**Sustainable Agriculture and Food Security in India**

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**ABSTRACT:**

In a country like India, food security has taken on paramount importance due to its rapidly growing population, which is increasing at a geometric rate, while agricultural production can only keep up at an arithmetic rate. Addressing this challenge will require substantial efforts aimed at sustainable agricultural production, meeting the escalating food demands, curbing food losses and waste, and ensuring that those suffering from hunger and malnutrition have access to nutritious food. To achieve this, it's imperative to adopt holistic and integrated sustainable agricultural practices that encompass both production and consumption. India's population is anticipated to reach 1.668 billion by 2050, necessitating a substantial boost in food production to cater to this exponentially growing populace. Agriculture plays a pivotal role in enhancing food availability, preserving the food supply, and ultimately ensuring food security. However, this task is made more complex by the impact of climate change on agriculture. Sustainable agricultural practices must be founded on the capacity of farmland to continually yield food to meet human needs while also considering the sustainable impact on the environment. Hence, sustainable agriculture must encompass comprehensive approaches and exhibit adaptability and flexibility over time to effectively respond to the demands for increased food production. This chapter is intended to raise awareness about food security and sheds light on the prospects of sustainable food production and security for the betterment of human society.

**Keywords:** Food Demand, Population, Climate, Crop Production, Sustainable Agriculture

**INTRODUCTION**

Agriculture holds a substantial share, approximately 18.8%, of India's gross value added (GVA) and stands as the largest employer of the workforce, as per the 2021-22 Economic Survey. Agricultural sustainability entails the effective management of agricultural resources to meet evolving human needs while simultaneously preserving or enhancing environmental quality and conserving natural resources, as articulated by Gregory in 1989. Sustainable agriculture encompasses practices that protect the environment, conserve natural resources, reduce chemical usage, and foster economic independence. In countries like India, characterized by a significant population below the poverty line and high production technology expenses, sustainable agriculture becomes both an economic and environmental imperative. Therefore, progress should be assessed using both qualitative and quantitative criteria, considering the impacts of agricultural development on social, environmental, and health aspects. Attaining food security is of paramount importance for achieving the Sustainable Development Goals, particularly in a nation like India where over 20% of the population lives below the poverty line. According to the Global Food Security Index 2022, India grapples with challenges such as a 16.3% prevalence of undernutrition, 30.9% of children experiencing stunted growth, 33.4% being underweight, and 3.8% suffering from obesity. The International Food Security assessment for 2022-23 notes that India, owing to its vast population, significantly influences food insecurity trends, accounting for 65% of the food-insecure population in the same period. Over the next decade, the number of food-insecure individuals in India is projected to decline to 24.7 million, constituting 1.7%. National Food Security plays a pivotal role in economic development and poverty alleviation by providing nutritional support and enhancing livelihoods.

Food security is a concept that has undergone a gradual evolution in its meaning and scope over time. Traditional notions of food security primarily revolved around straightforward measures like domestic food production, grain storage, national self-sufficiency in food, and food utility. With the burgeoning global population, there has been a surge in food consumption, posing substantial challenges for agriculture. These challenges are further compounded by the adverse impacts of climate variations and climate change, soil and land degradation, and the depletion of vital resources such as freshwater, phosphates, fossil fuels, and fertile topsoil. Projections indicate that annual crop yields are expected to increase by less than 1% in the coming decades, and the availability of arable land for expansion is exceedingly limited (as observed by Alexandratos and Bruinsma in 2012). As the global population continues to grow, the overall demand for food is on the rise. Additionally, increased income and economic development have prompted dietary shifts toward meat and animal products, which are more resource-intensive to produce (FAO, 2010). To address the challenges of food scarcity and increasing food demand, technology plays a crucial role. This encompasses the development and utilization of nutrients, pest control solutions, crop cultivation techniques, and advanced farm equipment. It also encompasses the concept of genetically modified crops designed to offer enhanced nutritional efficiency, such as increased calorie yield or greater overall yield. Furthermore, it involves the manipulation of natural pest control agents and the implementation of farm management practices that emphasize long-term whole farm productivity, rather than focusing solely on annual production per hectare (as described by Stone and Pedigo in 1972). Achieving sustainable agricultural growth requires the adoption of economically and environmentally sustainable agricultural practices, offering a viable approach to address the challenges of food security resulting from population growth and environmental degradation (as discussed by Simon et al. in 2013).

