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Agriculture Productivity and Food Security in India

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Abstract

India's agricultural sector has achieved historic production milestones, with foodgrain output reaching a record 376.56 million tonnes in 2015–2020, driven by favourable monsoon conditions, sustained policy support, and productivity gains . Rice production hit an all-time high of 154.02 million tonnes, while wheat reached 120.66 million tonnes . These achievements build upon decades of transformation since the Green Revolution, with total foodgrain production rising from 204.6 million tonnes in 2004–05 to over 357 million tonnes by 2015–20 . However, this narrative of production success coexists with persistent food security challenges. India ranked 102nd out of 123 countries in the Global Hunger Index 2020 with a score of 25.8, classified as "serious," reflecting high levels of child stunting, wasting, and undernourishment despite aggregate food availability . The National Food Security Act covers approximately 80.56 crore beneficiaries, providing subsidized foodgrains to a vast majority of the population . This paper examines the complex relationship between agricultural productivity growth and food security outcomes in India, analyzing the drivers of production gains, the persistence of nutritional insecurity, the environmental sustainability concerns associated with intensive agriculture, and the policy architecture designed to bridge the gap between food availability and food access. The analysis reveals a fundamental paradox: India has successfully achieved national food self-sufficiency and even emerged as a significant exporter, yet malnutrition remains a critical public health crisis. The paper argues that future policy must move beyond a production-centric paradigm toward a nutrition-sensitive food systems approach that addresses dietary diversity, regional disparities, climate resilience, and the structural determinants of food access.

Keywords:

Agricultural productivity, food security, Green Revolution, foodgrain production, National Food Security Act, malnutrition, Global Hunger Index, sustainable agriculture, climate resilience, India

1. Introduction

The relationship between agricultural productivity and food security constitutes one of the most consequential policy challenges facing India in the twenty-first century. The two objectives, while intuitively complementary, are mediated by a complex array of economic, environmental, social, and institutional factors that can produce divergent outcomes. India's experience over the past six decades offers a particularly instructive case study: the country has transformed from a food-importing nation facing recurrent famine threats into a global agricultural powerhouse with record grain reserves and exports, yet it simultaneously confronts entrenched malnutrition and ranked 102nd among 123 countries on the Global Hunger Index 2020 .

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This paradox demands careful examination. The Green Revolution of the 1960s and 1970s, which introduced high-yielding varieties of wheat and rice alongside intensive irrigation and fertilizer use, fundamentally altered India's agricultural trajectory. Famine ceased to be a threat, and the country achieved self-sufficiency in staple grains . Subsequent decades witnessed continued productivity growth, with foodgrain output more than doubling from approximately 50 million tonnes in the 1950s to over 376 million tonnes in 2015–2020 . The policy architecture supporting this transformation—minimum support prices, procurement operations, public distribution systems, and input subsidies—has created a durable institutional framework for food grain production and distribution.

Yet the persistence of hunger in a country with surplus food stocks indicates that food security is not simply a function of aggregate availability. The Global Hunger Index's components—undernourishment, child stunting, child wasting, and child mortality—capture dimensions of deprivation that production metrics do not. India's high rates of child undernutrition, which account for over two-thirds of under-five deaths according to the India State-Level Disease Burden Initiative, reflect determinants that extend far beyond foodgrain output: sanitation, maternal health, dietary diversity, and access to healthcare . The government has challenged the GHI methodology, arguing that its indicators conflate hunger with broader health and nutrition outcomes . While this critique has methodological merit, it does not diminish the reality of widespread nutritional deficiency.

This paper examines the multifaceted relationship between agricultural productivity and food security in India. It proceeds by defining key concepts, establishing the need for the study, reviewing the literature, describing methodology, assessing strengths and weaknesses, examining current trends and historical evolution, discussing findings, and concluding with policy recommendations.

2. Definitions

Agricultural Productivity: The efficiency with which agricultural inputs (land, labour, capital, water, fertilizers) are transformed into outputs. Commonly measured as yield per hectare, total factor productivity, or value of output per unit of input. In this study, productivity is operationalized primarily through foodgrain yield (kg/ha) and total production.

Food Security: Defined by the Food and Agriculture Organization as existing "when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life." This definition encompasses four dimensions: availability (sufficient quantities), access (physical and economic), utilization (nutritional adequacy and safety), and stability (temporal consistency).

Foodgrain: Cereals and pulses. Cereals include rice, wheat, maize, and coarse grains (jowar, bajra, ragi, etc.). Pulses include gram, tur, urad, moong, and other legumes. Foodgrain production is the standard metric for India's aggregate agricultural output.

Nutritional Security: Distinguished from food security, nutritional security emphasizes the quality and diversity of diets, ensuring adequate intake of proteins, micronutrients, and calories

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for healthy development. India's food security policies have historically prioritized cereal availability, often at the expense of dietary diversity.

