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Governance Transformed

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Chapter 4. Indian Agriculture: Green Revolution Stagnates, Allied Sectors Grow

Siraj Hussain¹⁰

Introduction

India's agriculture has provided food security to a large population. This was possible due to the success of the Green Revolution. However, in the last few years, it has come in for a lot of criticism. It has been blamed for the deterioration of soil, depletion of underground water resources, excessive use of chemical fertilisers and pesticides, and poorer quality of food grains produced in the country. The residues of chemicals are also blamed for the prevalence of cancer in certain pockets of India. While some of these points may be true, it is also a fact that in the absence of the Green Revolution, India would not have found itself capable of feeding the increasing population in the country. Indian agriculture is a success story, but it faces several challenges, most notably from climate change.

In the last two decades, crop productivity in the original Green Revolution has stagnated, but the country has achieved great success in the allied sectors of horticulture, dairy, and fisheries.

India's success in achieving food security is a fascinating story of the coming together of science, governance, and

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farmers' willingness to adopt technological advances. It has inspired several food-insecure countries in Africa and Asia.

Indian Agriculture at Independence

When India achieved independence from British colonial rule, the country was very poor, and the agriculture sector was hardly able to produce enough to meet the domestic requirement for food. Pakistan received more irrigated area than India. The productivity of food grains, including wheat, rice, maize, and gram, in the area which went to Pakistan was 40% higher than in India in 1945–1946 (NITI Aayog, 2023).

In the pre-colonial period, India exported several items of agricultural produce, including cotton, fine textiles made from muslin, silk, sugar, rice, spices, etc. Nearly 25% of world manufacturing was in India. The colonial policies of the British resulted in the transfer of wealth to Great Britain (Aiyer, 2012). As a result, India experienced severe food shortages, leading to famines and deaths of many people. Climatic conditions, especially deficient rainfall, may have contributed to these shortages, but the colonial government's failure to ensure the distribution of available food grains also contributed to the same. It is estimated that famines resulted in more than 30 million deaths in the 18th, 19th, and early 20th centuries (Table 1).

The famines were caused not only by scarcity of food grains, but they were also facilitated by unaffordability of food, not least due to the insensitivity of British colonial regime. The early history of the Green Revolution is quite revealing about the importance of food security for any nation (Chand, 2023).

Table 1: Famines in Pre-independent India

S. no.	Indian famine	Year	Deaths (million)
1	Bengal Famine	1769–70	2–10
2	Chalisa Famine	1783–84	11
3	Doji Bara Famine	1791–92	11
4	Agra Famine	1837–38	0.8
5	Upper Doab Famine	1860–61	2
6	Orrisa Famine	1865–67	4–5
7	Rajasthan Famine	1868–70	1.5
8	Bihar Famine	1873–74	2.5
9	Southern India Famine	1876–78	6–10
10	Indian Famine	1896–97	12–16
11	Indian Famine	1899–1900	3–10
12	Great Bengal Famine	1943	2–3

Source: *Indian Agriculture after Independence (ICAR)*, 2022.

The deaths in famines would have had the highest influence on the minds of independent India's first generation of leaders and policymakers. It is no wonder that India's first Prime Minister, Jawaharlal Nehru, said that "everything can wait but agriculture."

Independence to Green Revolution to Impressive Growth in Allied Sectors

The first two decades after independence did not see any improvement in overall food availability; per capita annual production of total food was stagnant at 296 kg until 1966–1967. NITI Aayog in its paper, "From Green Revolution to Amrit Kaal," has divided the growth of the agriculture sector into seven phases.

In the pre-Green Revolution (1950–1951 to 1961–1962) phase, the growth in agriculture came from the expansion in the area

under cultivation. In the food crisis phase (1961–1962 to 1967–1968), India experienced food shortages and depended on import of wheat, largely from the USA. This was followed by the Green Revolution (1967–1968 to 1975–1976). The seeds of dwarf wheat, coupled with the use of urea, setting up of the Commission for Agriculture Costs and Prices (CACP), and procurement of surplus produce of wheat and rice at minimum support price (MSP), starting with Punjab, Haryana, and western Uttar Pradesh, were the main drivers of substantial increase in productivity. However, this was largely confined to the north-west region of India. Since the area under the Green Revolution was quite restricted, the next phase of five years witnessed a decline in the growth of agriculture and allied sectors. However, from 1979–1980 to 1996–1997, the Green Revolution technology covered newer crops, and a wider area was brought under high-value crops.

Then came the phase of globalisation (1996–1997 to 2005–2006) in which there was a decline in global prices, and growth rate of agriculture dropped. Then came the emphasis on the expansion of the Green Revolution to eastern India which had low productivity. Coupled with higher procurement in these regions (Odisha, Chhattisgarh, and West Bengal) and high global prices, the agriculture sector witnessed high growth by enabling the export of agricultural produce. The NITI Aayog paper documents the value of output in various sectors of agriculture in different phases. In terms of value of output, the fisheries sector showed an impressive growth of 7.1% in value of output from 2005–2006 to 2020–2021. The livestock sector also witnessed a handsome growth during the Green Revolution period, and the same has continued since then. In fact, there has been stagnation in the value of output of the crop sector (Table 2).

