



Nutri-sensitive agriculture in India: A comprehensive review

G.S. POOJA¹, S.P. LAL^{2*} AND V.G. REDDY³

^{1,3}*Department of Agricultural Extension Education, Jayashankar Telangana Agricultural University, Hyderabad-500030, India*

^{2*}*Agricultural Technology Information Centre, Directorate of Extension Education, RPCAU, Pusa, Samastipur, Bihar- 848125, India*

**sudhanand.lal@rpcau.in*

Date of receipt: 02.11.2025

Date of acceptance: 24.05.2026

ABSTRACT

Nutri-sensitive agriculture (NSA) has emerged as an essential approach for achieving sustainable food systems, improved health and ecological stability. It integrates nutritional goals with agricultural production through crop diversification, dietary diversity, biofortification and environmentally sustainable practices. Although India has achieved self-sufficiency in food production with a TWR-5, total output of 353.9 million tonnes and national availability of 283.1 million tonnes, widespread malnutrition persists. Around 172.1 million people remain undernourished, and about 586.5 million individuals cannot afford a healthy diet. The prevalence of anaemia among women exceeds 50%, while among children below five years of age, 32.1% are underweight, 19.3% suffer from wasting, and 35.5% are stunted. These nutritional deficiencies highlight the urgent need to integrate nutrition-focused and environmentally responsible strategies into agricultural systems. The recent release of 152 biofortified crop varieties between 2014–2024 has been a significant step towards improving the nutritional value of staple foods, aligning with NSA objectives. The present study examines the need assessment and evolution of NSA in India by analyzing food production trends, affordability of healthy diets and nutritional outcomes from 1951 to 2025. It also describes the initiatives, policies, and interventions that have contributed to combating malnutrition since independence. The study emphasizes the role of environmental sustainability in achieving nutrition goals and suggests strategic integration of nutrition into agriculture through established frameworks of FAO, UNICEF, MSSRF and IFAD.

Key words: Biofortification, food availability, framework, nutri-sensitive agriculture, sustainability

INTRODUCTION

India, being an agrarian country, has witnessed a whopping 500% rise in food grain production since independence, boosting the overall rural economy. In 2023-24, total food grain production was estimated at 332.3 million tonnes (PIB, 2025). Food grain availability on a per capita per day basis rose from 395 g in 1951 to 638.8 in 2023 (Economic survey, 2024-25). Despite sustainably producing food grain, about 172.1 million people in

India were malnourished (FAO, 2025). Over US \$ 12 billion in GDP per year in India is lost to vitamin and mineral deficiencies (HarvestPlus, 2021) and India contributes a third of the global burden of malnutrition (WHO, 2023). India holds 11.1% of the world's extreme poor, a proportion that is steadily decreasing but remains the second largest in absolute numbers after Nigeria, according to recent global poverty estimates (Singh and Singh, 2018). This provides evidence of improved food availability and accessibility; however people still face food

and nutrition insecurity. However, by achieving high levels of food production, India has paved its way towards attaining food security. However, ambiguity remains regarding the achievement of comprehensive nutritional security across the country.

Food security is all about gaining or fulfilling the 4 dimensions such as availability, accessibility, utilization and stability (Gross et al., 2000; Hahn, 2000; Rötten, 2000; Weingärtner, 2009), which, when coupled with adequate food intake and good health, improves nutritional status. Nutritional Security can be defined by the availability, accessibility of diverse, nutritious food (Ruel, 2013). Thus, achieving food and nutritional security primarily depends on agriculture and integrating nutrition into agriculture that pave the way to attain nutritional security with environmental sustainability by providing nutritious and diverse foods. This has led to the emergence of nutri-sensitive agriculture (NSA). The conventional farming system is primarily focussed on food production and productivity aiming at food security while NSA aims to improve the accessibility and availability of nutrient-rich foods. NSA promotes crop diversification and sustainable intensification aimed at both productivity and environmental sustainability (FAO, 2017). NSA not only contributes in striking the nutritional deficiencies but also contributes to 12 sustainable development goal-indicators (Global Food Policy Report, 2016; Yadava et al., 2022; United Nations, 2025).

MATERIALS AND METHODS

This study employed an analytical mixed-methods approach based on the qualitative and quantitative data. The analysis spanned a long-term period from 1990 to 2025, analyzing data exclusively from selected national and international sources. The data sources include Economic Survey of India, National Family Health Survey (NFHS) of India, Indiastat, Press Information Bureau: Prime Ministers Office, India, Global Hunger Index, FAOSTAT, the State of Food Security and Nutrition in the World (SOFI) reports, jointly produced by UN agencies (IFAD, UNICEF, WFP and WHO). The data were examined to provide a holistic

understanding of nutri-sensitive agriculture in India particularly focusing on the pathway toward sustainability.