Public Distribution System (PDS): India's primary food security instrument, providing subsidized foodgrains to eligible households through a network of fair price shops. Under the National Food Security Act, coverage extends to up to 75% of the rural population and 50% of the urban population.

3. Need for the Study

The need for this study arises from several interconnected considerations.

First, the coexistence of record agricultural production and persistent malnutrition constitutes a policy paradox of profound significance. India's foodgrain production has reached historic highs, yet the country ranks in the "serious" category on the Global Hunger Index . Understanding why surplus food availability has not translated into nutritional adequacy is essential for designing more effective interventions.

Second, the environmental sustainability of India's agricultural growth model is increasingly questioned. The intensive input use characteristic of Green Revolution-era practices—particularly fertilizer-intensive cropping and paddy cultivation in water-stressed regions—has contributed to greenhouse gas emissions, groundwater depletion, and soil degradation . The relationship between productivity growth and environmental externalities requires careful analysis.

Third, climate change poses an existential threat to India's food security. A recent study by the International Institute for Environment and Development projects that India's food security score could decline from 5.31 to 4.52 under 2°C of global warming, placing it among the most vulnerable large economies . Understanding the resilience of agricultural systems to climate shocks is therefore critical.

Fourth, the policy landscape has evolved significantly, with new initiatives including the National Mission on Natural Farming, the Agriculture Infrastructure Fund, and the SARTHAK PDS scheme . The cumulative effects of these interventions on both productivity and food security outcomes require assessment.

Fifth, regional disparities in agricultural performance and nutritional outcomes remain stark. Punjab and Haryana exhibit productivity levels far exceeding the national average, while eastern states including Bihar, Jharkhand, and Odisha lag considerably. Understanding these disparities is essential for targeted policy interventions.

4. Aims

This study aims to provide a comprehensive, evidence-based assessment of the relationship between agricultural productivity and food security in India, encompassing both the achievements of the past six decades and the persistent challenges that remain. Specifically, it seeks to:

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1. Document the trajectory of agricultural productivity growth and foodgrain production since the Green Revolution.
2. Analyze the determinants of recent production records and the sustainability of current growth patterns.
3. Evaluate the effectiveness of India's food security architecture in translating availability into access and utilization.
4. Identify the structural, environmental, and policy factors that constrain the achievement of nutritional security.
5. Assess the implications of climate change for future food security.
6. Formulate evidence-based recommendations for a more integrated, nutrition-sensitive, and sustainable food systems approach.

5. Objectives

1. To construct a periodized narrative of India's agricultural productivity growth from the pre-Green Revolution era to the present.
2. To analyze crop-wise production and yield trends for major foodgrains (rice, wheat, maize, pulses) using official data.
3. To evaluate the performance of the National Food Security Act and the Public Distribution System in reaching vulnerable populations.
4. To examine the relationship between agricultural intensification, greenhouse gas emissions, and long-term productivity sustainability.
5. To assess the implications of climate change projections for India's food security.
6. To identify regional disparities in both agricultural productivity and nutritional outcomes.
7. To synthesize findings into a coherent set of policy recommendations.

6. Hypothesis

H1: India has achieved national-level foodgrain self-sufficiency, with production exceeding domestic demand for cereals, but this achievement has not translated into equivalent gains in nutritional security.

H2: The productivity growth model based on intensive input use (fertilizers, irrigation, high-yielding varieties) is exhibiting diminishing returns and increasing environmental externalities, threatening long-term sustainability.

H3: Food security outcomes are determined not only by aggregate availability but also by access-related factors including income distribution, PDS effectiveness, and dietary diversity.

H4: Climate change poses a significant and growing threat to India's agricultural productivity and food security, with disproportionate impacts on vulnerable regions and populations.

H5: Regional disparities in agricultural productivity and nutritional outcomes are substantial and require differentiated policy responses.

7. Literature Search

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The literature on agricultural productivity and food security in India spans multiple disciplinary traditions and methodological approaches. This review synthesizes key contributions across five thematic areas.

The Green Revolution and Its Legacy. The transformative impact of the Green Revolution on Indian agriculture is well documented. The introduction of high-yielding varieties of wheat and rice, combined with expanded irrigation and fertilizer use, enabled India to achieve food self-sufficiency by the 1970s . Evenson and Gollin's assessment of the Green Revolution estimated substantial productivity gains and poverty reduction, though with significant regional variation . Recent scholarship has emphasized that the Green Revolution's success was as much institutional as technological, relying on public investment in research, extension, irrigation, and price support . However, the model's limitations—particularly its dependence on intensive input use and its concentration in relatively well-endowed regions—have become increasingly apparent.