Table 2: Growth Rate in Value of Output of Various Sub-sectors/Segments of Agriculture and Allied Sectors During Various Phases Since 1950–1951

Sub-sector/ segment	Pre-Green Revolution	Food crisis period	1st phase of Green Revolution	Green Revolution in restricted area	Wider adoption and diversification	Start of globalisation	BGREI + diversification + export
	1950–51 to 1961–62	1961– 62 to 1967– 68	1967–68 to 1975–76	1975–76 to 1979–80	1979–80 to 1996–97	1996–97 to 2005–06	2005–06 to 2020–21
1. Crop sector	3.09	0.78	2.19	–0.01	2.88	1.6	2.55
1.1 Fruits and vegetables	0.96	6.15	5.43	1.96	3.25	2.86	4.53
1.2 Other crops	3.36	0.09	1.65	–0.41	2.81	1.27	1.91
2. Livestock	1.45	0.49	2.7	4.45	4.41	3.44	5.36
3. Fishery	5.43	4.25	4.34	0.54	6.12	2.9	7.1
4. Forestry	0.68	4.25	2.03	–4.51	0.2	1.64	1.53
5. Total (1 to 4)	2.29	1.61	2.27	–0.24	2.88	2.07	3.44

Source: From Green Revolution to Amrit Kaal, NITI Aayog Working Paper, February 2023.

Note: Output at 2011–12 prices. BGREI, Bringing Green Revolution to Eastern India.

Even if the benefits of the Green Revolution in cereal crops were stagnating, livestock sector had already become a beacon of India's success story. The policymakers also gave attention to allied sectors like horticulture and fisheries, and impressive growth was witnessed in these sectors. Between 1970–1971 and 2020–2021, the milk sector alone contributed about 25% of the increase in the total output of agriculture and allied sectors. The share of fruits and vegetables in the incremental value of output of agriculture and allied sectors was 16.72% which is higher than cereals which contributed 13.23% of the increase in output.

India's success in allied sectors is examined in the following sections.

Livestock and Dairy

Shortages of milk and milk products were common as the milk output increased by just about 1.36% per year during 1950–1951 to 1973–1974. This was lower than the rate of population growth (Birthal et al., 2019). In 1970, the Government of India launched the “Operation Flood” or White Revolution to transform India from a milk-deficient nation into the world’s largest milk producer. The seeds of the White Revolution were sown by Sardar Vallabhbhai Patel who conceived a model through cooperatives of dairy farmers in 1942. The three-tier model integrated village-level dairy farmers with district- and state-level federations (Kurien, 2005).

In 1950, Dr. Kurien joined the Kaira District Co-operative Milk Producers’ Union (KDCMPU) as General Manager. By 1957, the KDCMPU evolved into Anand Milk Union Limited (AMUL). He was the brain behind seeking financial and infrastructure support from a number of sources, including UNICEF, the Government of New Zealand (under the Colombo Plan), and the Government of Bombay (Department of Fisheries, 2023, p. 6). In 1964, he invited Prime Minister Lal Bahadur Shastri to spend a night with milk producers. This visit later led to the formation of the National Dairy Development Board (NDDB) with Kurien as its first Chairman in 1965. The NDDB planned Operation Flood (OF), which came to be known as “the billion-litre” idea.

But government’s policies continued to favour cooperatives, and the Industrial Development and Regulation Act of 1951 prescribed a highly restrictive licencing regime for milk processing units. Entry of the private sector was restricted through the Industrial Development and Regulation Act, 1951, which had a very restrictive licencing and registration system. It was only in 2003 that the private sector was allowed to invest, and the dairy industry was completely de-licenced. Since then, the private sector has been investing in the sector and is now a major contributor to the growth of the dairy industry in India.

In 1951, India produced only 17 million tonnes of milk, while the production in the USA was 53 million tonnes. By 2020–2021, India had become the largest producer in the world (221 million tonnes), while the USA produced 102 million tonnes. The most remarkable achievement of India's dairy revolution is that it was achieved by small holders, mainly women, who reared only a few cows or buffaloes, and it is not industrial livestock management where the dairy farms produce a much higher quantity of milk.

Horticulture

In the Tenth Five-Year Plan (2005–2006 to 2010–2011), the Union Government launched the National Horticulture Mission (NHM). The scheme was continued during the Eleventh Five-Year Plan. To incentivise the production of horticulture crops, the Centre's share in the scheme was fixed at 85%, and the States' share was only 15%. The Centre also provided a 100% grant for northeast and Himalayan States. The scheme provided for the supply of high-quality planting material of horticulture crops and nurseries. Tissue culture units were supported for providing high-yielding and disease-resistant material to farmers. Protected cultivation through polyhouses, green houses, etc. was also supported to improve productivity and grow off-season high-value vegetables and flowers.

In 2014, NHM was merged under an umbrella scheme titled Mission for Integrated Development of Horticulture (MIDH). Under a review of the funding pattern of all the centrally sponsored schemes, the Centre's share under MIDH was also reduced to 90% for northeastern and Himalayan states and 60% for other states. It has been a highly successful intervention. Since the launch of the NHM, the productivity per hectare of fruits has increased by an impressive 44.7%, while the productivity of vegetables has increased by 20.6% (Table 3; Department of Agriculture and Farmers Welfare, 2023).

