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IN INDIA: VISION 2030**

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ACHIEVING SUSTAINABLE FOOD SECURITY IN INDIA: VISION 2030

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Abstract

India's growing population, projected to exceed 1.4 billion by 2030, intensifies the country's food security challenges. This paper examines the evolving landscape of food security in India, highlighting the urgency of addressing issues in food production, distribution, and access. With agriculture as the primary sector, climate-resilient approaches are essential to withstand unpredictable weather patterns. Sustainable farming practices, technological advancements, and crop diversification are evaluated for their potential to boost agricultural productivity. Emphasis is placed on precision agriculture and innovative techniques to increase yields and conserve resources. Market dynamics and distribution systems are analysed to ensure food availability and accessibility. Government policies, including subsidies, public distribution systems, and safety nets, are assessed for their impact on food security, alongside the influence of international trade agreements. The paper advocates for comprehensive policies encompassing sustainable agriculture, resource management, improved market access, and enhanced nutrition, with technology as a key driver of change. It aims to provide actionable insights for achieving equitable food access in India by 2030.

Keywords: Food Security, Sustainability Farming, Sustainable Development, Food Supply Chain, Social Safety Net

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I. Introduction

Agriculture assumes a pivotal role in securing not just sustenance but also adequate nutrition, serving as the bedrock for food production, an essential aspect in achieving nutritional security. Extensive research consistently underscores the significance of agricultural growth in reducing malnutrition. The correlation between agricultural advancement and nutrition is robust, emphasising the critical role of increased food production in bridging the gap between agricultural progress and improved nutrition. This nexus is particularly evident in India, where historical emphasis on food security revolved around grain sufficiency. While meeting dietary energy needs through grains is undeniably crucial, the importance of dietary diversity cannot be overstated in fulfilling broader nutrient requirements. Studies illuminate the multifaceted shifts in India's food consumption patterns due to factors such as economic growth, demographic changes, and evolving lifestyles. As income levels ascend, there's a notable increase in the availability and consumption of diverse food items, particularly high-value horticultural produce and animal-based products. This transformation in dietary habits marks a notable departure from traditional reliance solely on staple grains. This shift towards a more diverse and nutrient-rich diet in India holds immense promise, poised to yield positive impacts on overall health and nutritional outcomes. However, while acknowledging this trend's potential, it's essential to recognise the multifaceted dimensions of food security. A comprehensive understanding acknowledges that meeting energy requirements solely through grains might not suffice in addressing broader nutritional needs. As dietary preferences evolve and incomes rise, the availability of a diverse range of food commodities plays a crucial role in shaping consumption patterns and nutritional outcomes. Therefore, while India has made significant strides in achieving food security, acknowledging the pivotal role of agriculture in providing not just sustenance but also nutritional adequacy is crucial. This understanding forms the basis for policy frameworks that can adapt to changing dietary preferences and promote diverse agricultural production. By embracing this holistic approach, India can further bolster its efforts towards securing both food and nutritional security for its populace.

Food security is based on availability, access, utilisation, and stability which act as the four pillars of food security. Availability, the first dimension, ensures ample physical food for people's needs. Analysing India's major crop production, yield, and cultivation areas from 1950-51 to 2020-21 showcases India's transformation from a food-import-dependent nation in the 1960s to a significant agricultural exporter today. Despite substantial production growth, per capita food grain availability has plateaued, lingering around 510.1 grams per day in 1991 and sustaining at 507.9 grams per day in 2021. Assessing trends in protein and calorie production unveils a decrease in crop-derived proteins and calories, paralleled by an increase in animal-based food sources. Alarming food inflation in cereals, vegetables, and spices, especially in September 2022, poses significant hurdles for economically disadvantaged individuals in accessing adequate nutrition. However, implementing measures like export restrictions or subsidies to counter rising food prices may escalate global agricultural prices, impacting various regions. Utilisation, the second dimension, pertains to the biological utilisation of food, including a diet offering sufficient energy, essential nutrients, clean water, and proper sanitation. Analysis of nutrition indicators based on NFHS data, such as stunting, wasting, underweight, anaemia, and obesity, between 2015-16 and 2019-20, illustrates concerning state-wise patterns. Severe anaemia, particularly among women, persists across India, reflecting underlying issues related to hunger. Access, the third dimension, denotes economic access to food. Despite essential commodities being exempted from movement restrictions during the pandemic in India, farmers encountered market access challenges, leading to significant food wastage. The surge in food prices, especially in cereals, vegetables, and spices, intensified economic hardships, particularly for low-income groups. Studies indicate that even a slight increase in food inflation correlates with elevated rates of infant and child mortality and undernourishment, underscoring the grave repercussions of such economic pressures on vulnerable populations. Stability, the fourth dimension, aims for consistent access to food over time. Achieving stability necessitates mechanisms to counter price fluctuations and ensure a constant supply of nutritious food. Strategic planning, reserve management, and effective distribution systems are critical components in addressing food stability concerns. These multifaceted dimensions collectively reflect India's intricate food security landscape, highlighting challenges in availability, access,

