What do we know about THE FUTURE OF FOOD SYSTEMS IN INDIA?

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Key messages

- Rapid growth in the livestock and fisheries subsectors, driven by increasing demand, has advanced the frontiers of agricultural growth in India.
- Irrigation plays the dual role of enhancing both productivity and resilience in agriculture, but increasing reliance on groundwater for irrigation and the consequent decline in groundwater levels impede the sustainable transformation of India's agrifood production systems.
- Although climate change is a significant challenge to the sustainability of agriculture, implementation of climate-smart interventions can significantly improve agricultural productivity and resilience.
- Changing dietary patterns reinforce the need to reshape agricultural policies to promote diversification of agriculture in favor of nutrient-dense foods, including animal-source foods and fruits and vegetables.
- Diversification may contribute to the enhanced sustainability of natural resources, mitigate risk, and augment farm income, thereby addressing nutrition insecurity and reducing farm poverty.
- Enhancing self-sufficiency in specific commodities, such as edible oils and pulses, requires technological advancements and safeguards against low-cost imports.

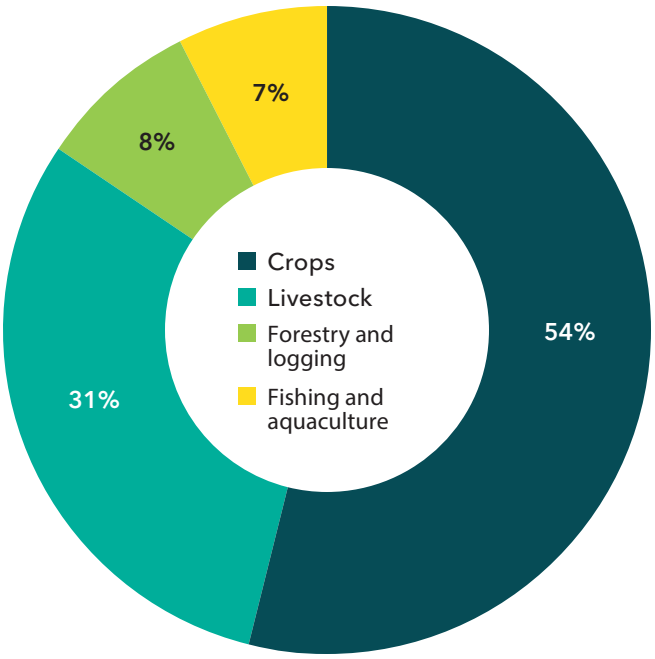
RECENT TRENDS AND CHALLENGES

The early 1990s marked a critical juncture in the Indian economy, with economic reforms signaling a departure from the historically modest rate of growth of approximately 3 percent. The economic reforms encompassed: (1) liberalization of trade by reducing import barriers and customs tariffs and devaluing the currency; and (2) liberalization of domestic markets by reducing licensing requirements for private sector investment, easing regulations, reducing corporate taxes, and decontrolling public sector monopolies to integrate the Indian economy with the global market. Consequently, the Indian economy transitioned to a higher, more sustainable growth trajectory. Since 1991, the country has experienced a robust growth rate of 6.3 percent (based on India, Ministry of Finance 2024).

India seeks to attain the status of a developed economy by 2047, coinciding with the centennial of its independence, with per capita income anticipated to increase to US$22,000 from the current US$2,500. Its strategy focuses on macroeconomic growth, but equally emphasizes inclusive development. Central to this strategy is the self-reinforcing virtuous cycle of investment, in which public sector investments are complemented by private sector initiatives. As the economy grows and disposable income increases, consumption patterns will shift toward nonfood items. However, the food basket is also expected to transition from calorie-dense cereals to pulses, fruits, vegetables, milk and meat that are richer in proteins and other nutrients. Meeting the evolving consumer preferences will necessitate changes in the food production system.

India's agriculture sector plays a vital role in economic transformation. It is crucial not only for overall economic growth, but also for the nation's food security and farmers' welfare. The sector contributes 14.5 percent to gross value added (GVA) and engages 45 percent of the total workforce. The sector has undergone substantial changes over the past six decades; the biochemical-based Green Revolution in the mid-1960s marked a pivotal moment in its development, and led to a substantial increase in food production within a short period of time. The success of the Green Revolution inspired similar transformative changes in dairying, termed the "White Revolution," and in fisheries, known as the "Blue Revolution." Poultry production too witnessed tremendous growth. The cumulative impact of these agricultural revolutions was profound, propelling India toward self-sufficiency in food production by the late 1980s, and enhancing its capacity to cope with risks to food security. Furthermore, increased agricultural production has opened new avenues for economic growth through agricultural exports. However, the country depends heavily on imports of edible oils and pulses to meet growing demand.