RESULTS AND DISCUSSION

Food grain production and per capita availability

India's food grain production has shown a six-fold rise since independence achieving macro-level food security (PIB, 2022). Total production has more than doubled from 169.9 Mt (1988-89) to a projected 353.9 Mt in 2024-25 (Fig. 1). The growth is dominated by rice and wheat, whose combined share increased significantly, largely driven by supportive policies and technological advancements since the Green Revolution era. This staple dominance prioritizes calorific yield over nutritional diversity. Pulses (protein-rich) and coarse cereals (nutri-millet), despite recent policy focus (e.g., NFSM-Pulses, Shree Anna), show slower and fluctuating growth; pulses productivity is 3.75 times lower than that of the rice-wheat system (Srivastava and Lal, 2021). Pulses reached a projected 24.3 Mt, and nutri-millet 62.1 Mt in 2024-25. In 2002-03 there was a sharp decline in the food grain production due to a severe drought that occurred leading to a deceleration in GDP growth to 4.0 per cent in 2002-03, mainly because of a sharp decline of 5.2 per cent in the agriculture and allied sector (PIB, 2004).

Per capita food grain availability rose from 395 g/day in 1951 to 514 g/day in 2023 (Fig.2). The previous peak was recorded at 510 g/day in 1991, reflecting shifts in production and population growth. The net per capita monthly availability was approximately 17.3 kg (Singh, 2025). Pulses, an important source of protein, have shown marginal growth in per capita availability, raising concerns about balanced nutrition. However, per capita consumption of cereals has declined amid changing diets, and limited growth in pulses highlights ongoing concerns about nutritional balance despite improved overall food security facing the dual challenge of improving nutritional quality and meeting the needs of a still-growing population (Singh et al., 2023).

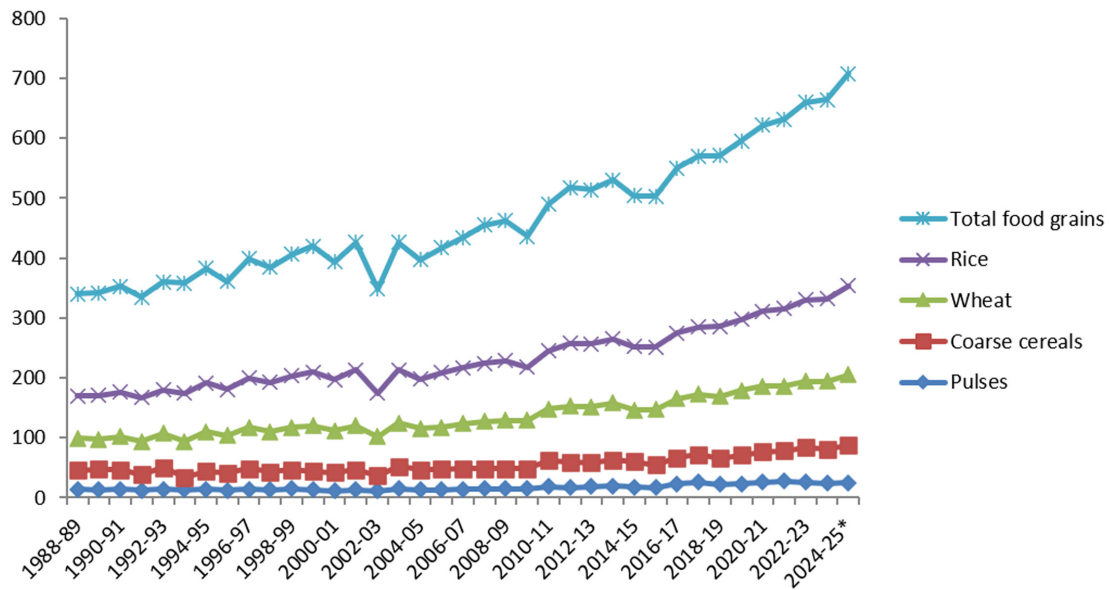


Fig. 1. Food grains production (million tonnes): 1988 - 2025

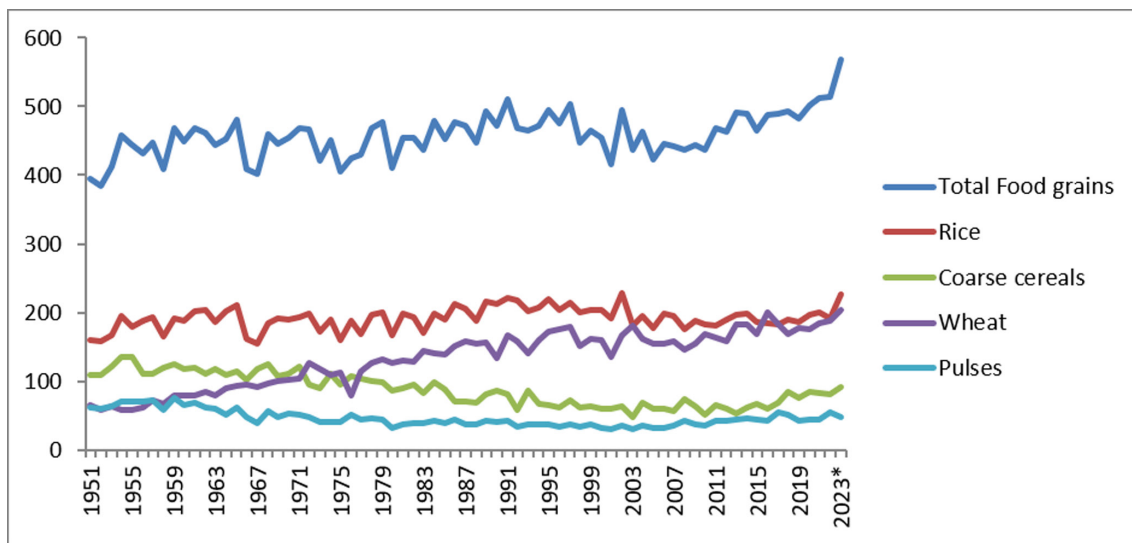


Fig. 2. Per capita availability of food grains (g/day): 1951-2023 (a quadrennial study)