utilisation, and stability that need comprehensive, coordinated efforts to ensure a nourished and resilient populace.

The deteriorating nutritional scenario in India demands a transformative shift in agricultural practices. M. S. Swaminathan (2010) discusses the strategies and advancements in agriculture needed to achieve food security in India, focusing on sustainable practices and technological innovations. Recent efforts have been made to enhance affordability and access to nutritious food. Despite millet production being concentrated in a few states, a coordinated effort involving both demand and supply-side measures is crucial to boost their popularity, production, and consumption. Millets, being cost-effective alternatives, can encourage dietary diversity, ensuring that no one is left behind in accessing nutritious food. Additionally, strategies need to be devised to minimise food wastage. According to the Food Waste Index Report 2021, Indian households around 50 kg of food per person is wasted annually. Addressing this issue is imperative to curtail wastage and improve resource utilisation. Agriculture contributes significantly to India's gross value added (GVA), accounting for about 18.8 per cent and employing a substantial portion of the workforce in 2021-22. There's an urgent need to realign the long-term trajectory of agri-food systems not only to bolster farm incomes but also to ensure widespread access to safe and nutritious foods. This necessitates a shift towards sustainable practices that minimise environmental impact and address climate concerns. Moreover, the link between food, nutrition, and overall health is evident. Inadequate nutrition doesn't only affect individuals but also influences broader societal outcomes. Intergenerational malnutrition perpetuates from undernourished mothers to low birth-weight babies, continuing through childhood and adolescence due to limited access to healthcare, inadequate feeding, early marriages, and frequent pregnancies. This cycle hampers cognitive and physical development, leading to poor educational and economic achievements, thereby perpetuating poverty. This vicious cycle can be broken through timely interventions. A higher proportion of inadequately nourished individuals results in increased morbidity, mortality rates, and adversely impacts a country's overall income. Addressing these issues is crucial for holistic societal development and economic progress.

II. The Question of Food Accessibility in India

The idea of food security embodies universal accessibility, encompassing both physical availability and economic affordability, crucial for sustaining a healthy and productive life. The most vulnerable segments of society, particularly daily-wage labourers, encountered acute food scarcity during these crises. In India, although essential commodities were exempted from movement restrictions amid lockdowns, farmers grappled with restricted access to markets, leading to substantial food wastage. Simultaneously, panic-induced hoarding by the middle class disrupted established supply chains, further exacerbating the situation. The mere existence of food within a country, however, is insufficient to ensure access for all. The economic accessibility of households to adequate food is contingent upon their purchasing power, a metric often gauged through food inflation. Raghav Gaiha and Vani S. Kulkarni (2005) analyse the link between food insecurity, malnutrition, and socio-economic inequality in India. They provide policy recommendations to address these issues. Low-income groups bear the disproportionate burden of food inflation, as a larger proportion of their earnings is allocated to food expenditures. The escalating prices render food unaffordable for these vulnerable populations, exacerbating poverty and perpetuating financial strain. In September 2022, India experienced an alarming 8.6 per cent year-on-year surge in food costs, with vegetables (18.05 per cent), spices (16.88 per cent), and cereals (11.53 per cent) registering the most significant spikes in nine years. Extensive studies, including one conducted by the ADB, have established a direct link between food inflation and adverse health outcomes. Even a marginal one percent increase in food inflation corresponds to a 0.3 per cent rise in infant and child mortality, alongside a 0.5 per cent increase in undernourishment. This intricate interplay between economic factors, rising food costs, and its severe implications on the well-being of vulnerable populations underscores the critical need for concerted efforts to alleviate food inflation's impact, ensuring equitable access to food for all segments of society. India faces approximately 40 per cent wastage in food production annually, attributed to fragmented systems and inefficient supply chains. The consequential loss of 11,520 tonnes of stored food grains in government godowns between 2017 and 2020, amounting to about Rs 150 million, underscores the severity of this issue. Tackling food waste aligns with Sustainable

Development Goal 12's objective of halving food waste and reducing loss across supply chains by 2030.

