NITI Aayog

WORKING GROUP REPORT ON

CROP HUSBANDRY, AGRICULTURE INPUTS, DEMAND & SUPPLY

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NITI Aayog

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The report covering projections of Demand and Supply of Crops and Livestock Products and Agriculture Inputs for 2025-26, 2030-31, 2035-36, 2040-41 and 2047-48 has been prepared by the experts of the Working Group.Every effort has been made to ensure the correctness of data/ information used in this report and the sources are mentioned in the report. NITI Aayog does not accept any legal liability for the accuracy or inferences drawn from the material contained therein or for any consequences arising from the use of this material.

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Preface

Over the past five decades, the technological change supported by investment in irrigation and infrastructure, institutions and incentives have led to significant increases in food production, ensuring affordable access to food for all. Nevertheless, the need to produce more food remains as urgent as in the past to feed the ever-increasing population, and under the growing resource constraints of land and water, and weather aberrations.

To adequately feed the people in future requires information on the likely demand and supply of different food commodities to devise appropriate strategies and policy support for their production, distribution, and trade. To generate such information, the National Institution for Transforming India (NITI) Aayog constituted a Working Group deriving members from the academic and research organizations, concerned Ministries of the Central and State Governments, and the commodity-specific associations of manufacturers.

For smooth functioning of the Working Group, it was divided into three sub-groups to generate futuristic scenarios on 'demand and supply of food commodities'; 'input demand'; and 'agricultural exports'. Each sub-group was headed by an expert, and had the flexibility to co-opt any expert from outside the constituted Working Group, if required. Dr. Shivendra Kumar Srivastava, Senior Scientist, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, steered the sub-group on 'demand and supply'. The sub-group on 'agricultural exports' was led by Dr. Raka Saxena, Head, Division of Technology and Sustainable Agriculture, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi. Professor C.S.C. Sekhar from the Institute of Economic Growth, led the sub-group on 'input demand'. Dr. N. Sivaramane, Principal Scientist, ICAR-National Academy of Agricultural Research Management, Hyderabad, and Dr. Ranjit Kumar Paul, Senior Scientist, ICAR-Indian Agricultural Statistics Research Institute, New Delhi, provided significant support in empirical analysis. I profusely appreciate their hard work and patience, and thank all of them for accomplishing this arduous task.

The Working Group has immensely benefitted from the inputs, information and suggestions received from several other professionals, especially from the Indian Council of Agricultural Research, the National Institute of Nutrition, and Fertilizer Association of India.

Finally, I place on record my sincere gratitude to Professor Ramesh Chand, Member, NITI Aayog, who provided valuable inputs to the Working Group that helped us refine the estimates of demand and supply presented in this Report. My special thanks are to Dr. Neelam Patel, Senior Advisor, NITI Aayog, Member Secretary to this Working Group, and Dr Tanu Sethi, Senior Associate, NITI Aayog for facilitating the functioning of the Working Group and arranging meetings and consultations which helped us draw various inputs required for the Report.

Pratap Singh Birthal
Chairman, Working Group

Executive Summary

India is envisioned to be in the league of developed nations by 2047, the centenary year of its Independence. To realize this vision, the economy has to grow at an accelerated rate of about 8% per year or so, from the 6.34% realized in the recent decade. In 2047, India's population will cross the 1.6 billion mark, and about half of it is expected to be urbanized. There will be a demographic transition, in terms of age, literacy, and work-force participation. These trends will cause a significant change in dietary patterns and an increase in demand for different food commodities although differentially, depending on the consumer preferences. Besides the food demand for human consumption, there will be an increasing demand for food commodities in feed, fuel, and pharmaceutical industries.

On the other hand, the country has limited land and water resources, which will shrink in future on account of their competing demand for domestic, energy and industrial uses. Concurrently, the food production system will also come under a confluence of several biotic and abiotic pressures, including climate change and infestation of insect pests and diseases, which may adversely affect crop yields and food supplies in the absence of remedial measures. Therefore, managing food in the future, from both demand and supply sides, will be a major concern for policy makers and the scientific community.