Table 3: Horticulture: Area, Production, and Productivity

<i>Crop</i>	<i>Area (lakh ha)</i>			<i>Production (lakh tonnes)</i>			<i>Productivity (tonnes/ha)</i>		
	2004–05	2020–21	2021–22*	2004–05	2020–21	2021–22*	2004–05	2020–21	2021–22*
<i>Fruits</i>	50.49	69.3	70.49	508.67	1024.81	1072.42	10.07	14.79	15.2
<i>Vegetables</i>	67.44	108.59	113.48	1,012.46	2,004.45	2,048.35	15.01	18.46	18.1
<i>Flowers</i>	1.18	3.22	2.83	6.59	29.8	31.28	5.58	9.25	11.1
<i>Aromatic and medicinal crops</i>	1.31	6.53	6.68	1.59	8.25	6.89	1.21	1.26	1
<i>Plantation crops</i>	31.47	42.55	42.39	98.35	166.29	154.88	3.13	3.91	3.7
<i>Spices</i>	31.5	44.57	44.87	40.01	111.17	108.14	1.27	2.49	2.4
<i>Others</i>	1.06	–	–	1.72	1.25	1.33	–	–	–
<i>Total</i>	184.45	274.76	280.75	1,669.39	3,346.03	3,423.29	9.05	12.18	12.2

Source: Annual report 2022–2023 (Department of Agriculture and Farmers Welfare, 2023).

Sugar

Sugar production in India has also been a success story. This is primarily due to the support and protection it receives from the government. While the domestic consumption is 28–29 million tonnes, production in normal years of monsoon rain ranges between 38 and 39 million tonnes. A new variety of sugarcane, Co-0238, was responsible for the transformation of sugar production in Uttar Pradesh which has overtaken Maharashtra in some years as the largest sugar-producing state. It has delivered a higher yield of sugarcane (80 tonnes per hectare against an average of 60 tonnes/ha) and a higher recovery of sugar from sugarcane, up from 9.25% to 11.5% (Damodaran,

2022). Every step of the sugar supply chain, from the production of sugarcane to the sale price of sugar and its by-products, including ethanol in recent years, is controlled by the government (Saini et al., 2022).

Fisheries

Fish production has increased from 6.57 million tonnes in 2005–2006 to 16.25 million tonnes in 2022–2023. The growth was spearheaded by the significant contribution of inland fisheries. Freshwater aquaculture had a share of only about 34% in inland fisheries in the mid-1980s. It has now increased to about 76% in recent years. Out of this, 12.12 million tonnes is produced in the inland sector and 4.13 million tonnes in the marine sector (Department of Fisheries, 2023). In February 2019, the Union Government set up a separate Department of Fisheries from the Department of Animal Husbandry, Dairying and Fisheries. Export of marine products during 2021–2022 was 1.37 million tonnes with a value of US\$7.76 billion.

Poultry

Another success story of India's agriculture and allied sectors is poultry. In the last four decades, the sector has evolved from conventional backyard poultry to a highly commercialised production system with a high level of backward and forward integration. The production of eggs has increased from 66.45 billion in 2011–2012 to 129.6 billion in 2021–2022 (Department of Animal Husbandry and Dairying, 2023, p. 11). About 80% of poultry production is now in the commercial sector, and only about 20% is contributed by backyard poultry. The success of the poultry sector is attributed to integrator-led production, under which the poultry producer's risk is minimised as the

integrator provides 1-day-old chicks, poultry feed, antibiotics, etc. The producer offers physical space, labour, and maintenance of the poultry farm. The poultry farmer provides land, shed, labour, water, and equipment like litter shed. The farmer provides day-to-day management, but veterinary services are provided by the integrator, whose representative pays regular visits to the producer's premises. The integrator takes back 35-day-old chicks, and the marketing risk of prices is entirely borne by the integrator.

The poultry sector witnessed a tectonic shift from indigenous bird varieties to hybrid birds with much faster growth of eggs and meat per bird. Like the NDDDB in the milk sector, the National Egg Coordination Committee (NECC), set up in 1982, provided enormous support in creating demand for eggs and subsequent innovations in hatcheries and extension services to poultry producers. India has successfully increased the feed conversion ratio (the amount of feed ingested by a bird which can be converted into one kilo of live weight) from 2.20 in the 1990s to about 1.65 (Gulati et al., 2022).

The model of contract production of poultry through integrators has been so successful that the Government of India has issued detailed guidelines for commercial contracts between the producers and the contracting company (Department of Animal Husbandry and Dairying, 2022). The demand for eggs would be even higher if the state governments provided eggs under the Poshan scheme. The system of voluntary compliance with prices declared by NECC is still holding as the integrators follow the price advisory issued by NECC. The poultry producers receive about 75% of the price of eggs paid by the consumers, but the main success of the presence of integrators is that the risk of price fluctuation is borne by them and not by the poultry producers.

Current Challenges Confronting Agriculture and Allied Sectors

Despite all the successes of agriculture and allied sectors, it cannot be denied that India is facing enormous challenges. For the crop sector, the following five challenges are most critical.