The Food Waste Index Report 2021 by UNEP revealed that an estimated 930 million tonnes of food, constituting 17 per cent of all consumer-level available food, was wasted globally in 2019. The primary contributors to this waste were households (11 per cent), followed by food services (5 per cent) and retail outlets (2 per cent). Interestingly, per capita food wastage was notably higher in West Asian and sub-Saharan African nations compared to many South Asian, European, and North American countries. This challenges previous notions of higher food waste occurring primarily in developed countries. Within South Asia, countries like Afghanistan, Nepal, Sri Lanka, Pakistan, and Bangladesh reported higher levels of food wastage, with figures ranging from 65 kg to 82 kg per person per year. India stands among these nations, with a recorded 50 kg per person annually, although this figure remains comparatively high. However, it's crucial to note that excessive food waste often finds its way into landfills, leading to the release of potent greenhouse gases, significantly impacting the environment in adverse ways.

III. Determinants of Food Security in India and Major Gaps

Food security hinges on various interconnected factors that collectively ensure access to nutritious food for all individuals within a population. In India, while progress has been made in certain domains, several key determinants are still lacking on a nominal scale, impeding comprehensive food security.

Agricultural productivity is fundamental, yet it's hampered by outdated farming methods, inadequate infrastructure, and the adverse effects of climate change. Insufficient irrigation facilities, reliance on traditional techniques, and erratic weather patterns contribute to yield variability, making it challenging to consistently meet food demands. Distribution systems play a pivotal role in ensuring food reaches those in need. However, infrastructural deficiencies, especially in rural areas, hinder efficient transportation and market access. Consequently, disparities persist in food availability, exacerbating food insecurity among marginalised communities. Economic stability is crucial for individuals to afford sufficient and nutritious food. Despite economic growth, income inequality and

poverty levels persist, limiting people's purchasing power and access to diverse food options. This disparity perpetuates the cycle of food insecurity, particularly among vulnerable populations. Environmental factors further exacerbate food security challenges. Water scarcity, soil degradation, and environmental degradation threaten agricultural sustainability, jeopardising future food production. Without adequate measures to mitigate these issues, long-term food security remains uncertain. Government policies and interventions are instrumental in addressing these challenges. However, gaps in implementation and inadequate social safety nets undermine their effectiveness. Strengthening governance structures, enhancing market infrastructure, promoting sustainable agricultural practices, and expanding social protection programs are crucial steps toward achieving comprehensive food security in India. Overall, addressing these missing factors requires a multifaceted approach, encompassing policy reforms, infrastructure development, community empowerment, and sustainable agricultural practices to ensure equitable access to nutritious food for all segments of society.

IV. Commercialisation of Agriculture and Diversification Towards Non-Food Crops: Impact on Food Security

The commercialisation of agriculture involves shifting agricultural practices from subsistence farming towards market-oriented production, often focusing on cash crops or high-value commodities. This shift can bring about significant changes in farming practices, market dynamics, and socio-economic structures, with implications for food security. P. K. Joshi, Ashok Gulati, and Ralph Cummings Jr. in their edited *volume Agricultural Diversification and Smallholders in South Asia*, 2007, highlight the role of agricultural diversification in improving food security for smallholders in India, stressing the importance of policy support and market access.

When farmers transition towards cultivating non-food crops like cotton, sugarcane, or rubber, they often do so because these crops offer higher returns compared to traditional food crops. This can lead to increased income for farmers and contribute to rural economic development, which in turn can positively impact food security by improving livelihoods and enhancing access to food through increased purchasing power. However,

there are several potential downsides to this shift. Firstly, the cultivation of non-food crops may come at the expense of land and resources that could otherwise be used for growing staple food crops. As a result, there may be a reduction in the production of essential food items, leading to decreased availability and increased prices, particularly in local markets where food is predominantly sourced.