Accessibility

Nearly 80.1 crore beneficiaries, including households under the Antyodaya Anna Yojana and priority households, access subsidized grains through the PDS at over 5.4 lakh fair price shops across India. India's net food grain production has steadily grown, rising from 48.1 Mt in 1951 to 295.6 Mt by 2023, accompanied by increases in net availability, which moved from 52.4 to 289.1 Mt over the same period. The share of food grains

distributed through the PDS expanded from 8 Mt in 1951 to approximately 55–57 Mt annually since 2015 (Table 1), mirroring the nation's commitment to food security and inclusive access. This alignment emphasizes how policy reforms, technological adoption, and expanded irrigation have enabled consistent production gains, often following droughts and key interventions (Swaminathan and Bhavani, 2013). The significant PDS expansion, especially after the enactment of the National Food

Security Act, 2013 and the adoption of targeted subsidies, has played a vital role in supporting vulnerable groups and cushioning food security during the COVID-19 pandemic crisis (George and McKay, 2019; Pooja et al., 2023).

Table 1. Net production, net availability and public distribution of food grains in million tonnes (from 1951 - 2001 decade wise and 2001-2023 year wise)

Year	Net production of food grains (in Mt)	Net availability of food grains (in Mt)	Public distribution
1951	48.1	52.4	8
1961	72	75.7	4
1971	94.9	94.3	7.8
1981	113.4	114.3	13
1991	154.3	158.6	20.8
2001	172.2	156.9	13.2
2002	186.2	189.5	18.2
2003	152.9	170.6	23.2
2004	186.5	183.3	28.3
2005	173.6	170	31
2006	182.5	181.9	31.8
2007	190.1	183.7	32.8
2008	210.2	183.5	34.7
2009	205.2	189.5	41.3
2010	190.8	189.2	43.7
2011	213.9	203.1	47.9
2012	232.9	205.4	44.9
2013	231.9	220.6	44.5
2014	231.9	222.2	43.5
2015	220.5	213.8	53.7
2016	220.1	226.3	56.6
2017	241.7	229.8	57.8
2018	255.3	234.6	56.4
2019	255.7	235.7	56.6
2020	266.6	247.9	56.2
2021	278.4	255.3	53
2022	283.1	259.1	55.9
2023	295.6	289.1	55.8

Food grains stock under targeted public distribution system (TPDS) and other welfare schemes (OWS)

India has a massive food grain stock, equivalent to stacking bags of grain 2.347 times the distance to the moon (Lal et al., 2022). Between 2019 and 2024, food grain stocks under the Targeted Public Distribution System (TPDS) displayed fluctuations driven by procurement levels, consumption patterns, government policies, and interventions. Stocks rose from 458.2 lakh tonnes in 2019 to a peak of 568.5 lakh tonnes in 2020, maintained elevated levels through 2021, and then declined to a low of 332.1 lakh tonnes by 2023, before slightly recovering to 376.6 lakh metric tonnes in 2024 (Fig.3). The accumulation of stocks during the pandemic years (2020–21) was a strategic effort to safeguard food security, expand welfare initiatives like Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY), and manage market uncertainty. The sharp downturn after 2021 was due to higher distribution through welfare schemes, market interventions to stabilize prices, and efforts to reduce excess stocks and associated storage costs, combined with variable harvests and export restrictions. The recent increase in 2024 reflects renewed procurement and government efforts to rebuild buffer reserves. These trends underscore the role of TPDS food grain stocks in addressing both policy shifts and situational demands, ensuring food security, stabilizing prices, and supporting vulnerable populations through timely government interventions.

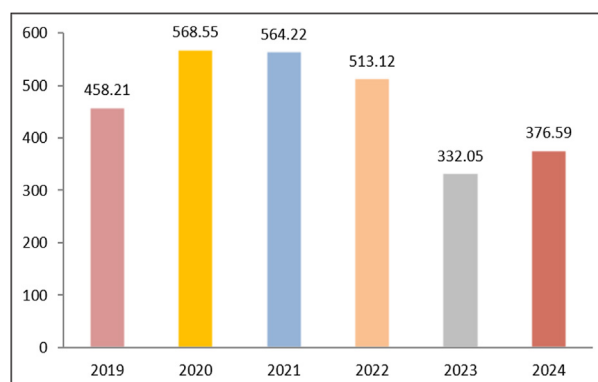


Fig. 3. Stock position of food grains under TPDS and OWS (million tonnes)

Affordability of healthy diet

The number of Indians unable to afford a healthy diet reduced from about 804.9 million in 2017 to 586.5 million in 2024. Correspondingly, India's share of the global population in this category also fell from 27.4% to 22.5% during the same period, paralleling a global decline as the worldwide tally fell from 2,934.2 million to 2,604.6 million (Table 2).