Food Security

Despite the slowing growth of the population since the 1980s, India is projected to have nearly 1.7 billion people by the mid-2060s. India will continue to be the most populous country even beyond 2100 (Rukmini, 2024). It is estimated that India's population growth rate is now below the world average. The foremost challenge is to provide food and nutritional security to every Indian. India's Public Distribution System (PDS), legislated through the National Food Security Act 2013 (NFSA), is the world's largest food-based welfare programme which annually distributes about 62–65 MMTs of food grains, mainly rice and wheat, to about 813 million identified people of the country. By producing enough rice and wheat, India has achieved food security at the macro-level; however, at the micro-level, nutritional deprivation and absorption issues persist. Rice and wheat alone cannot resolve India's nutritional challenges, and therefore, PDS in its current form, at least for financially better-off states, requires a rethink (Saini et al., 2017).

In the last few decades, food habits have undergone a change across expenditure classes. In both rural and urban areas, the consumption of staple food grains like wheat and rice has been going down, while the consumption of protein and nutritious food items, like milk, poultry, fruits, vegetables, and even processed food, has been going up. The latest Household Consumption Expenditure Survey 2022–2023 finds that, for the first time, household expenditure on food is less than 40% in

urban India. Even in rural India, it is less than 50% of the total consumption expenditure (National Sample Survey Office, no date).

Despite the survey showing lower household expenditure on staple grains, food inflation is a perennial issue, and the government struggles to keep it in check. In 2023–2024, the inflation, even in wheat and rice, was in double digits. In March 2024, year-on-year food inflation was 7.68%. It looks low because of negative inflation of 11.72% in the case of edible oils, due to cheaper imports. Pulses, a major source of protein for a large section of the population, witnessed an inflation of 17.71%. Being perishable, there is a large fluctuation in the inflation of vegetables. In March, inflation in vegetables was 28.34% (National Statistical Office, 2024).

Sustainability Under Climate Change

The second challenge is not only to produce enough food but to do it sustainably. In the last few years, the impact on climate change has become quite visible. Climate change has already resulted in higher temperatures, changes in the pattern of rainfall with intensive rain hitting the ground on just a few days, and frequent droughts in parts of India. And it is not only the crops which would be adversely impacted by climate change. Livestock and fisheries will also suffer from climatic stress (Aggarwal et al., 2022).

Lack of Surpluses and the Residual Nature of Agricultural Exports

For rice, India is world's largest exporter, and about 40% of global trade in rice originates from India. For wheat, India is an occasional exporter. For edible oils, India is largely dependent on imports, and about 55% to 60% of edible oil consumption is imported, with about 60% in the form of palm oil from Indonesia and Malaysia. In the case of sugar, India generally

produces more than its requirement, and it is an occasional exporter. In some years, exports are not permitted by the government to keep domestic inflation in check.

It is feared that climate change will result in significant adverse impacts on production and productivity, especially in the tropical regions of India. It is estimated that climate change may cause a 12% lower production of kharif crops and 6% for rabi crops. Wheat crop of 2022–2023 was adversely impacted due to higher-than-normal temperatures in February 2022. Since then, the government has been forced to take several measures to augment the domestic availability of agricultural produce. Due to the evolving aggressive mandates under ethanol-for-fuel blending, the dedicated area for crops-for-fuel requires strategic land-planning by policymakers.

It is acknowledged that the success of the Green Revolution was achieved through the expansion of irrigation, but it has resulted in the indiscriminate and overuse of water, leading to the depletion of groundwater resources. Highly subsidised or free electricity (Table 4) has resulted in an enormous increase in the use of pumps which extract water. It has also resulted in the distortion of crop choices, ignoring the agro-ecological suitability of crops to a particular area. It must be noted that it is not the state of Punjab alone which is providing a large subsidy for electricity to the agriculture sector.

A NABARD-ICRIER study has estimated the irrigation water productivity of crops rather than per hectare productivity (Sharma et al., 2018, p. 40). It found that although Punjab and Haryana have high productivity per hectare of cultivated area, they have very low irrigation-water productivity, even though the entire area under paddy is under assured irrigation. They are thus rapidly depleting their groundwater resources. In India, about 78% of freshwater resources are used for agriculture, but the use of irrigation water is highly distorted. Paddy and sugarcane are grown on only about 25% of the gross cropped area but consume over 60% of irrigation water. The

other crops are therefore deprived of water, resulting in low productivity (Sharma et al., 2018, p. 212).

Table 4: Electricity Subsidy to the Agriculture Sector in FY2022–2023

S. no.	State	Total subsidy (in crores)	Agriculture subsidy (in crores)	Agriculture's share in total subsidy (%)
1	Rajasthan	25,260	20,394	80.74
2	Karnataka	13,000	12,480	96
3	Andhra Pradesh	11,123	9,512	85.52
4	Punjab	12,164	9,064	74.51
5	Gujarat	9,892	8,300	83.91
6	Uttar Pradesh	13,600	7,097	52.18
7	Telangana	8,221	6,736	81.94
8	Haryana	6,758	6,050	89.52
9	Tamil Nadu	12,558	5,984	47.65
10	Maharashtra	12,841	5,808	45.23
11	India	1,64,105	1,01,745	62

Source: Communication from Council on Energy, Environment and Water.