**SUSTAINABLE AGRICULTURE**

The term 'sustain,' derived from the Latin sustinere (combining 'sus-' meaning from below and 'tenere' meaning to hold or maintain), embodies the idea of long-term support and permanence. In the context of agriculture, sustainable agriculture refers to farming systems that can consistently maintain their productivity and societal utility over an extended period. These systems should effectively conserve resources, provide social benefits, remain competitive economically, and exhibit environmental responsibility. Sustainable agricultural systems are strategically developed to make the most of existing soil nutrients and water cycles, energy dynamics, beneficial soil microorganisms, and natural methods of pest control. This approach helps minimize the potential for environmental harm by harnessing existing cycles and processes (as discussed by Chel & Kaushik in 2010). Sustainable agricultural practices have gained significant recognition due to concerns about the environmental consequences of modern agriculture, agriculture's reliance on finite resources, and the long-term productivity of agricultural systems heavily dependent on substantial external inputs (as emphasized by Leal Filho in 2000).

Sustainable Agriculture presents an alternative approach to addressing both fundamental and practical issues, as highlighted by Lal in 2008. While Green Revolution agriculture predominantly focused on productivity concerns, Sustainable Agriculture goes a step further, placing a stronger emphasis on productivity while also considering the multidimensional aspects of sustainability, including economic, environmental, and social dimensions, as noted by Rao and Rogers in 2006. Sustainable agriculture encompasses environmentally responsible, economically viable, socially equitable, culturally appropriate practices rooted in a comprehensive scientific approach, as outlined by Kandula in 2004. India's Agriculture Policy from 2000 defines sustainable agriculture as an approach that integrates technical comprehensiveness, economic feasibility, environmental non-degradation, and social suitability. It involves farming systems and methodologies that maintain or enhance the economic sustainability of agricultural production, safeguard natural resources, and consider various factors influenced by agricultural activities.

Indian government started the National Mission for Sustainable Agriculture (NMSA) in 2014-15.

Sustainable Agriculture pursues to integrate three main objectives into their work:

● A healthy environment

● Economic profitability

● Social and economic equity

To ensure a sustainable agriculture system, stakeholders in the food chain, such as producers, food processors, suppliers, retailers, consumers, and waste management, can all contribute.

The foundation of sustainability is the idea that we must satisfy our current needs without compromising the capacity of future generations to satisfy their own.

Agriculture has undergone significant transformations since the conclusion of World War II. Advances in techniques, machinery, increased chemical utilization, and the implementation of various government policies aimed at boosting food production and reducing prices have led to a substantial increase in food and fiber productivity. Consequently, numerous farmers are now able to produce more food and fiber at lower costs.

Sustainable Agriculture is not a singular, precisely defined objective. The scientific understanding of what constitutes sustainability in terms of the environment, society, and the economy is continually evolving and influenced by a multitude of factors. For instance, agriculture's capacity to adapt to climate change wasn't regarded as a critical concern two decades ago, but it has now garnered increasing attention. Furthermore, the specific criteria for what defines a sustainable system may vary from one set of conditions, such as soil types, climate, and labor costs, to another. They can also differ from one cultural and ideological perspective to another, leading to the term "sustainable" being a matter of ongoing debate. Hence, it is more constructive and pragmatic to consider agricultural systems as existing along a continuum from unsustainable to highly sustainable, rather than forcing them into a simple sustainable/unsustainable categorization.

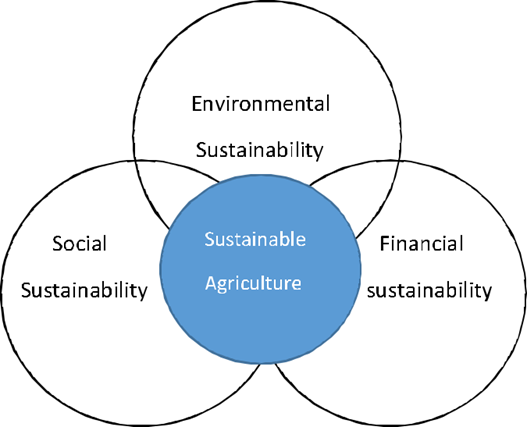


Fig: 1 Components of sustainable agriculture.

Goal oriented methods can be implemented and assessed for sustainability in agriculture (Von Wiren-Lehr (2001). The objective of sustainable development is to eliminate hunger, achieve food security, and improved nutrition. Some of the inter relationships that supports sustainable agriculture are to handleclimate change, endowing small farmers, promoting gender equality, removing poverty and ensuring healthy lifestyles,.

Sustainable agricultural practices and food systems encompass both the production and consumption of food products, and they should be approached from a holistic and integrated perspective. Key inputs for food production, such as land, soil, water, and plant resources, are of utmost importance. However, the increasing global demand for food has led to growing scarcity of these resources in many parts of the world, emphasizing the need to use and manage them sustainably.