Table 2. Comparative prevalence of unaffordability of healthy diet among people of India and world

Year	India (million)	World (million)	% share of India
2017	804.9	2934.2	27.43
2018	750.3	2818.5	26.62
2019	723.1	2762.1	26.18
2020	780.2	2911.4	26.80
2021	729.4	2746.7	26.56
2022	672.5	2683.7	25.06
2023	617.2	2653.4	23.26
2024	586.5	2604.6	22.52

Despite this progress, India still accounts for over one-fifth of all people globally unable to afford nutritious diets, highlighting the persistent challenge of nutritional security. Improvements are linked to enhanced agricultural self-sufficiency, broader social protection through schemes like the National Food Security Act (NFSA), TPDS and interventions to stabilize food prices, all of which helped prevent further deprivation during COVID-19 (Kaur, 2025). Nonetheless, nearly one-fourth of the world's diet-insecure population remains in India, with continuing constraints such as income inequality, food price inflation, dietary imbalance, and uneven reach of welfare measures. Additional barriers include increased costs of nutritious foods relative to staple grains, climate shocks, erratic weather patterns, inflation, stagnant farm incomes, and declining landholdings, all of which affect dietary diversity and affordability (UN-India, 2022; Jangir and Goswami, 2025; Sushmita et al., 2025).

Nutritional health status

The National Family Health Survey (NFHS) data and FAOSTAT undernourishment statistics reflect mixed progress for nutrition and health in India. Prevalence of anaemia in non-pregnant women (15–49 years) increased from 51.8% (NFHS-2) to 57.2% (NFHS-5). Anaemia among pregnant women fluctuated, with a low of 49.7% (NFHS-2), peaking at 57.9% (NFHS-3), and stabilizing around 52.2% in NFHS-5. Anaemia rates among adolescent girls (15–19 years) rose from 54.1% in NFHS-4 to 59.1% in NFHS-5 (Fig. 6). For men (15–49 years), anaemia was lowest in NFHS-4 (22.7%), but increased to 25% in NFHS-5 (Fig. 7).

The estimated number of undernourished people in India peaked at 247 million (2003–2005), declined steadily to 143.9 million (2016–2018), but rose again between 2018 and 2022, reaching 201.9 million (2020–2022) before falling to 172.1 million (2022–2024) as reflected in Fig. 4. 12% of the Indian population is undernourished. This reflects both progress during the push for food security and setbacks due to recent economic, climatic, and pandemic disruptions. Stunting prevalence declined from 51% (NFHS-2) to 35.5% (NFHS-5), while underweight decreased from 42.7% to 32.1%. Wasting rates fluctuated, peaking at 22.9% in NFHS-3, but fell to 19.3% in NFHS-5 (Fig. 5). Improvements are significant, but persistent rates remain among the highest globally, India ranks second in child wasting and twenty-first in child stunting in the Global Hunger Index, 2025.

Despite overall declines in stunting and underweight among children, the reduction rate is not sufficient to meet national and global nutrition targets, particularly after modest setbacks in recent years associated with socioeconomic and health system shocks (Mukherjee et al., 2022; PIB, 2023). Anaemia remains an acute public health challenge, especially among women and children, with NFHS-5 revealing a worsening trend compared to NFHS-4. Women's anaemia prevalence remains above 50%, and the gender gap is clear, as demonstrated by much lower rates among men (Sushmita et al., 2025; Jindal et al., 2025; Tripathi et al., 2023). The uptick in undernourished population since 2018

underscores the importance of resilient food and nutrition systems (Papola, 2025). Disruptions due to COVID-19, inflation, and uneven welfare access disproportionately affected vulnerable groups.

Multi-factorial causes such as mother's education, socio-economic status, sanitation, birth order, and maternal nutritional status drive child malnutrition in India (Shah et al., 2024).

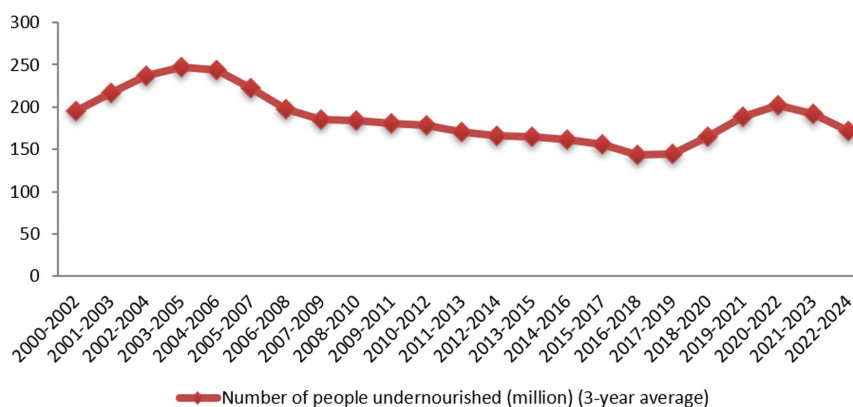


Fig. 4. Number of people undernourished in India (2000-2024)