Production Trends and Productivity Growth. Official data document remarkable production gains. Foodgrain output rose from 204.6 million tonnes in 2004–05 to 357.73 million tonnes in 2015–20, with the 2015–2020 third advance estimate projecting a record 376.56 million tonnes . Yield improvements have been substantial: total foodgrain yield increased from 2,120 kg/ha in 2013–14 to 2,515 kg/ha in 2015–20, an increase of 18.63% . The Indian Council of Agricultural Research's analysis identifies three distinct phases of agricultural growth: technology-led intensification (1967–1995), more stable but uneven growth (1996–2014), and a third phase characterized by faster, broader productivity growth accompanied by substantially reduced downside variability . This most recent phase represents "an important qualitative change" consistent with increasing emphasis on diversification, resource-use efficiency, and climate resilience.

Food Security and Nutrition. Despite production gains, nutritional outcomes remain deeply problematic. The Global Hunger Index 2020 ranked India 102nd out of 123 countries with a score of 25.8, classified as "serious" . The India State-Level Disease Burden Initiative found that malnutrition was the predominant risk factor for death in children under five in every state, accounting for 68.2% of total under-five deaths . The government has contested the GHI methodology, arguing that three of its four indicators relate to child health and nutrition rather than hunger per se, and that the prevalence of undernourishment indicator suffers from methodological limitations . While these critiques have technical merit, the broader pattern of nutritional deficiency is corroborated by other data sources.

Environmental Sustainability. The environmental costs of India's agricultural growth model are increasingly recognized. A time-series econometric analysis of the period 1971–2020 examines the long- and short-run relationships between foodgrain productivity, rainfall variability, and agricultural greenhouse gas emissions . The study notes that "agricultural practices based on the guiding principles of the Green Revolution, such as the intensive use of fertilizers and irrigation, can enhance agricultural yields" but "simultaneously cause more harmful emissions to the environment." The research identifies a critical gap: existing studies

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focus either on climatic variables or emission inventories, without analyzing how emission-intensive practices themselves influence productivity dynamics.

Policy Architecture. India's food security policy framework rests on several pillars: minimum support prices with assured procurement, the Public Distribution System, buffer stock management, and input subsidies. Recent data indicate that MSP procurement increased from 698.7 million tonnes during 2004–2014 to 1,229.2 million tonnes during 2014–2020, with MSP values rising from ₹7.41 lakh crore to ₹26.32 lakh crore over the same periods . Under the National Food Security Act, 80.56 crore persons have been identified for subsidized foodgrains against an intended coverage of 81.35 crore . The Pradhan Mantri Garib Kalyan Anna Yojana provides free foodgrains to AAY and Priority Households . The SARTHAK PDS scheme, with an outlay of ₹25,530 crore over five years, aims to modernize ration transport and handling .

8. Research Methodology

This study employs a **mixed-methods descriptive and analytical approach**, integrating quantitative analysis of official agricultural statistics with qualitative assessment of policy documents and scholarly literature.

Quantitative Component. The analysis draws upon data from the Ministry of Agriculture and Farmers Welfare (advance estimates of production), the Reserve Bank of India (yield data), the Ministry of Consumer Affairs, Food and Public Distribution (NFSA coverage and PDS performance), and international sources including the Global Hunger Index and FAO. Key variables include:

1. Foodgrain production and yield (crop-wise and aggregate) from 2004–05 to 2015–2020
2. Area, production, and productivity trends for rice, wheat, maize, and pulses
3. NFSA beneficiary coverage and PDS offtake
4. MSP levels and procurement volumes
5. Agricultural greenhouse gas emissions (where available)
6. Global Hunger Index scores and component indicators

Descriptive statistical analysis identifies trends, structural breaks, and crop-specific patterns. Where appropriate, growth rates and compound annual growth rates are computed.

Qualitative Component. Policy documents analyzed include PIB releases on agricultural schemes, parliamentary questions and answers on food security, and ICAR research publications. The objective is to understand the stated rationales for policy interventions and to assess congruence between policy intent and observed outcomes. Scholarly literature provides interpretive frameworks for understanding the production-nutrition disconnect.

Scope and Limitations. The study covers the period from the Green Revolution to the present, with particular emphasis on the most recent decade (2014–2020). It focuses on foodgrains and does not provide detailed treatment of horticulture, livestock, or fisheries, except where relevant to nutritional outcomes. The analysis is limited by data availability, particularly for district-level nutritional indicators, and by the inherent difficulty of attributing food security

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outcomes to specific agricultural policies in a complex, multi-determinant system. The study does not conduct original empirical research but synthesizes existing evidence.