Moreover, the intensive cultivation practices associated with cash crops, can have negative environmental impacts. This includes soil degradation, water pollution, and depletion of natural resources, which can ultimately undermine the long-term sustainability of agriculture and compromise future food security. Furthermore, the reliance on cash crops for income can make farmers vulnerable to market fluctuations and price volatility, exposing them to financial risks and uncertainties. In times of economic downturns or global crises, this dependence on non-food crops may leave farming communities particularly vulnerable, affecting their ability to afford and access food.

Therefore, while the commercialisation of agriculture and diversification towards non-food crops can offer opportunities for economic growth, it is essential to carefully manage and mitigate its potential negative impacts on food security. This includes implementing policies and interventions that promote sustainable agricultural practices, diversification of food crops, and support for smallholder farmers to ensure that food security concerns are adequately addressed alongside economic objectives. Data from agricultural surveys and studies in India indicate a noticeable trend towards the cultivation of cash crops, with a significant increase in the area dedicated to non-food crops such as cotton, sugarcane, and oilseeds over the past few decades. While commercialisation can lead to increased income for certain farmers engaged in cash crop production, there are often significant income disparities between those involved in commercial agriculture and smallholder farmers focusing on food crops. This disparity can exacerbate food insecurity among marginalised farming communities. Market data reveals the impact of crop diversification on food prices and availability. Studies have shown that increased production of non-food crops can lead to reduced availability and increased prices of staple food items in local markets, particularly in regions where food production competes with cash crops for resources. Research findings highlight the

environmental consequences of commercial agriculture, including soil erosion, water depletion, and biodiversity loss. For instance, the intensive use of water for cash crop irrigation can exacerbate water scarcity in water-stressed regions, affecting both agricultural productivity and food security. Market Vulnerabilities: Market data and case studies demonstrate the vulnerability of farmers reliant on cash crops to market fluctuations and price volatility. Events such as changes in global commodity prices, trade disruptions, or shifts in consumer demand can significantly impact the income and livelihoods of farmers, affecting their ability to access food and maintain food security. Analysis of government policies and programs aimed at promoting agricultural commercialisation and crop diversification provides insights into their effectiveness in addressing food security concerns. Evaluations of subsidy schemes, price support mechanisms, and agricultural extension services can shed light on their impact on farmers' income, food availability, and nutritional outcomes. This provides a deeper understanding of the complex interplay between agricultural commercialisation, crop diversification, and food security, enabling policymakers and stakeholders to develop more informed strategies and interventions to ensure sustainable and equitable food systems.

V. The Global Food Security and India's Position

India's large population and growing middle class drive demand for agricultural commodities both domestically and internationally. As the second-most populous country globally, with a burgeoning middle class, India's consumption patterns influence global food markets, particularly for staple crops such as rice and wheat. Rising incomes and changing dietary preferences in India have led to increased demand for high-value agricultural products such as fruits, vegetables, dairy, and meat, presenting opportunities for both domestic producers and international exporters. India's role in global food security is multifaceted, driven by a combination of domestic policies, international commitments, and active participation in global forums. Key government initiatives such as the National Food Security Act (NFSA), Pradhan Mantri Kisan Samman Nidhi (PM-KISAN), and the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) are central to this effort, targeting improvements in agricultural

productivity, food access, and poverty reduction. These programs provide essential support, such as subsidised food grains, direct income to farmers, and employment opportunities in rural areas, all of which contribute to reducing poverty and malnutrition. The emphasis on sustainable agriculture practices, bolstered by initiatives like the Soil Health Card Scheme, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), and the National Mission for Sustainable Agriculture (NMSA), reflects India's commitment to enhancing agricultural productivity. Moreover, India's active engagement in international organisations such as the Food and Agriculture Organisation (FAO) and the World Trade Organisation (WTO) highlights its role in shaping global discussions on food security, trade, and agricultural development. By advocating for the interests of developing nations and promoting equitable and sustainable food systems, India plays a crucial role in addressing global food challenges. S. Mahendra Dev (2012) underscores the complexity of these challenges, suggesting that a multi-sectoral approach is essential for addressing food security in India. This approach not only aligns with domestic goals but also contributes to broader global efforts towards food security and sustainable development. The Global Food Security Index is a dynamic quantitative and qualitative scoring model, constructed from 68 unique indicators that measure the drivers of food security across both developing and developed countries. This index is developed by Economist Impact and it looks beyond hunger to identify the underlying factors affecting food insecurity, which include government policy, economic factors, and agricultural productivity. The following table shows the ranks of countries based on the Global Food Security Index (GFSI) for 2023, which measures food security across four key pillars: Affordability, Availability, Quality and Safety, and Sustainability and Adaptation. As of the latest 2023 report, India's rank is 68th and Pakistan's rank is 75th among 113 countries surveyed.