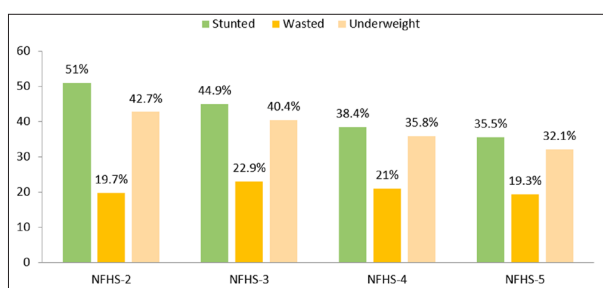


Fig. 5. Anthropometric indicators of child nutrition

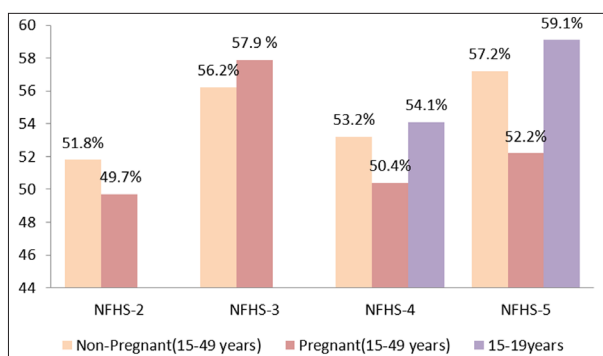


Fig. 6. Prevalence of anaemia in women

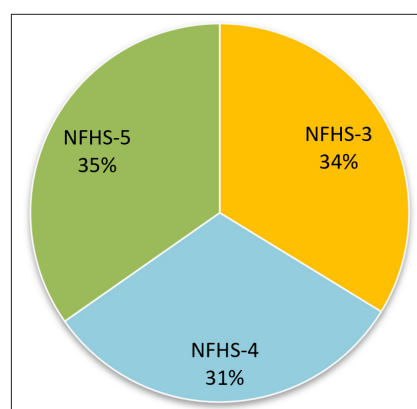


Fig. 7. Prevalence of anaemia in men

Global Hunger Index

India ranked 102nd out of 123 countries in the Global Hunger Index (GHI) 2025, with a score of 25.8, placing it in the “serious” hunger category (Table 3). The GHI score has gradually improved since 2000, but remains well above the “moderate” threshold, indicating persistent challenges to food security and nutrition.

Table 3. Global Hunger Index score of India (2000-2025)

Global Hunger Index	2000	2008	2015	2023	2025
Low					
Moderate					
Serious			29.2	28.7	25.8
Alarming	38.4	35.5			
Extremely alarming					

Schemes or initiatives in India to ensure food and nutritional security

India's approach to food and nutrition security has progressed from a focus on broad self-sufficiency to targeted nutritional interventions, beginning with the establishment of the Public Distribution System in 1947 and expanding through initiatives like Antyodaya Anna Yojana, (2000), National Food Security Act, (2013) and the major extension of Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY) in 2024 (Table 4). Nutrition-specific measures such as Integrated Child

Development Services (ICDS), rice fortification, Shree Anna Abhiyan, and the diversification of crops mark a gradual shift toward enhancing diet quality and addressing micronutrient deficiencies. The rebranding of the National Food Security Mission to the National Food Security and Nutrition Mission in 2024-25 expanded its coverage to include pulses and coarse cereals, supporting comprehensive nutritional outcomes, while the Mission for Aatmanirbharta in Pulses (2025) represents a recent push for pulse self-reliance and addressing chronic dietary deficits.

Table 4. Food and nutritional security programmes in India

Year	Scheme
1947	Public Distribution System
1970-71	Balwadi Nutrition Programme
1975	Integrated Child Development Services (ICDS) Scheme
1993	National Nutrition Policy
1995	Mid-Day Meal Scheme
1999	Annapurna Scheme
2000	Antyodaya Anna Yojana (AAY)
2005	National Rural Health Mission (NRHM)
2007	National Food Security Mission (NFSM)
2007	Rashtriya Krishi Vikas Yojana (RKVY)
2010	Indira Gandhi Matritva Sahyog Yojna (IGMSY)
2011	Mahila Kisan Sashaktikaran Pariyojana (MKSP)
2013	National Food Security Act (NFSA)
2013	National Health Mission (NHM)
2015-16	Direct Benefit Transfer (DBT) in PDS
2017	National Nutrition Mission (Poshan Abhiyaan - 2018)
2017	Pradhan Mantri Matru Vandana Yojana (PMMVY)
2017	Nutri-sensitive Agricultural Resources and Innovations (NARI)
2017	Knowledge Systems for Homestead Agriculture Management in Tribal Areas (KSHAMTA)
2017	Value Addition and Technology Incubation Centers in Agriculture
2019	One Nation One Ration Card
2019	Rice Fortification Initiative
2021	Pradhan Mantri POSHAN (POshan SHakti Nirman) Scheme
2021	Nutri-Smart Village Programme
2023	Shree Anna Abhiyan
2024	Pradhan Mantri Garib Kalyan Anna Yojana (PMGKAY)
2024-25	National Food Security and Nutrition Mission (NFSNM)
2025	Mission for Atmanirbharta in Pulses

The clear escalation in initiatives since 2014, particularly between 2014 and 2024, is highlighted by the introduction of 152 biofortified crop varieties (Fig. 8) and widespread launch of Poshan Vatikas, which enable communities to grow and access nutritious, diverse foods year-round (Kumari and Lal, 2023) with an emphasis on education and empowerment of women and children. Collectively, flagship programs like POSHAN Abhiyaan and these nutrition-sensitive agricultural interventions exemplify India's integrated, multi-level policy response, shifting decisively from simple calorie adequacy towards holistic, sustainable nutritional security.