FIGURE 1 Composition of agriculture and allied sectors in India, 2022/23



Source: India, Ministry of Statistics and Programme Implementation (2024).

Agriculture sector performance is best understood by examining its components. While the crop subsector continues to dominate agricultural GVA (54 percent), the livestock and fisheries subsectors account for a sizable share (Figure 1). A closer look at growth trends over the past decade (2012/13 to 2022/23) reveals a dynamic shift within the agricultural landscape. The crop subsector experienced modest growth of 2.1 percent per year, versus impressive growth of 7.6 percent and 8.9 percent in the livestock and fisheries subsectors, respectively. This robust growth may be attributed to factors such as changing dietary preferences in favor of protein-rich foods.

The average landholding in India is 1.08 hectares (ha), down from 2.28 ha in 1970/71. Approximately 70 percent of landholdings are 1 ha or smaller. How has agricultural growth translated into farmers' welfare? Farmers' incomes

have not increased much. Between 2012/13 and 2018/19, farmers' income in real terms increased at an annual rate of 3 percent. Nonetheless, their income sources changed. Due to the sluggish growth in farm income coupled with tiny landholdings, many farm households increasingly shifted toward wage labor during the same time period. Wage income now accounts for 40 percent of farmers' total income, surpassing income from crops (37.0 percent) and livestock (15.5 percent).

Furthermore, significant interpersonal and interregional disparities persist in agriculture. While land productivity tends to converge across regions, labor productivity does not (Balaji and Deb Pal 2014), potentially due to the relative abundance of labor compared to land. Farm income, encompassing both crop and livestock, has been gradually converging across districts, albeit at a slower rate (<1 percent), particularly among lower-income groups. The primary factors influencing these trends are irrigation, agricultural diversification, and market access. Notably, middle-income farmers tend to benefit more from these trends than their wealthiest and poorest counterparts (Balaji and Gopinath 2023).

Climate change is a major threat to both productivity and income growth. Since 1980/81, climate-related risks have reduced the country's agricultural growth by one-fourth, despite technological advancements (Birthal, Hazrana, and Negi 2021a). Sustained income growth is projected to increase India's greenhouse gas (GHG) emissions per capita by 40 percent in 2030 (Karstensen et al. 2020). Nonetheless, climate-smart agricultural practices have significant potential for reducing production risk for farmers, with studies indicating a reduction range of 12–25 percent (Deb Pal, Kumar, and Patan 2022). Practices such as crop diversification, improved water management, and soil conservation not only help farmers adapt to changing climate conditions but also contribute to mitigation by reducing GHG emissions from agricultural activities. It is noteworthy that when these practices are implemented jointly, their effect on both productivity and resilience is greater than when they are implemented in isolation (Birthal, Hazrana, and Negi 2021b). Furthermore, a nationwide program on crop insurance was implemented, although its coverage remains limited to one-third of the cropped area.