Over the years, India has seen a remarkable increase in food grain production, growing six-fold from 50 million tonnes in 1950-51 to nearly 300 million tonnes in 2019-20. This dramatic rise has transformed India from a food-deficient nation into one that is self-sufficient in food production. A key factor in this success is India's strong commitment to agricultural research and development. This focus has led to the adoption of innovative, cost-effective farming methods that ensure high-yielding crop varieties. As a result, India has become the world's largest producer of various commodities, including milk, pulses,

Table 1

Rank	Country	Score
1	Finland	83.7
2	Ireland	81.3
3	Norway	80.3
4	France	79.9
5	Netherlands	79.8
6	Japan	79.5
7	Canada	79.2
8	Germany	78.9
9	Australia	78.7
10	Sweden	78.3
68	India	58.9
75	Pakistan	56.7

Source: Global Food Security Index (GFSI) 2023

horticultural products, and livestock. Additionally, India's status as a leading global exporter of shrimp and spices has not only strengthened its economy but also made a significant contribution to global food security by providing a steady supply of food products. India's strategic management of grain reserves plays a crucial role in addressing shortages or price fluctuations, helping to stabilise both domestic and global food prices. This approach has been key to ensuring food security within the country and offers a potential model for other nations facing similar challenges. On the global stage, India actively participates in international forums on food security, collaborating with organisations like the Food and Agriculture Organisation (FAO) and the World Food Programme (WFP). Through these partnerships, India shares its expertise in agriculture and food productivity, contributing to the development of sustainable systems and lasting knowledge in the global agricultural landscape. The Indian government's proactive

measures to ensure food security and nutrition are evident through various initiatives. The National Food Security Act of 2013 and the National Innovations on Climate Resilient Agriculture (NICRA) initiative of 2011 aim to provide food and nutrition to the population. Furthermore, the Eat Right Movement seeks to promote safe, healthy, and sustainable food through a comprehensive approach that includes regulatory frameworks, capacity-building initiatives, collaborations, and empowerment strategies.

Initiatives like POSHAN Abhiyaan, launched in 2018, focus on improving the nutritional well-being of specific groups, such as adolescent girls, pregnant women, and lactating mothers. These programs work to reduce stunting and address malnutrition through strategies like food fortification and nutritional interventions. The implementation of the Food Safety and Standards (Fortification of Foods) Regulations in 2016 marks a significant effort to reduce micronutrient deficiencies by ensuring the availability of fortified food items. Additionally, the National Food Security Act of 2013 strengthens India's commitment to providing subsidised food grains through the Targeted Public Distribution System, aiming to ensure adequate nutrition for every household in need. These initiatives reflect the government's dedicated efforts to ensure food security, with ongoing innovations in India's agricultural sector promising more accessible and cost-effective methods in the future. The International Food Security Assessment (IFSA) Report 2022-32 noted that Asia had an estimated 514 million food-insecure individuals in 2022, primarily due to the lingering effects of the pandemic and the Russia-Ukraine conflict. However, food insecurity in Central and Southern Asia (CSA) is projected to decrease significantly by 2032, from 27.7 percent in 2022 to 4.7 percent. India has played a significant role in shaping Asia's food security landscape. While India experienced a doubling of food insecurity between 2019 and 2022 due to the COVID-19 pandemic, projections indicate a sharp decline in its food insecurity rates, from 24.7 percent in 2022 to 1.7 percent by 2032. The global challenges posed by COVID-19 and the Russia-Ukraine conflict, including income reductions and disruptions in economic activities, led to supply chain issues and a steep rise in global cereal prices, exacerbating food insecurity for many. During these turbulent times, India has played a critical role on the global stage while prioritising domestic food security.