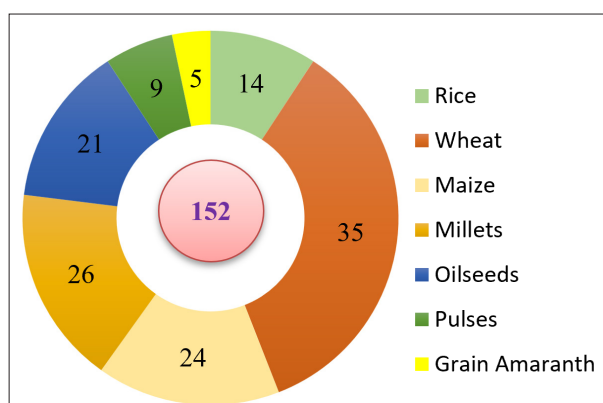


Fig. 8. Total number of biofortified varieties released during 2014 to 2024

Nutri-sensitive agriculture

Experts and agencies emphasize that accelerating progress in India's food system will require intensified nutrition-sensitive policies, greater investment in resilient local agriculture, expanded support for dietary diversity, and women's empowerment. Without this integrated approach, malnutrition risks being entrenched, impeding the country's achievement of UN sustainable development goals (UN-India, 2022; Gulati et al., 2023; Jangir, 2025; Singh, 2025). Nutrition-sensitive agriculture places nutritionally rich foods, dietary diversity, and food fortification at the core of overcoming malnutrition and micronutrient deficiencies, as advocated by FAO (2014). This concept involves integrating nutrition into agricultural policy through crop

diversification, biofortification, dietary diversity, nutrition education, and gender-inclusion, aiming to improve the nutritional status of vulnerable populations. It also recognizes women's critical role in food production and nutrition outcomes.

Several frameworks integrate nutrition with agriculture and health care systems that have been presented below.

UNICEF conceptual framework for under-nutrition

The UNICEF conceptual framework for undernutrition describes how a range of factors at national, community, household, and individual levels that influence nutritional status. It highlights that undernutrition has immediate causes (poor diet and disease), underlying causes (household food insecurity, inadequate care, and poor health services and sanitation), and basic causes (social, economic, and political conditions). The framework underscores that children's nutrition depends on access to nutritious food, adequate care, healthcare services, and a safe environment. These influences can trap families in cycles of illness and poverty across generations and highlight the importance of addressing nutrition early in life to prevent stunting, poor brain development, and long-term disease. Understanding these interconnected factors helps guide effective interventions to reduce undernutrition and improve public health.

Duncan et al. (2022) expanded this framework to integrate the food and agriculture sector with nutrition outcomes. The integration recognizes that the food and agriculture sector is deeply connected to underlying causes of malnutrition. The expanded framework identifies how nutritional outcomes and agriculture are linked in six important ways through evidence-based food and agriculture system components: (i) Food (ii) Income (iii) Food prices (iv) Women's empowerment (v) Women's time utilization (vi) Women's health and nutritional status. The food and agriculture sector facilitates interventions through multiple pathways such as production activities, processing activities, consumption activities and farmer practices and behaviour. This framework

helps identify intervention points for planning and implementing multisectoral nutrition programs.

Farming systems for nutrition-MSSRF

The FSN framework is designed as a comprehensive approach to address nutritional deficiencies through agriculture-based interventions. The framework was developed to explore nutrition-sensitive agricultural interventions and tested in India from 2013-2018. The model was designed with community members consultation to create a participatory approach that addresses local nutrition needs. The framework recognizes the potential to impact nutrition outcomes, particularly given that farming is the main livelihood for a majority of people in India while the country continues to host a large undernourished population. The M.S. Swaminathan Research Foundation (MSSRF) has been promoting FSN both in its regular programmes and Leveraging Agriculture for Nutrition in South Asia (LANSA) project, supported by UKAid. The Key components include production diversification, animal food access, biofortification and capacity building.

The framework utilizes location-specific FSN models promoting sustainable and healthy diets from locally available food resources (plant and animal). The approach has demonstrated feasibility in addressing nutrition deficiencies in farm families as evidence by higher production and consumption of nutrient-rich foods, improved household dietary diversity, and enhanced understanding and acceptance of nutrition-sensitive agriculture (Girard et al., 2012; Pradhan et al., 2021). The framework has shown measurable improvements in the number of items consumed under each food group, frequency of food consumption, and average per capita intake of nutrient-rich foods.