To assess the demand and supply of different food commodities towards 2047, the National Institution for Transforming India (NITI) Aayog, the Government of India vide OM dated 29th August, 2022 constituted a Working Group on *Crop Husbandry, Agriculture Inputs, Demand and Supply* under the Chairmanship of Prof Pratap Singh Birthal, Director, ICAR-National Institute of Agricultural Economics and Policy Research, New Delhi, with the following terms of reference:

i. to study and analyze the trends in demand and supply of major food commodities and examine the changing consumer preferences for food and related items;

ii. to assess the demand and supply of various food commodities and farm inputs namely fertilizer, seeds, credit, feed and fodder for 2025-26, 2030-31, 2035-36, 2040-41, and 2047-48;

iii. to estimate the normative requirements of rice, wheat, maize, nutri-cereals, pulses, foodgrains, oilseeds, sugarcane, fruits, vegetables, and animal products, viz., milk, meat, eggs, and fish; and

iv. to estimate the feasible level of export of the above-mentioned commodities for the years 2025-26, 2030-21, 2035-36, 2040-41, and 2047-48

The Working Group critically assessed and examined the data requirements and methodological issues in arriving at realistic estimates of demand and supply of food commodities, input demand, and feasible levels of exports. One of the main limitations for estimating the food demand is the non-availability of data on food consumption after 2011-12. Nonetheless, the Group has tried to overcome this limitation by cross-validating

the projected food demand for 2019-20 with actual availability, and supplementing with other data sources such as private food consumption expenditure of National Accounts Statistics from 2011-12 to 2019-20, Consumer Pyramid Surveys, 2016-2022 of Centre for Monitoring Indian Economy (CMIE), etc.

Key Highlights

1. Changes in food preferences and demand

- There is an increasing trend in the total household expenditure, but the share of food expenditure in it has declined considerably, from 69% in 1972-73 to 44% in 2011-12, and the decline is observed across all expenditure classes and in rural as well as urban areas.
- Food commodities are demanded for direct human consumption and for their other uses such as seed, feed, and intermediate inputs in food processing and other industries. Nevertheless, household demand has the largest share (61%) in the total demand for food commodities.
- Demand for cereals has declined due to changing consumer preferences for nutritious foods, and also due to reduced energy requirements. Rice and wheat have increasingly substituted nutri-cereals and maize. Further, the consumption of nutri-cereals has been shifting from lower expenditure classes to higher expenditure classes and from rural to urban areas. With the recent focus on nutri-cereals, their demand is expected to increase in the future. The average per capita consumption of cereals is more than their recommended minimum requirement.
- There is a significant change in food preferences across all expenditure classes and in rural and urban areas, away from staple foodgrains towards high-value food commodities such as fruits, vegetables, animal-source foods, and processed foods and beverages. Thus, the household demand for pulses and high-value food commodities, including fruits, vegetables, and animal-source foods, has been increasing faster compared to other food commodities.
- The household demand for edible oils has increased significantly. Refined oil is emerging as the most consumed edible oil substituting groundnut oil and Vanaspati ghee. On the other hand, the demand for sugar and sugar products has declined although at the margin.

2. Trend in production of food commodities

- India is a major producer of most food commodities. The domestic production sufficiently meets the demand for most food commodities, except edible oils and pulses.
- The per capita total food production has increased considerably, leading to an improvement in the national food security. The growth trajectory of different

food commodities, however, is different. The share of nutri-cereals in the cereal basket has declined sharply on account of the steady increase in the production of rice, wheat and maize. The area under cereals, except maize, has remained either stagnant or declined, in recent years. Yield improvements have been the main contributors to their incremental production.

- After stagnating for long, pulses production increased considerably in recent years, but mainly due to area expansion.
- India imports about 60% of its edible oil demand. The matter of concern is the deceleration in the growth of oilseeds production on account of the stagnation in their area. Approximately two-third of the edible oil production comes from primary sources (i.e., oilseeds), and the rest from secondary sources, including trees.
- Production of fruits and vegetables has increased steadily. However, the growth in fruit production has decelerated due to stagnation in the area. Production of vegetables has increased, largely due to area expansion.
- Owing to improvements in the yield of sugarcane and sugar recovery rate, India is self-sufficient in sugar, despite a slight decline in sugarcane area.
- Driven by changes in herd composition in favour of crossbred cows, and improvements in milk yield of almost all milch species, milk production has increased significantly over the past three decades. The production of other animal products, including eggs, meat and fish, has also increased considerably.
- India occupies the top position in area and production of several crops, but lags far behind in terms of yield. There exists a huge scope to increase food production to meet the rising food demand by harnessing yield potential and improving land utilization efficiency.