If the over-exploitation of groundwater resources is to be checked, a policy has to be evolved which will incentivise the cultivation of crops in accordance with the agro-ecological needs of various regions. It will mean a lower area under paddy in Punjab and Haryana. Efficient use of irrigation water through drip, sprinklers, and sensors has to become mainstream rather than being confined to certain states of India (Maharashtra, Karnataka, and Tamil Nadu). It is not only the misuse of water resources which is a cause of concern for the sustainability of crop production. There is indiscriminate use of chemical fertilisers and pesticides, some of which may also be leaching into the soil and water bodies, ultimately finding their way into

the food chain (Sharma et al., 2023). Some pesticides of the older generation are rather cheap, but they can remain in soil and water for years. Many of these have been banned by the government (Soman et al., 2024).

Degradation of soil is another area of concern. Due to the intensive cultivation of crops, the erosion of soil has been rising. The Indian Council of Agricultural Research (ICAR) estimates that about 36.70% (120.72 million hectares) of India's total land area is degraded. About 60.27% (73.27 million hectares) is affected by water erosion, while about 10.30% (12.40 million hectares) is attributed to wind erosion. It is a matter of great concern that about 14.50% (17.45 million hectares) of land faces chemical degradation (Maji et al, 2010). In his book, *From Green to Evergreen Revolution*, Dr. M. S. Swaminathan wrote that countries like India require "do ecology" which will generate an "economic stake in conservation" (Swaminathan, 2010). He referred to the change in attitude of Punjab farmers where the Green Revolution was becoming "greed revolution." Sadly, much has not changed since the book was published in 2010. An important reason contributing to the lopsided cropping pattern in the north-western states of India is the policy of MSP. Almost 90% of market arrivals of paddy are purchased by government agencies at MSP (Table 5).

Since no crop other than sugarcane offers an assured price, Punjab farmers continue to grow paddy, knowing very well that it is extremely harmful to their long-term interests (Gulati et al., 2017). However, the Government of Punjab has also taken several steps to reduce the consumption of water for the cultivation of paddy. The government has banned the cultivation of Pusa-44 (a high-yield variety with better recovery of rice) and other long-duration (155–160 days) rice varieties since they require much more irrigation water than short-duration varieties. These varieties also produce more stubble, the burning of which causes major pollution in the National Capital Region in October and November. The state is

promoting short-duration varieties like PR-126, which are ready in only 120–125 days.

Table 5: Crop-Wise Relative Average Gross Returns (%) with Respect to Paddy, TE 2021–2022

<i>Crop</i>	<i>Relative average gross return over cost of cultivation A2+FL with respect to paddy</i>
A. Cereals	
Paddy	100
Maize	86.2
Jowar	30.7
Bajra	35.3
Ragi	9.7
B. Pulses	
Arhar (Tur)	102.3
Moong	27.1
Urad	29.3
C. Oilseeds	
Groundnut	95.7
Soybean	43.9
Sunflower	54.7
Sesamum	38.2
Niger seed	–4.1
D. Commercial Crop	
Cotton	87

Source: Price Policy for Kharif Crops for the Marketing Season 2023–2024, CACP, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi, March 2023.

Punjab also offers an incentive of ₹1,500 per acre for farmers who use the Direct Seeding of Rice (DSR) method of paddy cultivation, which uses much less irrigation water. In this method, pre-germinated seeds are directly drilled into the field by a tractor-powered machine. Nurseries are not needed in this

system, and there is no transplantation. According to an analysis by the Punjab Agricultural University, Ludhiana, the DSR reduces water consumption by 15% to 20%. Only 15 to 18 rounds of irrigation are required in DSR, compared to 25 to 27 rounds in the traditional continuous irrigation method (Chaba, 2022). The Government of Haryana also offers financial incentives to encourage farmers to diversify from paddy (*The Tribune*, 2023). Under the “Mera Pani Meri Virasat” scheme, the farmers are eligible to receive ₹7,000 per acre as financial assistance if they grow other kharif crops, like pulses, maize, or cotton instead of paddy. The scheme has been quite successful. As a result, the area under paddy cultivation decreased by 10% in 2021 compared to 2020.

Due to its financial constraints, Punjab is not offering any such incentive. Since Punjab has provided food security to India for several decades by reaping the benefits of the Green Revolution and government procurement, it is only appropriate that the Union Government provides a grant to the Punjab Government for at least 5 years to reduce the area under paddy cultivation. Finally, it must be remembered that agriculture is not only the victim of climate change, but it also contributes about 17% of greenhouse gas (GHG) emissions in India. The GHG emitted from agricultural activities is not the subject of much scrutiny or debate in India. The GHG in agriculture is contributed by the application of inputs to the soil and the burning of residues, etc. The livestock sector also contributes to GHG through rearing and enteric fermentation, and the contribution of stray cattle, whose population is 5.02 million (20th Livestock Census 2019, Department of Animal Husbandry and Dairying, Government of India), has not even been estimated. There is a need to improve the productivity of dairy animals. As per the Integrated Sample Survey, the average annual productivity of cattle in India during 2019–2020 was only 1,777 kg per animal per year, as against the world average of 2,699 kg per animal per year during 2019 (Ministry of Fisheries, Animal Husbandry and Dairying, 2021).

Farmers' Income

The third challenge before India is to get a remunerative income for farmers. From time to time, farmers protest for their demands which are basically related to their low incomes.