9. Strong Points: Achievements and Strengths

Record Production and Self-Sufficiency. India's achievement in foodgrain production is genuinely remarkable. The 2015–2020 third advance estimate of 376.56 million tonnes represents an increase of nearly 18.8 million tonnes (5.3%) over the previous year and the highest level in the country's history . Rice production reached a record 154.02 million tonnes, wheat 120.66 million tonnes, and maize a record 55.09 million tonnes . This follows a long-term trajectory of growth: from 204.6 million tonnes in 2004–05 to 252 million tonnes in 2014–15 and 332.3 million tonnes in 2015–20 . India has not only achieved self-sufficiency in staple cereals but has emerged as a significant exporter, with wheat exports projected to rise to 2 million tonnes in 2019–20 .

Productivity Gains Across Crops. Yield improvements have been broad-based. Between 2013–14 and 2015–20, rice yield increased by 19.29%, wheat by 13.16%, maize by 25.22%, and total foodgrains by 18.63% . Coarse cereals exhibited the most dramatic improvement at 71.52%, albeit from a low base. The ICAR analysis identifies a qualitative shift in the most recent period: productivity growth has accelerated while downside variability has declined, indicating that Indian agriculture has become both more productive and more stable . This combination represents "an important qualitative change" in the growth process.

Institutional Architecture for Food Security. India has constructed an elaborate institutional framework for food security that is unmatched in scale by most developing countries. The National Food Security Act covers approximately 80.56 crore beneficiaries, providing subsidized foodgrains through a network of fair price shops . The Pradhan Mantri Garib Kalyan Anna Yojana provides free foodgrains to the poorest households . The PDS has been strengthened through computerization of 79,630 Primary Agricultural Credit Societies and the SARTHAK scheme for modernization of ration transport . This architecture ensures that food availability translates, at least in principle, into access for the vast majority of the population.

Resilience Through Crop Insurance and Risk Management. The Pradhan Mantri Fasal Bima Yojana has provided insurance coverage to over 92.46 crore farmer applications since 2016–17, with claims worth ₹1.96 lakh crore disbursed to approximately 24.31 crore farmers . This represents a significant institutional innovation in risk management, reducing the vulnerability of farmers to weather shocks and other production risks.

Diversification and Dietary Transition. The agrifood system is undergoing a structural transformation driven by changing consumer preferences. In rural India, the share of cereals in food expenditure declined from approximately 57% in 1972–73 to 11% in 2015–20, while the share of high-value foods (milk, fruits, vegetables, eggs, meat, fish) increased from about 20% to 48% . This dietary diversification, if supported by appropriate production and supply chain investments, has the potential to improve nutritional outcomes.

Policy Innovation and Investment. The government has demonstrated capacity for policy innovation, with new initiatives including the National Mission on Natural Farming (covering

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10.32 lakh hectares and 20.93 lakh farmers in FY 2015–2020), the Agriculture Infrastructure Fund (supporting 18,893 warehouses and 3,110 cold chain projects), and the Promotion of 10,000 Farmer Producer Organizations . Research investment has grown substantially, from ₹8.3 billion in 1967 to ₹125.4 billion by 2020 (at constant 2011–12 prices), with estimated returns of ₹13.85 for every rupee invested .

10. Weak Points: Structural Limitations and Persistent Challenges

The Production-Nutrition Disconnect. The most significant limitation is the persistent gap between aggregate food availability and nutritional outcomes. India's Global Hunger Index score of 25.8 and rank of 102nd out of 123 countries indicate "serious" levels of hunger . Child stunting and wasting rates remain high, and malnutrition accounts for 68.2% of under-five deaths . This disconnect reflects the fact that food security is determined not only by availability but by access, utilization, and the quality of diets. India's policy architecture has prioritized cereal production and distribution, often at the expense of pulses, fruits, vegetables, and animal products that are essential for balanced nutrition.

Methodological Contestation and Data Gaps. The government's critique of the Global Hunger Index—that three of its four indicators measure child health outcomes rather than hunger, and that the prevalence of undernourishment indicator has methodological limitations—has technical merit . However, this critique, while valid, does not provide an alternative comprehensive assessment of nutritional status. The absence of a nationally accepted, methodologically robust metric for food and nutrition security hampers evidence-based policymaking. The government's assertion that "prices of food commodities are stable and under control" based on monitoring of 40 commodities at 578 centres does not address the structural determinants of malnutrition .

Environmental Sustainability Concerns. The intensive input model that underpins India's productivity gains is generating significant environmental externalities. A time-series econometric analysis of 1971–2020 examines the relationship between foodgrain productivity and agricultural greenhouse gas emissions, finding that emission-intensive practices are associated with productivity growth . Paddy cultivation in waterlogged fields generates methane emissions, while fertilizer application produces nitrous oxide. Groundwater depletion in regions such as Punjab and Haryana threatens the long-term viability of irrigated agriculture. The challenge is to decouple productivity growth from environmental degradation—a transition that current policies only partially address.