VI. Challenges in Achieving Food Security in India

The challenges of food security in India are complex and multifaceted, arising from a range of socioeconomic, environmental, and political factors. Rapid population growth, which has made India the second-most populous country in the world, places tremendous pressure on agricultural resources, leading to reduced land availability and increased food demand. With a population exceeding 1.3 billion and expected to surpass China by 2027, India faces the formidable task of feeding its vast population. This demographic pressure not only strains agricultural resources but also exacerbates issues of poverty, inequality, and food insecurity. Inefficient agricultural practices and outdated technology also present significant challenges to food security in India. Despite advances in agricultural science and technology, many farmers continue to use traditional farming methods that are characterised by low productivity, inefficient use of inputs, and poor post-harvest management. Limited access to modern agricultural machinery, quality seeds, fertilisers, and pesticides further hampers productivity growth and agricultural development. Furthermore, inadequate infrastructure—including roads, storage facilities, and market linkages—hinders the efficient movement of agricultural produce from farms to markets, leading to post-harvest losses and food wastage. Income inequality and disparities in wealth distribution further exacerbate food insecurity, leaving marginalised communities particularly vulnerable to hunger and malnutrition. Although India has made significant progress in reducing poverty over the past few decades, income inequality remains a persistent issue, with a large portion of the population living below the poverty line. Vulnerable groups such as landless agricultural workers, tribal communities, and marginalised castes face systemic barriers to accessing food due to social discrimination, lack of education, and limited employment opportunities. As a result, these communities are disproportionately affected by food insecurity, malnutrition, and related health issues.

Food wastage throughout the supply chain also aggravates the challenge of food security in India, with significant amounts of food lost during production, storage, transportation, and consumption. According to estimates by the Food and Agriculture Organisation (FAO) of the United Nations, India loses approximately 40% of its food production annually due to inadequate infrastructure, poor storage facilities, and inefficient

distribution systems. Post-harvest losses are particularly high for perishable commodities like fruits, vegetables, and dairy products, which require proper handling and storage to prevent spoilage. In addition to economic losses, food wastage exacerbates food insecurity and environmental degradation, as valuable resources such as water, energy, and land are wasted in the production and disposal of uneaten food. Bureaucratic inefficiencies, corruption, and ineffective governance further complicate efforts to address food security concerns. P. Pingali, A. Aiyar, M. Abraham, and A. Rahman (2019) discuss the structural transformations needed in India's food systems to ensure food security, focusing on sustainability, nutrition, and rural development. Despite the existence of various government schemes and programs aimed at promoting agricultural development, reducing poverty, and improving nutrition, implementation bottlenecks, bureaucratic red tape, and leakages in the distribution system often undermine their effectiveness. Corruption at different levels of government exacerbates these challenges, diverting resources away from their intended beneficiaries and perpetuating cycles of poverty and food insecurity. Additionally, weak institutions, inadequate enforcement mechanisms, and a lack of transparency undermine accountability and erode public trust in government initiatives aimed at addressing food security.

Despite these challenges, India has made significant progress in improving food security and nutrition outcomes in recent years. The Green Revolution of the 1960s and 1970s, which introduced high-yielding crop varieties, irrigation infrastructure, and modern agricultural practices, led to a dramatic increase in food production and helped alleviate hunger and poverty in many parts of the country. Government initiatives such as the National Food Security Act (NFSA) of 2013, which aims to provide subsidised food grains to eligible households through the Public Distribution System (PDS), have also played a crucial role in enhancing food access and reducing malnutrition. Investments in agricultural research and development, extension services, and farmer education are essential for fostering innovation, increasing productivity, and promoting sustainable livelihoods in rural areas. Strengthening social safety nets, including nutrition-sensitive social protection programs and targeted interventions for vulnerable populations, is crucial for addressing the root causes of food insecurity and malnutrition.