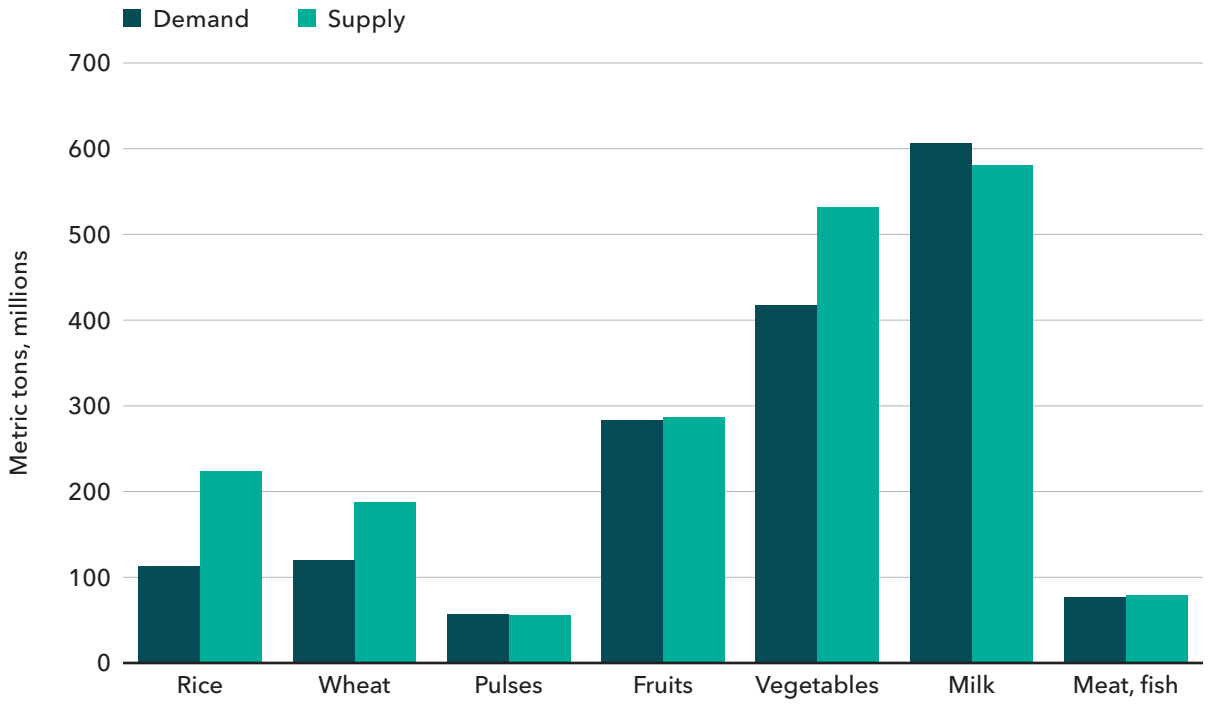
Implementation of climate-smart practices and insurance on a large-scale still face challenges, primarily because farmers lack access to financial resources. Evidence indicates that financial access significantly affects productivity and resilience. Birthal et al. (2024) find a 24 percent increase in productivity and a 16 percent reduction in downside risks when farmers have access to credit. This underscores the need for more robust and formal financial support systems to help farmers adopt technologies and practices for risk mitigation. Irrigation positively impacts agricultural productivity and its resilience, but the decline in groundwater levels — particularly in the Green Revolution states of Punjab and Haryana — raises significant concerns about the long-term sustainability of India's water use. In fact, benefits of irrigation have started tapering off (Birthal et al. 2021c). Despite various policy efforts to regulate groundwater use, measures have largely been ineffective (Kishore et al. 2024; Rosencranz et al. 2021). The Government of India has been making efforts to wean farmers away from paddy cultivation and promote micro-irrigation. However, the effectiveness of these interventions has been limited, highlighting the challenge of balancing agricultural productivity with sustainable water management.

LATEST FORESIGHT RESEARCH

Income growth and population dynamics are key drivers of food security, and significantly influence the transformation of food systems. Food consumption patterns over the past three decades indicate that cereals and pulses are no longer the predominant food items for households in India. In both rural and urban areas, cereals constitute only approximately one-tenth of total food expenditure, while only 4 percent of spending is allocated to pulses (India, Ministry of Statistics and Programme Implementation 2024). Conversely, food demand and supply projections for India suggest a surplus of rice and wheat, two major staples, by 2047/48 (Figure 2). However, projections for high-value food commodities such as fruits, milk, meat, and fish (on which a sizable share of income is spent) demonstrate only a narrow gap between demand and supply (India, NITI Aayog 2024a). This underscores the necessity for India to accelerate its transition toward a more nutrient-dense and value-based production system, achieved through both crop diversification and expansion of cultivation of these essential foods.

Ex ante research suggests that shifting cropland from staple crops like rice and wheat to nutri-cereals such as

FIGURE 2 Demand and supply projections for major food items for 2047/48 (million metric tons)



Source: GoI (2024d).

sorghum and pearl millet not only reduces farm subsidies but can also help mitigate GHG emissions (for example, if farmers adopt a millet-based cropping system) (Balaji 2024). If households return to the level of pearl millet consumption seen in the early 1990s, the government could save up to an estimated US$75 million in farm subsidies. This implies that these savings could be reinvested in agriculture to fund climate adaptation and mitigation, thereby supporting a more sustainable food system. Additionally, the transition to nutri-cereals could result in a reduction in net GHG emissions of 3.3–3.6 million metric tons of CO_2 equivalent (MMT CO_2e), contributing to both environmental sustainability and food security.