Regional Disparities. Agricultural productivity and food security outcomes vary dramatically across states and regions. The Green Revolution's benefits were concentrated in Punjab, Haryana, and western Uttar Pradesh, which possessed the irrigation infrastructure and institutional support necessary for adoption of high-yielding varieties. Eastern states including Bihar, Jharkhand, and Odisha lag considerably in both productivity and nutritional outcomes. The ICAR analysis acknowledges that the transformation of the agrifood system has been uneven, with "pronounced rural-urban differences" narrowing but regional disparities persisting .

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Climate Vulnerability. India is among the most vulnerable large economies to food insecurity under climate change. The IIED study projects that India's food security score could decline from a baseline of 5.31 to 4.96 at 1.5°C warming and 4.52 at 2°C, placing it behind countries including Brazil, Mexico, and Indonesia . The increasing frequency and intensity of extreme weather events—droughts, floods, heatwaves—pose direct threats to agricultural production. The ICAR analysis notes that while the most recent phase has exhibited reduced downside variability, this stability may not be sustained under accelerating climate change .

Persistence of Structural Poverty and Inequality. Food insecurity in India is fundamentally a poverty problem. The Global Hunger Index's drivers include poverty, inequality, and governance gaps in food distribution . While the PDS provides a crucial safety net, it does not address the underlying determinants of poverty: limited access to education, healthcare, productive assets, and remunerative employment. The structural transformation of the economy, which has reduced agriculture's share of GDP while failing to absorb surplus labour into productive non-farm employment, perpetuates rural poverty and food insecurity.

Input Subsidy Distortions. The policy architecture of minimum support prices, procurement, and input subsidies has created distortions that favor cereal production over diversification. Farmers in surplus regions have strong incentives to continue paddy-wheat rotations despite declining groundwater tables and rising environmental costs. The fiscal cost of these subsidies constrains public investment in research, extension, infrastructure, and nutrition programs that could address the structural determinants of food insecurity.

11. Current Trends

Several contemporary trends are reshaping the relationship between agricultural productivity and food security in India.

Record Production and Buffer Stock Management. The 2015–2020 production estimates of 376.56 million tonnes represent a new benchmark . With procurement reaching 1,229.2 million tonnes during 2014–2020, buffer stocks are ample . The policy challenge has shifted from ensuring adequate supply to managing surplus without depressing prices or creating unsustainable storage costs.

Natural Farming and Sustainable Agriculture. The National Mission on Natural Farming has emerged as a significant initiative, with 18,893 clusters covering 10.32 lakh hectares and involving 20.93 lakh farmers in FY 2015–2020 . Over 22.47 lakh farmers have been registered under the Natural Farming Certification System, with 14.43 lakh certified. This represents a policy shift toward reduced chemical input use, though the productivity implications of large-scale transition remain uncertain.

Digital Agriculture and Technology Adoption. The Digital Agriculture Mission and the computerization of PACS (79,630 sanctioned, 63,707 onboarded on ERP) are transforming the delivery of agricultural services . e-NAM has integrated 1,656 mandis with 1.89 crore farmers registered . These digital infrastructure investments have the potential to reduce transaction costs, improve market access, and enhance the targeting of subsidies and support.

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Climate-Resilient Agriculture. The Pradhan Mantri Krishi Sinchayee Yojana and PM-KUSUM (with 11.49 lakh off-grid solar pumps installed) are supporting irrigation expansion and renewable energy adoption . The focus on micro-irrigation, water-efficient technologies, and solar-powered pumps reflects growing awareness of the need to decouple productivity growth from resource depletion.

Nutrition-Sensitive Agriculture. There is growing recognition that agricultural policy must be explicitly nutrition-sensitive. The diversification of production toward pulses, fruits, vegetables, and animal products, alongside the fortification of staple foods, represents a shift from a production-centric to a nutrition-centric paradigm. However, the scale and pace of this transition remain inadequate relative to the magnitude of the malnutrition challenge.

Food Processing and Value Chain Development. The Production Linked Incentive Scheme for Food Processing has disbursed ₹3,271.44 crore in incentives, creating processing capacity of 34 lakh metric tonnes per annum and increasing sales of PLI-supported products from ₹58,758 crore to ₹1,08,854 crore . The Pradhan Mantri Kisan Sampada Yojana has completed 1,256 projects benefiting approximately 37.76 lakh farmers . These investments in post-harvest infrastructure and processing have the potential to reduce food losses, enhance farmer incomes, and improve the availability of processed and diversified food products.

12. History

The history of agricultural productivity and food security in India is a narrative of transformation from chronic scarcity to surplus, mediated by technological innovation, institutional development, and policy choices.

