticulture, dairy farming, poultry, goat rearing, beekeeping, fish farming managing together on same farm for emphasizes farm income. The goal of IFS is mitigating risk barrier, efficient uses of resource and maintain sustainability (Silici et al., 2015). It is a cyclic process to be gain synergistically outcomes which are help one enterprise to be managing other enterprises. Crop production, dairy farming and fish farming which theses are integrated in each other's. Crop produces biological product to be used dairy feed material; cow dung is used to be manures input of crop production and addition of fish pound water uses irrigation in field and other uses on farm. Thus, integration of enterprises to help rise farm income and suppress risk.

6.8 Protected cultivation and Mechanization

Protected cultivation, modern technology is growing of vegetable and flowers in off season without affecting climatic factor like precipitation, temperature and humidity. It is modernized well mortified structure such as poly house, net house and glass houses raise plant in a fully a controlled manner. They can control sunlight, temperature, humidity, carbon dioxide concentration etc. which are required of plants. Hydroponics farming and vertical farming system is farming of crops in nutrient rich water rather than soil media. They can manage diseases and pest very effective manner. Arability of diverse food product in all season and other perspective of farmer's secure income for better livelihood stander. Mechanization of farm are adopted farm machinery tractor, seed drill, rotavator, power tiller and reaper which work take on very fast in consuming minimum time for attain maximum output. Its secure maximum profit acquires and gave more production in minimum

uses of inputs.



7. Indian Perspective on Sustainable Agriculture

India stand is reflecting agriculture production recent decade increasing production which consumption in national and international levels. This is possible because adopted sustainable practices to be emphasizes production with retain productivity. It is globally exporting agriculture products 53,242 USD million in 2024-25. UAE, Saudi Arabia, USA, Iraq, Vietnam, Malaysia, Bangladesh, Benin and Iran countries are major trade partner with India that countries share about 49% total export in 2024-25. Non-Basmati rice, basmati rice, fresh fruit & vegetable, groundnut, dairy product and poultry are top export commodities in agriculture trade. Organic product demand increases very rapidly 147 USD billion in 2023 (IFOAM-Organic International report 2025). Awareness increasing to health consciousness people are preferred healthy and chemical free food that overcomes disease and disorder. The Indian government are built a specific organization and institution which are focusing on specific filed as NPOP

supervision and regulate of organic production, APEDA for Agri export with DGFT. ICAR established for agriculture research Centre in various location specific region which specific categories viz. NDRI Karnal for dairy research, CIAH, Bikaner for arid horticulture etc. In addition of Govt. run various types of schemes like RKVY, PKVY, PMKSY, SMAM and PM-KISAN that provides financial assistance for adopted technology and magnify income. PM-Fasal Bima scheme (PMFBY) accrued crop insurance in again adverse climate change like drought, hails and natural disaster. India's SDGs current status supervision under NITI Aayog, 94th rank out of 169 countries. India's only 33.33% SDGs targets are achieved by 2030 (UN Sustainable Development Report 2026). Policy is confirming innovation, research and farmer integration together necessary (Gupta et al., 2022). Comprehensive approaches to be strengthen farmer root for elevate livelihood stander and extension of farm money in a retain diversify environment.



8. Conclusion

Sustainable Agriculture is a unified strategy to encourage human well-being to secured nutrition and food security. Its conservation of environment through efficient soil health management, water conservation and biopesticide for retain biodiversity. Dynamic biodiversity aligns with United Nations (UN) SDGs to achieving globally for glowing sustainability that reduced poverty better emphasized good health. Today's Climatic Uncertainty are hazardous challenges which uncertainly rain, drought and flood. This challenge overcomes to adopt climate resilient varieties, Alonge with contingent climate strategies flexibility to move on within condition. Protected cultivation grows offseason crops and post-harvest management practices adopted to reduce food spoilage. The Government also supporting institution with financial support throw various types of schemes RKVY, PMKSY and PMFBY etc. Consequently, Sustainable Agriculture a pathway on the way to dynamic environment, resilient farming and secure present and future generation.

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