- In August 2017, farmers protested against the killing of farmers in Mandsaur, Madhya Pradesh, who were demanding MSP for their produce, including onions.
- In March 2018, farmers, farm labourers, and tribals staged a march from Nashik to Mumbai. Many of them walked barefoot. It is estimated that they numbered 70,000 by the time they reached Mumbai (Kulkarni, 2023).
- Delhi alone has witnessed a number of protests, primarily demanding a fair price (MSP) and debt waiver (Jagga, 2024).
- From November 25, 2020, to December 9, 2021, there was a massive protest by farmers at Delhi borders and in adjoining states (Express Web Desk, 2021).

The root cause of farmers' agitations is the low incomes earned by most of them. From January to December 2019, the National Statistical Office (NSO) carried out a survey on "Land and Livestock Holdings of Households and Situation Assessment of Agricultural Households." The survey defined an agricultural household as one which received more than ₹4,000 as the value of produce from agricultural activities which included not only the cultivation of field, fodder, and horticultural crops but also plantation, animal husbandry, poultry, fishery, piggery, bee-keeping, vermiculture, sericulture, etc. Moreover, at least one member of the household should have been self-employed in agriculture, either in the principal status or in subsidiary status, during the last 365 days. Out of 172.44 million rural households, 93.09 million were agricultural households, and 17.24 million were non-agricultural households. The average area (ha) owned per household was only 0.512 hectares. About 94% of households owned less than 2 hectares of land.

It was found that the average monthly income of agricultural households was just ₹10,218. It includes income from wages; leasing out of land; and net receipts from crop production, from farming of animals, and from non-farm business. Out of this, only ₹3,798 came from crop production while income from wages was ₹4,063. The survey found that an agricultural household earns half of its total income from farming only when the land size exceeds 1 hectare. About 70% of agricultural households do not fall into this category (Damodaran et al., 2021). More worryingly, the income of agricultural households in several states like Bihar, Jharkhand, Madhya Pradesh, Odisha, West Bengal, and Uttar Pradesh was lower than ₹8,000 per month, and in Uttar Pradesh, it was only slightly above that (Table 6).

Table 6: Average Monthly Income of Agricultural Households (Considering Paid-Out Expenses Only) During the Agricultural Year July 2018–June 2019

<i>State/group of UTs</i>	<i>Average monthly income of agricultural household</i>
Andhra Pradesh	10,480
Arunachal Pradesh	19,225
Assam	10,675
Bihar	7,542
Chhattisgarh	9,677
Gujarat	12,631
Haryana	22,841
Himachal Pradesh	12,153
Jammu and Kashmir	18,918
Jharkhand	4,895
Karnataka	13,441
Kerala	17,915
Madhya Pradesh	8,339
Maharashtra	11,492

Manipur	11,227
Meghalaya	29,348
Mizoram	17,964
Nagaland	9,877
Odisha	5,112
Punjab	26,701
Rajasthan	12,520
Sikkim	12,447
Tamil Nadu	11,924
Telangana	9,403
Tripura	9,918
Uttarakhand	13,552
Uttar Pradesh	8,061
West Bengal	6,762
Group of N E States	16,863
Group of UTs	18,511
All India	10,218

On February 28, 2016, in a rally, the Prime Minister gave a call to double farmers' income by 2022. It was mentioned in the budget speeches of 2016–2017 and 2017–2018. The NITI Aayog clarified that the target is to double the farmers' income in real terms and not just in nominal terms. In April 2016, the government set up a committee under the chairmanship of Dr. Ashok Dalwai, IAS, Additional Secretary, Ministry of Agriculture, to recommend the strategy to achieve this. The Committee adopted the National Council of Applied Economic Research (NCAER), National Institute of Agricultural Research Policy (NIAP), and the National Centre for Cold Chain Development (NCCD) as knowledge partners. It held consultations across India and took the support of 100 resource persons for preparing the report.

The Committee submitted its voluminous report of about 3,000 pages in 14 volumes in September 2018. It made about 619 recommendations in Volume 14 which is titled “Comprehensive Policy Recommendations.” The Committee recommended six areas of action for doubling farmers’ income. These are improvement in crop productivity, livestock productivity, resource use efficiency, increase in cropping intensity, diversification to high-value crops, and enhancement of the real prices received by farmers. The Committee clarified that the target is to double the farmers’ incomes in real terms by 2022–2023 over the income level of 2015–2016. It projected that by 2022–2023, the average income is targeted to reach ₹16,118 per month (in real terms) over the average income of ₹8,059 per month in 2015–2016 (as assessed by the Committee). For achieving this, the required growth rate was estimated by the Committee to be 10.4% per annum (Gulati et al., 2021). On the basis of previous NSSO surveys on farm incomes from 2002–2003 to 2012–2013, the Committee found that farmers’ real incomes grew by 3.6% per annum.