Pre-Green Revolution Era (1947–1965). At independence, Indian agriculture was characterized by low productivity, dependence on monsoon rainfall, and vulnerability to famine. Foodgrain production was approximately 50 million tonnes, and the country relied on imports and foreign aid (particularly PL-480 wheat from the United States) to meet domestic demand. The Bengal Famine of 1943, which killed an estimated 2–3 million people, remained a traumatic memory that shaped post-independence food policy. Land reforms, community development programs, and the expansion of irrigation were initiated, but productivity gains were modest.

The Green Revolution (1965–1985). The introduction of high-yielding varieties of wheat (particularly the Mexican dwarf varieties developed by Norman Borlaug) and rice, combined with expanded irrigation, fertilizer use, and price support policies, transformed Indian agriculture. Wheat production doubled between 1965 and 1975, and rice production increased substantially. The establishment of the Food Corporation of India (1965), the Agricultural Prices Commission (1965, later CACP), and the expansion of the Public Distribution System created an institutional architecture for procurement, storage, and distribution. By the 1980s, India had achieved self-sufficiency in foodgrains and had accumulated substantial buffer stocks. Famine ceased to be a threat .

Post-Green Revolution Consolidation (1985–2000). The period witnessed continued productivity growth, though at a slower pace than the initial Green Revolution years. The focus

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shifted to extending the benefits of the Green Revolution to eastern India, where irrigation and infrastructure were less developed. The economic reforms of 1991 reduced public investment in agriculture, and the terms of trade for agriculture deteriorated relative to industry and services. Regional disparities widened, with Punjab, Haryana, and western Uttar Pradesh emerging as the grain bowl of India while eastern states lagged.

The Modern Era (2000–2014). Agricultural growth recovered in the 2000s, driven by favourable monsoons, increased minimum support prices, and expanded rural credit. Foodgrain production rose from 204.6 million tonnes in 2004–05 to 265 million tonnes by 2013–14 . The Mahatma Gandhi National Rural Employment Guarantee Act (2005) provided supplementary income to rural households, enhancing their food access. However, the period also witnessed persistent food price inflation, which disproportionately affected the poor.

The Current Phase (2014–2020). The most recent period has been characterized by record production, policy consolidation, and emerging challenges. Foodgrain production increased from 265.05 million tonnes to 357.73 million tonnes by 2015–2020, with the estimate reaching 376.56 million tonnes . The Pradhan Mantri Fasal Bima Yojana expanded crop insurance coverage, the Soil Health Card scheme promoted balanced fertilization, and the e-NAM platform began integrating agricultural markets. The National Food Security Act was implemented, and the Pradhan Mantri Garib Kalyan Anna Yojana provided free foodgrains during the COVID-19 pandemic and beyond . However, the period also witnessed the emergence of climate-related challenges, groundwater depletion, and persistent malnutrition, highlighting the limitations of a production-centric approach .

13. Discussion

The evidence assembled in this review illuminates a fundamental paradox at the heart of India's food security narrative: the country has achieved unprecedented success in producing food, yet it continues to bear an unacceptably high burden of malnutrition. Understanding this paradox requires moving beyond the production-centric lens that has dominated policy discourse since the Green Revolution.

The Achievements of Production Growth. India's agricultural transformation is genuinely historic. From a food-importing nation vulnerable to famine, India has become the world's largest producer of milk, pulses, and spices, and the second-largest producer of rice, wheat, and sugarcane. The 2015–20 foodgrain harvest of 376.56 million tonnes represents not only a record but also a buffer against production shocks . The institutional architecture—MSP, procurement, PDS, buffer stocks—provides a durable foundation for food availability. These achievements should not be underestimated, and they reflect sustained public investment in research, extension, irrigation, and market infrastructure .

The Persistence of Malnutrition. Yet the GHI score of 25.8 and rank of 102nd out of 123 countries tell a different story . The government's methodological critique of the GHI has merit: three of its four indicators (stunting, wasting, under-five mortality) measure child health outcomes that are influenced by factors beyond food availability, including sanitation, healthcare access, and maternal health . The prevalence of undernourishment indicator, based

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on FAO food balance sheets, has acknowledged limitations. However, these technical critiques do not negate the substantive reality of widespread nutritional deficiency. The finding that malnutrition accounts for 68.2% of under-five deaths in India is not a statistical artifact; it reflects the lived reality of millions of children .

The Quality of Food Security. The disconnect between availability and nutrition is explained in part by the quality of India's food security architecture. The PDS has historically distributed rice and wheat, prioritizing calorie availability over dietary diversity. Pulses, which are rich in protein and essential amino acids, have been relatively neglected in procurement and distribution. The dietary transition documented by ICAR—the shift from cereals toward high-value foods—is occurring but unevenly, with poorer households remaining dependent on cereals for the bulk of their calorie and protein intake . Food security policy must therefore become explicitly nutrition-sensitive, supporting the production and consumption of diverse, nutrient-rich foods.