Boosting yields on existing agricultural land involves not only enhancing the productivity of fertile areas but also restoring degraded land through sustainable agricultural practices. Effective management of limited water resources, along with the adoption of improved irrigation and storage technologies, can contribute significantly to sustaining the productivity of arid and semi-arid regions. Additionally, the development of new crop varieties that are more resilient to drought conditions plays a crucial role in achieving these sustainability goals.

**FOOD SECURITY**

Food security pertains to the continuous availability, accessibility, and affordability of food for all individuals at all times, underscoring its status as a fundamental human right. The right to food is intrinsically linked to the right to life, as stipulated in Article 21 of the Constitution of India, 1950. The concept of "food security" encompasses both physical and economic access to food, with accessibility encompassing both the presence and affordability of food. Food security can be defined as ensuring that every person, at all times, has the means to obtain enough safe and nutritious food to sustain a healthy and active life, as articulated by The World Food Summit in 1996. The World Health Organization (WHO) recognizes that food security comprises three critical components: "food availability," "food access," and "food use." Notably, the Food and Agriculture Organization of the United Nations (FAO 2009) introduced a fourth dimension, which is "the dependability of the first three aspects of food security over time." As such, food security is a multi-dimensional and intricate concept.

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It has following dimensions:

● Availability: It means food production within the country, food imports and the stock

stored in government granaries.

● Accessibility: It means food is within range of every person without any discrimination.

● Affordability: It implies that having adequate money to buy enough, safe and healthy

food to meet dietary needs.

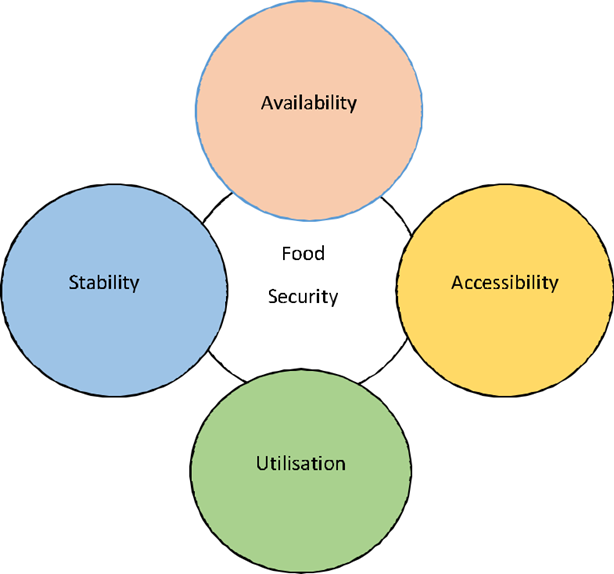


Fig: 2 Dimensions of Food Security

Thus, a nation can only be guaranteed food security if there is enough food for each and every person, if everyone makes enough money to buy food of a reasonable caliber, and if there are no obstacles in the way.

India aspires to attain self-sufficiency in food production, which is integral to upholding national food security. Simultaneously, to bolster domestic food security, it is imperative to foster economic growth that elevates the income and purchasing capacity of disadvantaged populations. Furthermore, agricultural regulations play a pivotal role in securing food access within the country by establishing fixed procurement prices for food grains and implementing public distribution systems. These measures remain essential even when achieving self-sufficiency at the national level. Governments play a significant role in governing and stabilizing a substantial portion of the food supply through these interventions. However, inefficient pricing mechanisms can lead to undesirable consequences and hinder access to food supplies. Despite India's remarkable economic growth in recent years, it has yet to overcome persistent challenges related to poverty and food security. Food represents a fundamental and indispensable necessity for an individual's sustenance, development, and growth. While the Indian government has proactively addressed household food security through initiatives such as the Public Distribution System (PDS) and the National Food Security Act (NFSA) of 2013, concerns about food security persist, particularly in the face of increasing population, climate change, and global supply disruptions like the Russia-Ukraine War. These issues demand continued attention and resolution.

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**Issues and challenges related to Sustainable Agriculture and Food Security in India** -

**Challenges related to Sustainable Agriculture:**

1. Rising Population and degraded Ecosystem: Growing population and damaged ecosystem have made intensive, conventional farming (using HYV seeds and chemical fertilizers) and deforestation more resilient.
2. Lack of capital: Large portions of the agricultural community (Small and medium farmers) lack 2the funds necessary to make the switch to Sustainable Agriculture production.
3. Lack of Access to information & Technology: There is a lack of access to information and technology to enhance agriculture practices, processing and marketing of agricultural products.
4. Lack of Economic Incentives: Farmers are uncertain of the benefits of switching to

Sustainable farming.

1. Lack of Public Policy & Infrastructure: Public policies and fundamental infrastructure are insufficient to encourage the use of Sustainable Agriculture.