Conscious of the challenge of low income for farmers, the Union Government substantially enhanced the budgetary allocation of the Ministry of Agriculture and Farmers Welfare from ₹27,662.67 crore (BE) during 2013–2014 to ₹125,035.79 crore (BE) during 2023–2024. Even before the objective of doubling farmers income was announced by the Prime Minister, a number of new schemes and programmes have been initiated since the formation of the National Democratic Alliance (NDA) Government under Prime Minister Modi in 2014–2015 (Ministry of Agriculture and Farmers Welfare, 2024, February 6). These include a scheme for soil health cards for all the farmers, National Agriculture Market (e-NAM), Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), and Pradhan Mantri Fasal Bima Yojana (PMFBY) which provides very low premiums for farmers. The maximum premium is only 2% of the sum insured for kharif crops. For rabi crops, it is just 1.5%. In the case of annual commercial and horticultural crops, maximum

premium is 5%. The launch of the free-to-air DD Kisan TV channel was also a significant decision to reach out to farmers and producers. The funding pattern of several centrally sponsored schemes was also changed in 2015–2016, and the state's share was increased to 40%. In several schemes for agriculture and allied sectors, this led to a doubling of the states' contribution from 20% to 40% (Rai, 2024). A flagship scheme, Rashtriya Krishi Vikas Yojana (RKVY), initiated by the United Progressive Alliance (UPA) Government in 2006, provided flexibility to states to design their own schemes. The idea was to incentivise the states to increase public investment in agriculture and allied sectors. It provided autonomy to states in planning and executing agriculture sector schemes. The Central share in the scheme was reduced in 2015–2016 from 100% to 60%. For northeastern and Himalayan states, the Central funding was fixed at 90% (Department of Agriculture and Farmers Welfare, 2024b).

The NDA Government, since 2014, has, however, continued several schemes which were initiated by the previous UPA Government. These include the promotion of organic farming, beekeeping (National Beekeeping and Honey Mission) micro-irrigation (for which the Micro Irrigation Fund was set up, providing interest subvention), as well as the Mission for Integrated Development of Horticulture (MIDH). The government has also provided a much stronger thrust on Farmer Producer Organisations (FPOs) which enable farmers to form groups which can then source the inputs and market the produce. A major initiative since December 2018 has been to provide direct income support of ₹6,000 per annum to all the landholders (with some exceptions) under PM Kisan. This scheme receives the highest allocation of all the schemes of Ministry of Agriculture. An amount of ₹60,000 crore has been provided for the financial year 2024–2025 (BE as per the interim budget).

Table 7: Percentage Increase in MSP Between 2013–2014 and 2023–2024

<i>Paddy</i>	66.60%
<i>Paddy A</i>	63.80%
<i>Jowar</i>	112%
<i>Bajra</i>	100%
<i>Maize</i>	59.50%
<i>Arhar (tur)</i>	62.80%
<i>Moong</i>	90.20%
<i>Urad</i>	61.60%
<i>Cotton medium staple</i>	78.90%
<i>Cotton long staple</i>	75.50%
<i>Groundnut</i>	59.40%
<i>Sunflower</i>	82.70%
<i>Soybean</i>	79.70%
<i>Sesamum</i>	91.90%
<i>Rabi Crops</i>	
<i>Wheat</i>	62.50%
<i>Barley</i>	68.20%
<i>Gram</i>	75.50%
<i>Masur</i>	117.80%
<i>Mustard</i>	85.20%
<i>Safflower</i>	93.30%
<i>Sugarcane (FRP)*</i>	54.50%

Source: Author's compilation from data of MSP.

Note: FRP, fair and remunerative price.

The most important and meaningful decision of the government to deliver higher income to farmers was the increase in MSP. In the Union Budget of 2018–2019 it was announced that the MSP for all the crops would be at least one and a half times the cost of production (Ministry of Agriculture

and Farmers Welfare, 2020). Since then, the government has been increasing the MSP for all the mandated kharif, rabi, and other commercial crops. In addition, the government announced a substantial hike in the MSP of pulses and oilseed crops (Table 7).

To ensure that the farmers of crops other than wheat and paddy also receive the MSP announced by the government, it launched an umbrella scheme Pradhan Mantri Annadata Aay Sanrakshan Abhiyan (PM-AASHA) aimed at providing an assurance of a remunerative price. This umbrella scheme comprises the ongoing Price Support Scheme (PSS) for pulses, oilseeds, etc., Price Deficiency Payment Scheme (PDPS) and Pilot of Private Procurement and Stockist Scheme (PPSS) for oilseeds to ensure MSP to the farmers. PSS enabled government agencies like NAFED to procure pulses and oilseeds at MSP, thus providing some support to farmers. However, the procurement operations were not as widespread and consistent as those for wheat and rice. The two new schemes, PDPS and PPSS, have not really been taken up for any crop in any meaningful way.

As a result of the attractive MSP for pulses, their production went up from 19.26 million tonnes in 2013–2014 to 27.50 million tonnes in 2022–2023. However, in 2023–2024, it is estimated to have decreased to 24.49 million tonnes (Ministry of Agriculture and Farmers Welfare, 2024, June 4). This is attributed to low prices of gram in the last few years and non-protection of MSP. As a result, the area under pulses has gone down, and the vision of becoming self-sufficient in pulses looks even farther (Hussain, 2023). The government also set up the Agri Infrastructure Fund (AIF) to provide an interest subvention of 3% on loans for infrastructure projects, including projects for post-harvest infrastructure and aggregation points. This initiative provides impetus for the development of farm gate and aggregation points, as well as affordable and financially viable post-harvest management infrastructure (Department of Agriculture and Farmers Welfare, 2024a). The government has also launched a National Mission on Edible Oils–Oil Palm

(NMEO-OP) to increase the domestic production of edible oils. It is projected that the area under oil palm and its yield will increase as a result of an attractive price for Fresh Fruit Bunches (FFB) (Union Cabinet, 2021).