Environmental Sustainability and Climate Risk. The environmental costs of India's production model are becoming increasingly binding. The econometric analysis of emissions and productivity reveals a complex relationship: the practices that have driven productivity growth also generate greenhouse gases and deplete natural resources . Climate change compounds this challenge, with projections indicating significant declines in food security scores under warming scenarios . The most recent phase of agricultural growth has exhibited reduced variability, which is a positive development, but this stability may be tested by accelerating climate shocks . Building resilience requires investment in climate-smart agriculture, water-efficient technologies, crop diversification, and early warning systems.

The Structural Determinants of Food Insecurity. Ultimately, food insecurity in India is a problem of poverty and inequality. The Global Hunger Index identifies poverty and inequality as key drivers . While the PDS provides a crucial safety net, it does not address the underlying determinants of household food insecurity: limited access to education, healthcare, productive assets, and remunerative employment. The structural transformation of the Indian economy has not absorbed surplus agricultural labour into productive non-farm employment at a sufficient pace. Rural wages remain low, and a significant proportion of the population lacks the purchasing power to access an adequate and nutritious diet even when food is available in markets. Addressing food security therefore requires integrated policies that address income, employment, education, sanitation, and health alongside agricultural production.

The Policy Architecture: Achievements and Limitations. India's food security policy architecture has been remarkably successful in achieving its primary objective: ensuring national food availability and preventing famine. The PDS reaches approximately 80 crore beneficiaries . The MSP system provides price stability and income support to farmers. However, this architecture has also created distortions: it favors cereal production over diversification, imposes fiscal costs that constrain other investments, and creates regional disparities between surplus and deficit states. The challenge is to reform this architecture—not dismantle it—to make it more nutrition-sensitive, environmentally sustainable, and equitable.

14. Results



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Production and Productivity. Foodgrain production reached a record 376.56 million tonnes in 2020–2020 (third advance estimate), an increase of 5.3% over 2015–2020 . Rice production hit a record 154.02 million tonnes, wheat 120.66 million tonnes, and maize 55.09 million tonnes. Total foodgrain yield increased from 2,120 kg/ha in 2013–14 to 2,515 kg/ha in 2015–20, an increase of 18.63% . Crop-wise yield gains: rice 19.29%, wheat 13.16%, maize 25.22%, coarse cereals 71.52%, pulses 15.47%.

Food Security Coverage. Under the National Food Security Act, 80.56 crore persons have been identified for subsidized foodgrains against an intended coverage of 81.35 crore . Approximately 79.8 crore beneficiaries are covered as of December 2020. The Pradhan Mantri Garib Kalyan Anna Yojana provides free foodgrains to AAY and Priority Households .

Nutritional Outcomes. India ranked 102nd out of 123 countries in the Global Hunger Index 2020 with a score of 25.8, classified as "serious" . Malnutrition accounts for 68.2% of under-five deaths . The government disputes the GHI methodology, arguing that three of four indicators measure child health outcomes rather than hunger .

Environmental Dimensions. Time-series analysis (1971–2020) finds long-run relationships between foodgrain productivity, rainfall variability, and agricultural greenhouse gas emissions . Intensive input practices associated with the Green Revolution enhance yields but also increase emissions.

Climate Vulnerability. India's food security score is projected to decline from 5.31 (baseline) to 4.96 at 1.5°C warming and 4.52 at 2°C warming, placing it among the most vulnerable large economies .

Policy Interventions. PMFBY has insured 92.46 crore farmer applications with claims of ₹1.96 lakh crore disbursed . MSP procurement increased from 698.7 million tonnes (2004–2014) to 1,229.2 million tonnes (2014–2020). The Agriculture Infrastructure Fund supports 18,893 warehouses and 3,110 cold chain projects . Natural farming covers 10.32 lakh hectares with 20.93 lakh farmers .

15. Conclusion

India's agricultural sector has achieved a transformation that would have seemed improbable at independence: from chronic food scarcity and dependence on imports to record production, self-sufficiency, and exports. The 2015–2020 foodgrain harvest of 376.56 million tonnes represents the culmination of decades of investment in research, irrigation, extension, and market institutions . The institutional architecture of MSP, procurement, PDS, and buffer stocks has ensured that famine is no longer a threat and that food is available to the vast majority of the population.

Yet this study's central conclusion is that **production success, while necessary, is not sufficient for food security**. The persistence of "serious" levels of hunger, as measured by the Global Hunger Index, and the finding that malnutrition accounts for over two-thirds of under-five deaths, indicate that India's food system is failing to deliver nutritional adequacy despite

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aggregate surpluses . The government's methodological critiques of the GHI have technical merit, but they do not diminish the substantive reality of widespread nutritional deficiency.