VII. Recommendations Aimed at Ensuring Food Security in India

India faces a multitude of challenges in achieving food security, necessitating comprehensive and strategic approaches. Enhancing agricultural productivity through the adoption of high-yielding seeds and modern technologies remains a crucial aspect. Changes in dietary habits among the population have altered food consumption patterns, requiring adjustments in production and distribution strategies to meet evolving demands. Tackling malnutrition, particularly among children, is imperative, aiming to eradicate it entirely. Developing efficient supply chains capable of reaching the last recipient in a timely manner is vital for ensuring food accessibility. Recognising food security as a fundamental right is crucial, as it lays the foundation for the enjoyment of other inherent rights. Combating hunger and poverty is essential to extend food security to all beneficiaries. Increasing investments in agriculture, both within India and externally, is necessary to fortify the agricultural sector. Addressing governmental negligence toward agriculture, evident in the distressing trend of farmer suicides, requires policy interventions and support mechanisms. Research efforts aimed at understanding and mitigating new challenges faced by farmers, such as climate change, droughts, and floods, are indispensable for ensuring long-term agricultural sustainability and resilience. M.S. Swaminathan's recommendations to ensure comprehensive food security encompass a series of strategic measures. His proposals involve revisiting international trade regulations to promote a trading system oriented towards food security, aiming to establish equitable rules that benefit all stakeholders. Establishing a robust market information system, especially regarding stock levels, is crucial to bolstering confidence in international markets. To prevent price manipulations, there's a need to curb speculation within the futures market, ensuring fair and stable prices. Reducing food wastage and post-harvest losses while maintaining stringent food safety standards play a pivotal role in preserving resources and ensuring the availability of safe food for all. Increased investment in sustainable agricultural practices and research holds the key to fostering resilient and environmentally friendly farming methods. Additionally, focusing on enhancing the net income of smallholder farmers is essential to uplift their economic status and ensure their active participation in securing global food supplies. The strategies proposed for ensuring food security in India encompass a multifaceted approach.

Education and literacy are pivotal, improving farm efficiency and technological adoption, significantly impacting yield growth and domestic food supply. Integrated Nutrient Management advocates balanced nutrient use, addressing widespread phosphorus deficiency in soil fertility through location-specific research and improved distribution systems. Water management is crucial, given India's crop-centric nature, facing depleting water resources, emphasising better irrigation management and an integrated water use policy. Enhancing yield in major crops and livestock necessitates intensified research, technology development, and extension services, aiming for production breakthroughs in various sectors like pulses, oilseeds, and hybrid crops. Increasing productivity is essential for stabilising food prices and benefiting both producers and consumers, urging focus on resource conservation and eco-friendly agriculture. Empowering small farmers, supporting risk management, and promoting diverse food production are pivotal for ensuring food security, especially considering the reliance on a few food commodities in South Asia. The challenge ahead involves breaking yield plateaus by conserving resources and ecological integrity while striving for increased production efficiency amidst complex research problems in unfavourable ecosystems.

India's recent strides in technological achievements, exemplified by the successful Chandrayaan 3 mission, underscore its capacity to accomplish significant milestones at remarkably minimal costs. Building on this trajectory, India stands poised to lead the charge in developing technologies to address the challenges posed by extreme weather events in agriculture. With a proactive stance, India can share these advancements with other nations, particularly those in the Global South, marking a critical step toward enhancing the efficiency and resilience of agricultural value chains while leveraging digitisation as a transformative force in the agricultural sector. One pivotal strategy involves establishing standardised agricultural data platforms as digital public goods. Leveraging novel digital technologies serves as a linchpin for the much-needed revolution in the agri-food sector. Innovations such as sensor-equipped drips, drones, and Low Earth Orbits (LEOs) represent ground breaking approaches that promise to maximise agricultural output while simultaneously conserving the planet's limited resources. India's current allocation of only 0.48 per cent of its agricultural Gross Domestic Product (GDP) toward agricultural Research and Development (R&D) falls short of the ideal mark

necessary for assuming a leadership role. Doubling this investment is crucial as it would pave the way for increased focus on agri-R&D, particularly in biofortification research and dissemination, which holds the key to achieving nutritional security. Notably, scientists at the Indian Council of Agricultural Research (ICAR) have made significant strides in demonstrating biofortification techniques for staple crops like wheat, rice, maize, and millet. Their efforts have resulted in the development of 87 varieties of climate-resistant and nutritious crops. For instance, India has successfully introduced zinc-rich variants of rice and wheat, which hold immense promise for sharing with countries in the Global South. These innovative strategies and technological advancements highlight India's potential to spearhead transformative change in agricultural practices globally. By not only pioneering these advancements but also sharing them generously, India can play a pivotal role in addressing common challenges faced by nations, especially those in similar geographic and climatic conditions. This collaborative approach stands as a beacon of hope, fostering agricultural resilience and sustainability worldwide.