FAO framework for nutri-sensitive agriculture

The framework for nutri-sensitive agriculture, outlined by FAO (Herforth and Ballard, 2016) presents a simplified impact pathway understanding how agricultural interventions influence nutrition by addressing the underlying determinants (food access and care practices) of nutritional status and the broader food and health environment. Six primary outcome areas are identified as food access

(through production and market diversity), on-farm availability and diversity, income and livelihoods, women's empowerment, nutrition and food safety knowledge, and natural resource management alongside health and sanitation. Improvements in agricultural production, income, and empowerment drive access to diverse, safe, and nutritious foods, enhance dietary diversity, and support overall nutritional improvements, while effective natural resource management further reduces disease burden. The framework recommends selecting context-appropriate indicators, such as dietary diversity scores (Minimum Dietary Diversity for Women [MDD-W], Household Dietary Diversity) [HDDS], food security indices (Food Insecurity Experience Scale) [FIES], economic measures (income, asset ownership, gender-disaggregated sales), women's empowerment surveys, and health and sanitation access metrics. Projects should tailor evaluation metrics to realistic impact pathways and local context, prioritizing outcomes such as diet quality and food access over direct anthropometric changes, with systematic documentation of broader market, health, and social impacts for holistic assessment. This approach guides the design, monitoring, and evaluation of nutrition-sensitive agriculture, demonstrating how policy, agricultural systems, markets, practices, and resource stewardship together shape improved nutritional outcomes.

IFAD framework

The International Fund for Agricultural Development framework for mainstreaming nutrition-sensitive agriculture is a comprehensive model designed to transform rural agricultural investments and policies, aiming to build resilient and nutrition-enhancing food systems for smallholders and marginalized groups. The framework is guided by principles that prioritize holistic impact by embedding nutrition goals throughout project stages, multisectoral convergence (linking agriculture with health, sanitation, education, and social protection), and equity, with an emphasis on gender sensitivity, empowerment, and support for the most vulnerable. Strategic action areas include; systematic mainstreaming of nutrition into all investment operations and strategies; strengthening

the capacity of stakeholders through training and technical assistance; policy influence and advocacy for enabling environments aligning projects with global and national nutrition strategies; knowledge management and evidence generation using research, monitoring, and evaluation; building organizational capacity for nutrition mainstreaming with dedicated resources.

IFAD's practical project design involves starting with situation analysis, supporting nutrition-sensitive value chains, promoting dietary diversity, empowering excluded groups, advancing nutrition education and behaviour change, and rigorous monitoring with tailored nutrition indicators. Of special note is support for neglected and underutilized species (NUS), which enhance agrobiodiversity and dietary diversity. By integrating nutrition at every level, from policy to implementation, the framework sets benchmarks for global multisectoral nutrition governance, driving the transition to sustainable, inclusive, and nutrition-sensitive agricultural development.

CONCLUSION

Nutri-sensitive agriculture in India is essential for achieving food and nutrition security by integrating diverse, nutrient-rich foods with sustainable production practices. Strengthening these interventions is crucial for environmental sustainability and improved health outcomes for the population. Learning from leading frameworks such as those of the FAO, IFAD, UNICEF, and context-specific models like the Farming Systems for Nutrition (FSN), it is evident that integrating nutrition into agriculture demands a multisectoral and participatory approach, emphasizing gender equity, crop diversification, biofortification, and inclusive value chain development. These frameworks highlight the importance of empowering women, promoting dietary diversity, enhancing knowledge, attitudes, and practices (KAP), and strengthening behavioural communication to encourage the adoption of nutritious choices from farm to consumer. By operationalizing these principles, India can transform its agricultural sector into a primary engine for nutrition security and sustainable development, ensuring that

improvements in production directly translate into improved nutritional outcomes for all segments of society.

REFERENCES

- Duncan, E., Ashton, L., Abdulai, A.R., Sawadogo-Lewis, T., King, S.E., Fraser, E.D.G., Vosti, S., Haines, J., Knight, F. and Robertson, T. 2022. Connecting the food and agriculture sector to nutrition interventions for improved health outcomes. *Food Secur.*, **14**(3): 657–675.
- FAO. 2014. Nutrition-Sensitive Agriculture. Rome: Food and Agriculture Organization of the United Nations.
- FAO. 2017. Nutrition-sensitive agriculture and food systems in practice: Options for intervention. Revised edn. FAO, Rome, Italy.
- FAO. 2025. *FAOSTAT: Suite of food security indicators*. FAO, Rome, Italy.
- George, N.A. and McKay, F.H. 2019. The public distribution system and food security in India. *Int. J. Environ. Res. Public Health*, **16**(17): 3221.
- Girard, A.W., Self, J.L., McAuliffe, C. and Olude, O. 2012. The effects of household food production strategies on the health and nutrition outcomes of women and young children: A systematic review. *Paediatr. Perinat. Epidemiol.*, **26**: 205–222.
- Global food policy report. 2016. IFPRI, Washington, DC, USA.
- Gross, R., Schoeneberger, H., Pfeifer, H. and Preuss, H. 2000. Four dimensions of food and nutrition security: Definitions and concepts.
- Gulati, A., Paroda, R., Puri, S., Narain, D. and Ghanwat, A. 2023. Food system in India: Challenges, performance and promise. In: *Science and innovations for food systems transformation*. pp. 813–828.
- Hahn, H. 2000. *Conceptual framework of food and nutrition security*. FAO/ In WEnt. pp. 1–15.
- HarvestPlus. 2021. Addressing malnutrition and improving public health in India.
- Herforth, A. and Ballard, T.J. 2016. Nutrition indicators in agriculture projects: Current measurement, priorities and gaps. *Glob. Food Secur.*, **10**: 1–10.
- Jangir, R.K. and Goswami, A. 2025. Food security in India: Concerns and challenges. *Scholars Bull.*, **11**(1): 7–12.
- Jindal, H., Suresh, V., Agarwal, S., Vyas, P. and Bari, N. 2025. Understanding the dynamics of malnutrition dichotomy in Ind.: Trends and insights from the National Family Health Surveys. *Dialogues Health*, Feb 23;6:doi:10.1016/j.dialog.2025.10209.