Similarly, the Department of Animal Husbandry and Dairying also started a number of schemes with the objective of increasing the income of farmers. These include a livestock health and disease control programme, the setting up of an Infrastructure Development Fund, and the Rashtriya Gokul Mission. For the promotion of the fisheries sector, the government in 2020 approved the Pradhan Mantri Matsya Sampada Yojana (PMMSY). To meet the infrastructure needs of the fisheries sector, the government set up the Fisheries and Aquaculture Infrastructure Development Fund (FIDF). It provides interest subvention for fisheries infrastructure (Ministry of Fisheries, Animal Husbandry and Dairying, 2023). While the schemes would have provided much-required support to farmers in various aspects of farming and allied activities, the full impact of the same on farmers' income is not known as there was no survey of income levels of farmers in 2022–2023. Therefore, it is not possible to evaluate if the target of doubling farmers' income was achieved. However, as mentioned above, the latest situation assessment survey shows that the average annual income of agricultural households increased from ₹8,058 per month in 2015–2016 to ₹10,218 in 2018–2019.

Looking Ahead

Going forward, food security for an increasing population through sustainable production will continue to be the foremost challenge, as discussed in previous pages. A Working Group (WG) under the chairmanship of Prof. Pratap Singh Birthal, Director of ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, was set up by NITI Aayog to project the demand and supply of crops and livestock products

up to 2047–2048. Its report was submitted in October 2023 (NITI Aayog, 2024). The WG estimated the normative requirements of rice, wheat, maize, nutri-cereals, pulses, food grains, oilseeds, sugarcane, fruits, vegetables, and animal products like milk, meat, eggs, and fish. The possibilities of exports were also assessed by the WG. In the absence of a Consumer Expenditure Survey, the WG relied on other data sources like the Consumer Pyramid Surveys of Centre for Monitoring Indian Economy (CMIE) and private food consumption expenditure data from the National Accounts Statistics from 2011–2012 to 2019–2020. Under the business-as-usual scenario (BAU), the WG has projected the demand for food grains at 402 million tonnes in 2047–2048. Under the high-income growth scenario, the same is projected at 415–437 million tonnes.

It is projected that the growth in demand for maize, pulses, and nutri-cereals will be higher compared to rice and wheat. The demand for pulses is expected to be 49–57 million tonnes by 2047–2048. By 2047–2048, the demand for vegetables and fruits is expected to increase to 365 million tonnes and 233 million tonnes, respectively, in the BAU. Under a high-income growth scenario, the demand for vegetables may rise to 385–417 million tonnes and the same for fruits to 252–283 million tonnes. The production of fruits and vegetables is less than the demand, and the shortfall is projected to continue in the future unless there is a substantial increase in yield or there is a diversion of area to fruit and vegetables. India's import dependence for edible oils is also projected to continue as the demand is expected to increase to 31–33 million tonnes. Production of sugar and its products is likely to remain higher than demand. The WG also projects that domestic production of meat, poultry, and eggs will meet the demand in a BAU scenario. In the case of high growth in incomes, however, the demand will be higher.

Despite the current challenges outlined in this paper, the WG has projected that we can expect growth in the yield of all the crops, with maize likely to achieve the highest growth. If India is able to achieve high growth in yield, it will be possible to

produce genuine, reliable surpluses for export. As a result of higher yields, the production of various crops (except nutri-cereals in the BAU scenario) as well as milk, meat, poultry, and fish will be higher.

The good news is that the production of food grains will be more than the demand in both BAU and other scenarios, and there will be an opportunity to export the surplus which will mainly come from rice and wheat. The supply of nutri-cereals may fall short of demand unless the yields go up. It is possible that this will be achieved through higher production of maize by both area expansion and higher yield. Therefore, achieving a higher yield of pulses needs to be a high priority for the government. To meet the demand for fruits and vegetables, a much higher growth in yield is needed. In the last two decades, since the launch of NHM, the private sector has contributed significantly to the development of varieties which have led to high yield growth. The use of appropriate technologies and the creation of better cold chain infrastructure will be needed to augment the availability of fruits and vegetables. These projections may face a threat from climate change, as the events since February 2022 (unusually high temperatures and erratic monsoons) have shown. India had to ban the export of wheat and wheat products, broken rice, non-basmati raw (white rice), and sugar. There is a minimum export price on basmati rice as well (Hussain and Khurana, 2024). Restrictions had to be imposed on the export of onions also. Therefore, adaptation and mitigation must be taken up as a high priority, and investment in research to develop climate-resilient varieties needs to be substantially raised. Now the time has come to allow genetically engineered seeds by taking recourse of new technologies of modification.

At its core, agriculture is a state subject even though the Union Government provides large subsidies on fertiliser, crop insurance, and credit. India needs large investments in agriculture and allied sectors. To attract private investment, stability in the policy regime is required. This is possible when

surpluses are consistently produced so that the government does not resort to export restrictions and stock limits under the Essential Commodities Act. The success achieved in the poultry sector is largely due to private sector investment and innovative methods of production. Similar breakthroughs are needed in other sectors as well. India should not close its doors to genetic engineering technologies.

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