**Current Framework for Sustainable Agriculture in India:**

**National Mission on Sustainable Agriculture:** Its goal is to increase Agricultural productivity, particularly in rainfed regions, by emphasizing integrated farming, managing soil health, and coordinating resource conservation.

**PradhanMantriKrishiVikasYojna (PMKVY):** The PMKVY program intends to encouragecommercial organic production by involving a group of farmers in organic farming.

**Network Project on Organic Farming of ICAR:** Its goal is to compare the performance of important agricultural systems that are peculiar to a given place under organic and conventional farming and estimates the agronomic efficiency of various production systems.

**Challenges related to Food Security:**

**Declining Soil Health**: Important element responsible for food production is healthy soil so good quality soil is required and its quality is declining due to various climatic and anthropogenic factors. Due to excessive, unsuitable use of agrochemicals and deforestation as well as natural disaster is an important challenge for the sustainable food production. About 33% of the soil of globe is already degraded.

**Climate change:** The monsoon contributes to approximately 70% of India's annual precipitation and serves as the primary water source for irrigating 60% of the country's net sown area. Agricultural land utilization and food production are significantly influenced by the limited availability of water for irrigation and various other contributing factors. India is experiencing the effects of climate change, including rising temperatures, irregular and inadequate rainfall, and an increasing occurrence of extreme weather events. These factors collectively exert adverse impacts on food production systems and agricultural development. Several reports have indicated that climate change plays a substantial role in the heightened frequency of extreme events, such as floods and droughts. Alterations in precipitation patterns and the escalating frequency and severity of extreme weather events, such as heatwaves and floods, are already diminishing agricultural productivity in India, posing a significant threat to food security.

**Crop Diversification:** In recent times, agricultural scientists have placed significant emphasis on the adoption of crop diversification. This shift is primarily driven by the stagnant prices of food grains, such as rice and wheat, resulting in low returns for farmers. By encouraging farmers to focus on cultivating different crops, they stand to attain more substantial profits. Another proposed solution is the establishment of decentralized food grain banks at the block or district level, which would enable rural communities to access subsidized food. This innovative concept aims to enhance the distribution of food grains while simultaneously reducing instances of corruption.

**Supply Chain Distribution due to Unstable Global Order:** In 2022, the Russia-Ukraine War disrupted the global supply of food grains, leading to food scarcity and price hikes, during a period when the Covid-19 epidemic had already affected food supplies worldwide in 2020.

**Current Framework for Food Security in India:**

**Buffer Stock:**Buffer Stock is the stock of food grains, particularly wheat and rice . The public sector of India maintains Buffer Stocks to ensure food security and prepare for unexpected situations like drought, starvation, conflicts, etc. Food Corporation of India (FCI) stored stock of foodgrains at MSP. The stocking of food grains was first implemented in 1969 during the 4th Five Year Plan (FYP). The objectives of Buffer Stock are :

* Better return for farmers
* Food Security
* Price Stability
* Foodgrains for welfare programs

**Public Distribution System:** The Public Distribution System (PDS) in India is a government - run program that aims to distribute essential food items to the economically vulnerable population at subsidized rates. PDS was a general entitlement scheme for all consumers till 1992 but in 1992, it became Revamped PDS (RPDS) which focused the poor families. RPDS became Targeted PDS (TPDS) in 1997 and established Fair Price Shops for the distribution of foodgrains at subsidized rates. The objectives of the PDS are :

* To provide essential food items at affordable prices.
* To hunger and malnutrition among economically weaker section.
* To prevent black marketing of food grains.
* To stabilize prices of essential commodities in the market.

**National Food Security Act. 2013 (NFSA,2013) :** Through ensuring access to a sufficient amount of high-quality food at reasonable rates, the National Food Security Act of 2013 seeks to ensure people's food and nutritional security. 75% of India's rural population and 50% of its urban population are eligible for subsidized food grains under the NFSA 2013 through the Targeted Public Distribution System (TPDS), which had a value of around 81.35 crore as per the 2011 Census.

**Conclusion:** Sustainable Agriculture is the approach that seeks to uphold equilibrium between the escalating food demand and future food production. As population growth, shifts in income demographics, and evolving food preferences occur, the demands for the food needs of the future population also undergo changes.

Sustainable Agriculture must incorporate social, economic and environmental sustainability which is essential. As population is growing day by day, resources are getting depleted, and risk of climate change is increasing, it will be impossible to meet future needs unless we shift to sustainable food and agricultural systems that make sure food security in India.Therefore, depending on the demand of the food toward increasing population, the active and sustainable agricultural research is required to fight against hunger and sustain the food security.

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