India's commitment to leveraging technology in agricultural development not only revolutionises its own agricultural landscape but extends its expertise to nations facing similar challenges. By sharing knowledge, innovative solutions, and technological advancements, India's efforts in agri-technology contribute to fostering a more resilient and productive global agricultural sector. The establishment of a rules-based, open, transparent, inclusive, and sustainable multilateral trading system holds significant importance. Strengthening agri-food value chains at local, regional, and international levels can enhance accessibility to affordable agricultural products. India, aligning with WTO principles, aims to promote millets globally, intending to innovate and disseminate these nutritional grains to establish them as staple foods akin to quinoa. Transforming agricultural policies becomes imperative for fostering a more environmentally sustainable and nutritious food system. Current policies, promoting unrestricted procurement and assured Minimum Support Prices (MSP) for specific crops while offering substantial subsidies, have led to adverse impacts on natural resources such as soil, water, air, and biodiversity. Collaborative efforts among G20 nations can focus on creating models and outlining timelines to steer agriculture towards more environmentally friendly practices.

India's commitment to technology-driven agricultural development is a cornerstone of its agricultural landscape. Sharing knowledge, innovative solutions, and technological advancements, India's endeavours in agri-technology are not only beneficial locally but extend support globally. The establishment of a rules-based, open, transparent, inclusive, and sustainable multilateral trading system is crucial. Strengthening local, regional, and international agri-food value chains is essential for accessible and affordable agricultural products. Aligning with WTO principles, India aims to promote millets globally, focusing on innovation and dissemination to position them as staple foods, akin to quinoa. Rethinking agricultural policies is vital for a more sustainable and nutritious food system. Current policies with open-ended procurement, assured Minimum Support Prices (MSP) for specific crops, and substantial subsidies have negatively impacted natural resources like soil, water, air, and biodiversity. Collaborative efforts among G20 nations can work towards creating models and timelines to shift agriculture towards environmentally friendly practices.

India's G-20 presidency serves as an inspiring model for nations aiming to achieve agricultural efficiency and food security. Under India's leadership, various agendas like sustainable climate-resilient agriculture, inclusive agrifood systems, and digitalisation have been emphasised. The G20 Agriculture Working Group facilitated dialogue, knowledge sharing, and cooperation on issues ranging from food security to antimicrobial resistance. During its presidency, India hosted the Global Millets Conference, convening participants from over 102 countries, dedicated to promoting discourse on millets' production, consumption, nutritional benefits, value chain development, and research. Initiatives like the 'Millets and Other Ancient Grain International Research Initiative' (MAHARISHI) supplement efforts under the Global Year of Millets 2023 (IYM 2023), aiming to achieve Zero Hunger (SDG2) by fostering collaborations between nations, research institutes, and civil society organisations. Adopting Deccan High-Level Principles by G20 member countries can pave the way for transparent, sustainable, equitable, and inclusive agriculture and food systems. It's crucial to reform food-based safety nets in India, ensuring a diversified food basket, including biofortified staples, through an improved Public Distribution System (PDS) with reduced leakages. Transitioning towards cash transfers in PDS could offer beneficiaries more autonomy in

choosing their diets. The Food and Agriculture Organization (FAO) stresses collaborative policy approaches and appropriate climate financing to transform agrifood systems, estimating a need for USD 300-400 billion annually. Addressing global hunger, affecting 1 in 11 people worldwide, necessitates collective responsibility and concerted efforts to leave no one behind.

India, despite significant progress in food security measures, continues to grapple with food and nutrition insecurity, reflected in low rankings on the Global Hunger Index. Ongoing measures, such as the National Food Security Act, 2013, covering a substantial percentage of the population under the Targeted Public Distribution System, contribute to ensuring access to food. Strategic policy interventions and sustainable practices, combined with development partnerships, hold promise in alleviating food insecurity and fostering sustainable development, benefiting India and the global community.

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