India is currently the world's largest importer of edible oil and pulses. Approximately 70 percent of domestic demand for edible oils and 10 percent for pulses are met through imports. Projections suggest that India will continue to face a shortfall in edible oil supply through 2047/48 (India, NITI Aayong 2024b). On the other hand, 12 million ha of rice-cropped area are left uncultivated in the alternate seasons. This rice-fallow land is often proposed as a potential area for pulses and oilseed cultivation, aiming to reduce India's reliance on imports. The persistent dominance of pro-liberalization policies over self-reliance strategies is frequently cited as a key factor behind such a huge dependence on imports of these commodities. If the current low-tariff regime persists, India will likely continue to rely on imports of edible oils to meet domestic demand. Interestingly, evidence indicates that even if tariffs on edible oil are increased, the impact on imports may be limited and may not lead to a significant increase in production of oilseeds and pulses (Balaji et al. 2022; Balaji, Umanath, and Arun 2021). This suggests the need for a technological breakthrough in their production.

Inflation control measures in India have often involved imposing export bans on key commodities, such as rice, wheat, and sugar. While stable trade policies can be beneficial in the long run, the uncertain impacts of climate change can disrupt the transition of the food system, particularly if sufficient investments are not made. Projections indicate that temperatures in India could rise by 1.1–5.1°C by 2100 under the SSP5 8.5 scenario (Kumar et al. 2023). This could adversely affect agricultural productivity, including paddy and wheat, two of the country's most important staples. Pulses and oilseeds, predominantly grown in rainfed areas, are also expected to face yield decline. Projections suggest that yield reductions

could range from −1.8 percent to −6.6 percent under the RCP 4.5, and from −7 percent to −23 percent under the more extreme RCP 8.5 (Birthal et al. 2021d). The financial implications of climate change are particularly significant, as they can impede the necessary actions for adaptation and mitigation. In the absence of adequate financial support, climate change can exacerbate the demand for food imports, further straining the economy.

KEY GAPS AND OPPORTUNITIES FOR FORESIGHT RESEARCH

The existing body of research has yielded valuable insights into the transformation of India's food system. However, there is a pressing need to broaden the scope of foresight research in this area. By exploring potential future scenarios, foresight research could facilitate proactive decision-making, foster innovation in agricultural ecosystems, and enhance equitable food access. For example, yields for several key crops in India — including staples, coarse cereals, pulses, and oilseeds — remain below the global average (GoI 2024f). Studies demonstrate that investments in agricultural research in India yield significant returns, with every rupee invested generating Rs 13.85 (Kandpal, Birthal, and Mishra 2024). A comprehensive foresight exercise could help project potential yield improvements of these crops and provide guidance on the means to enhance total factor productivity through research investments. This approach is equally pertinent for addressing crop yield disparities. For critical commodities such as oilseeds and pulses, on which India's import reliance is substantial, foresight research that anticipates potential shifts in future trade dynamics could inform the development of alternative strategies to safeguard the food supply and counteract the ramifications of trade disruptions.

Foresight research can provide crucial insights into addressing public health concerns. Changes in food consumption patterns have led to the rise in overweight as a public health issue, alongside the persistent challenges of undernutrition and micronutrient deficiencies (Meenakshi 2016). By employing foresight research, it may be possible to evaluate the welfare effects of a food system that emphasizes improved nutrition and promotes consumption of fruits and vegetables while restricting meat and sugar intake, particularly for low-income populations.

Exploring market reforms that promote collective action in agriculture is another area in which foresight research can contribute. Expanding collective institutions, such as farmer-producer organizations and self-help groups, and enhancing farmers' access to markets, credit, and extension services have been shown to positively impact income, yield, and product quality (Bizikova et al. 2020). Although India has made significant strides in promoting these collectives, foresight research that informs their effective scale-up and ensures their sustainability could play a crucial role in creating more inclusive and sustainable food systems in the future. The significance of foresight research extends to restructuring agricultural support systems, preserving agroclimatic diversity, and assessing the political, economic, and environmental viability of such transformations.

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Related chapters on the future of food system drivers and impacts, regional and national perspectives, food commodities, and foresight tools are available in our Table of Contents.

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