- Kaur, G. 2025. Food security in Ind.: A comprehensive examination of progress, challenges and pathways to sustainable development. *Int. Multidiscip. Res. J.*, **7**(1).
- Kumari, R. and Lal, S.P. 2023. Review on Navagraha Vatika: An eco-friendly pathway to landscape gardening. *e-planet*, **21**(2): 103–110.
- Lal, S.P., Mahendra, A. and Singh, A. 2022. Dietary analysis of traditional food cultures in India: An overview of 2600 BCE to the 21st century. *Toros Univ. J. Nutr. Gastron.*, **1**(1): 119–127.
- Ministry of Finance, Government of Ind. 2025. *Statistical appendix: Economic survey 2024–25*. Govt. of Ind., New Delhi, India.
- Mukherjee, A., Rizu and Parashar, R. 2022. Longitudinal trends in the health outcomes among children of the North Eastern States of Ind.: A comparative analysis using national DHS data from 2006 to 2020. *Eur. J. Clin. Nutr.*, **76**(11): 1528–1535.
- Papola, J. 2025. Ecosystem services provided by water birds in wetlands: A review. *e-planet*, **23**(2): 103–114.
- Pooja, G.S., Singh, A.K., Lal, S.P. and Baruah, B. 2023. Livelihood security and its determinants among farmers during COVID-19 pandemic in Telangana, India. *Ind. Res. J. Ext. Educ.*, **23**(2): 16–23.
- Pradhan, A., S, R., DJ, N., Panda, A.K., Wagh, R.D., Maske, M.R. and RV, B. 2021. Farming system for nutrition- A pathway to dietary diversity: Evidence from Ind. *PLoS One*, **16**(3): e0248698.
- Press Information Bureau, Government of Ind. 2004. *Economic editors' conference-November 17–18, 2004: State of the economy*. Govt. of Ind., New Delhi, India.
- Press Information Bureau, Government of Ind. 2022. *Increased food grain production in India*. Govt. of Ind., New Delhi, India.
- Press Information Bureau, Government of Ind. 2023. *Steady improvement in indicators for malnutrition*. Govt. of India, New Delhi, India.
- Press Information Bureau, Government of Ind. 2025. *Strengthening Ind.'s agricultural backbone: Key achievements and government initiatives*. Govt. of India, New Delhi, India.
- Rötten, U. 2000. *Food and nutrition security: Problems and perspectives*.
- Ruel, M. 2013. Food security and nutrition: Linkages and complementarities. In: *The road to good nutrition*. pp. 24–38.
- Shah, G., Siddiqi, M., Shankar, P., Karibayeva, I., Zubair, A. and Shah, B. 2024. Decoding India's child malnutrition puzzle: A multivariable analysis using a composite index. *Children*, **11**(8): 902.
- Singh, K. 2025. *Growing more, eating less: Ind.'s cereal consumption patterns*. Centre for Economic Data Analysis, Ashoka Univ., India.
- Singh, K.M., Ahmad, N. and Kumari, S.S. 2023. Dimensions and determinants of India's food security. *Agric. Assoc. Text. Chem. Crit. Rev. J.*, **11**(3): 429–445.
- Singh, K.M. and Singh, P. 2018. *Nutritional-sensitive and sustainable agricultural development-An overview*. Munich Pers. RePEc Arch.
- Srivastava, R.K. and Lal, S.P. 2021. Relational analysis of food grains and its seed production in Ind.: Current scenario and future prospects. *Biol. Forum*, **13**(2): 726–731.
- Sushmita, K., Sharma, P. and Lal, S.P. 2025. Global trajectory of organic agriculture: Trends, challenges and opportunities for a sustainable planet. *e-planet*, **23**(1): 37–46.
- Swaminathan, M.S. and Bhavani, R.V. 2013. Food production and availability-Essential prerequisites for sustainable food security. *Ind. J. Med. Res.*, **138**(3): 383–391.
- Tripathi, S., Pathak, V.K. and Lahariya, C. 2023. Key findings from NFHS-5 India report: Observing trends of health indicators between NFHS-4 and NFHS-5. *J. Fam. Med. Prim. Care*, **12**(9): 1759–1763.
- UN-India. 2022. *Nutrition and food security*. United Nations India, New Delhi, India.
- United Nations. 2025. *The sustainable development goals report 2025*. United Nations, New York, USA.
- Weingärtner, L. 2009. The concept of food and nutrition security. In: *Achieving food and nutrition security*, **3**: 21–52.
- WHO. 2023. *Nutrition and promotion profile model: Ending the inappropriate promotion of food products for older infants and young children*. WHO, South-East Asia.
- Yadava, D.K., Choudhury, P.R., Hossain, F., Kumar, D., Sharma, T.R. and Mohapatra, T. 2022. *Biofortified varieties: Sustainable way to alleviate malnutrition*. 4th edn. ICAR, New Delhi, India, p. 106.