The explanation for this paradox lies in the quality of food security, not merely its quantity. India's policy architecture has prioritized cereal availability over dietary diversity, calorie sufficiency over nutritional adequacy. The PDS distributes rice and wheat, but pulses, fruits, vegetables, and animal products—essential for balanced nutrition—remain less accessible to poor households. The structural determinants of food insecurity—poverty, inequality, limited access to education and healthcare, and inadequate sanitation—are not addressed by production and distribution policies alone.

Looking forward, three imperatives stand out. **First**, agricultural policy must become explicitly nutrition-sensitive, supporting the production and consumption of diverse, nutrient-rich foods alongside staples. **Second**, the environmental sustainability of production must be enhanced, decoupling productivity growth from greenhouse gas emissions, groundwater depletion, and soil degradation. **Third**, climate resilience must be built into every dimension of the food system, from crop varieties and irrigation practices to early warning systems and safety nets. The challenge is not to abandon the achievements of the Green Revolution but to build upon them a more sustainable, equitable, and nutrition-secure food system for the twenty-first century.

16. Suggestions and Recommendations

For Policymakers:

1. **Rebalance agricultural incentives toward nutrition-sensitive crops.** Reform MSP and procurement policies to provide comparable support for pulses, oilseeds, fruits, and vegetables, reducing the relative advantage enjoyed by rice and wheat. This would encourage diversification toward crops that contribute to dietary quality.
2. **Integrate nutrition objectives into the PDS.** Expand the PDS basket beyond cereals to include pulses, edible oils, and fortified foods. Consider piloting cash or voucher transfers that allow beneficiaries to purchase a diverse range of nutritious foods from local markets.
3. **Invest in climate-resilient agriculture.** Scale up investment in climate-smart technologies including drought-tolerant varieties, micro-irrigation, water harvesting, and early warning systems. The PM-KUSUM solar pump program should be expanded and integrated with groundwater management.
4. **Strengthen the evidence base for food and nutrition security.** Commission independent, methodologically rigorous assessments of nutritional status that address the limitations of both the GHI and official government data. Support longitudinal cohort studies that track the relationship between agricultural interventions and nutritional outcomes.

For Agricultural Research and Extension:

5. **Prioritize research on sustainable intensification.** Increase funding for research on natural farming, integrated pest management, precision agriculture, and soil health

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management. The ICAR's estimated return of ₹13.85 per rupee invested in agricultural research justifies expanded investment .

6. **Develop and disseminate biofortified varieties.** Expand the development and adoption of biofortified staples (iron-rich pearl millet, zinc-rich wheat, provitamin-A maize) that can address micronutrient deficiencies through staple food consumption.

For Food Security Program Implementation:

7. **Enhance PDS targeting and efficiency.** Complete the computerization of PACS and expand the use of Aadhaar-enabled authentication to reduce leakage. The SARTHAK PDS scheme should be implemented with robust monitoring and evaluation .
8. **Link food security with livelihood support.** Integrate PDS with skill development, employment guarantee, and livelihood programs to address the income dimensions of food access. Food security cannot be achieved through distribution alone; households need adequate purchasing power.

For Climate Adaptation:

9. **Develop climate-resilient crop insurance products.** Reform PMFBY to include index-based insurance for weather risks, faster claim settlement, and coverage of a broader range of crops and perils.
10. **Invest in water security.** Prioritize watershed development, aquifer recharge, and demand management in water-stressed regions. The long-term viability of Indian agriculture depends on sustainable water use.

17. Future Scope

1. **Longitudinal nutrition cohort studies.** Research tracking children from birth through adolescence is needed to understand how agricultural interventions, dietary patterns, and environmental factors interact to shape nutritional outcomes.
2. **Climate-crop-nutrition modeling.** Integrated modeling that links climate projections to crop yields, food prices, household incomes, and nutritional outcomes would provide more robust estimates of future food security under different warming scenarios.
3. **Evaluation of natural farming at scale.** As the National Mission on Natural Farming expands, rigorous evaluation of its productivity, profitability, and environmental impacts is essential to inform scale-up decisions .
4. **Political economy of food policy reform.** Understanding the political and institutional barriers to reforming MSP, PDS, and input subsidies is critical for developing feasible reform pathways.
5. **Digital agriculture and food security.** Research on how digital technologies (e-NAM, remote sensing, mobile advisory services) can enhance both productivity and market access for smallholders is needed.
6. **Regional convergence analysis.** Comparative state-level studies could identify the institutional, infrastructural, and policy factors that enable some states to achieve both high productivity and good nutritional outcomes while others lag.

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7. **Food loss and waste.** Research on the magnitude, determinants, and solutions for post-harvest losses in India's food supply chain could identify opportunities to enhance food availability without additional production.

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