3. Projections of food demand and supply

- In a business-as-usual (BAU) scenario, that is the continuance of the recent economic growth (6.34%) in the future as well, the overall food demand is expected to grow at an annual rate of 2.44% by 2047-48. It will accelerate up to 3.07% if the economic growth accelerates.
- In a BAU scenario, demand for foodgrains is estimated at 402 million tonnes in 2047-48, and to 415-437 million tonnes in high income growth (HIG) scenario. Growth in demand for maize, pulses and nutri-cereals will be higher as compared to rice and wheat. Demand for pulses is expected to be 49-57 million tonnes by 2047-48 under different income growth scenarios.
- By 2047-48, the demand for vegetables is expected to increase to 365 million tonnes, and of fruits to 233 million tonnes in the BAU, and 385-417 million tonnes and 252-283 million tonnes in HIG scenarios, respectively.
- By 2047-48, demand for sugar and its derivative products is estimated at 44-45 million tonnes, and for edible oils at 31-33 million tonnes.

- Demand for milk is projected at 480 million tonnes in 2047-48 in the BAU, and at 527-606 million tonnes in HIG scenarios. By 2047-48, demand for eggs, meat and fish is estimated at 16, 21 and 37 million tonnes, respectively in the BAU scenario, which, in a HIG scenario, will be 18-21, 24-29 and 41-48 million tonnes, respectively.
- Between 2019-20 and 2047-48, gross cropped area is expected to expand at annual growth of 0.45%, but would be driven primarily by the cropping intensity. Hence, the additional production to meet the domestic demand has to come from yield improvements. There exists a considerable yield gap in most crops, which offers scope to accelerate growth in crop yields.
- By 2047-48, production of food grains will surpass their demand, but the surpluses will be primarily for rice and wheat. With the government's promotional efforts, the demand for nutri-cereals will increase and their production will be insufficient in the absence of area expansion and yield improvements.
- In a BAU scenario, maize production will fall short of its demand. However, in high yield growth (HYG) scenario, its production is expected to be sufficient to meet the demand. Similarly, pulses production if following its historical trend growth, will be insufficient to meet their demand. There is a possibility of achieving self-sufficiency in pulses, if the current trend in their area expansion continues, and the yield growth accelerates.
- Presently, production of fruits and vegetables is short of their demand, and the shortfall may remain in future in the absence of a significant acceleration in their yield growth and area expansion.
- Likewise, edible oils production will remain short of their demand at least in the short-run. Yield improvements in cultivated oilseeds, and harnessing the potential of secondary edible oil sources can help achieve self-sufficiency in the long-run.
- Production of sugar and its derivative products will remain higher than their demand.
- Domestic production of animal source-foods, including milk, eggs and fish, but not of meat, will be adequate to meet their demand in a BAU scenario. However, their domestic production may fall short of demand if the economy grows faster.

4. Normative food demand

- The minimum requirement of food varies considerably across age, gender, and physical level of activities. With the rising population, total normative food demand is expected to rise in future.
- Food production is sufficient to meet the normative demand. However, the present level of food consumption is inadequate and imbalanced to meet nutrients' requirement for a healthy life.

- The actual aggregate food demand for human consumption was 31% short of the normative demand, based on recommended dietary allowance in 2011-12, and the gap reduced to 22% in 2019-20. By 2030-31, both are expected to converge, and the actual demand is likely to be 20% more than the normative demand by 2047-48. However, by commodity, pulses, fruits, and vegetables will remain insufficient by 2030-31, but not by 2047-48. If fact, actual demand for all food commodities is expected to be either at par or higher than their normative demand in 2047-48.
- Adequacy of production is a necessary condition but not sufficient condition to improve the nutritional security. This necessitates strengthening of accessibility and affordability dimensions of food and nutritional security.

5. Status of agricultural exports

- Agricultural exports have been rising steadily, and the export basket is also changing. India, with a share of 40% in global rice (Semi-milled) exports, is the largest exporter, and is highly competitive in the global market.
- India is also a significant exporter of sugar and its derivative products. Its exports of bovine meat and fish and fish products are competitive in the international market, offering an opportunity to enhance their exports.
- India is not a major exporter of wheat, dairy products and eggs because of lack of competitiveness. Importantly, their exports are volatile.

6. Feasible level of exports of selected commodities

- The projected rice exports (based on historical data) portray a gradual increase, culminating at 30.07 million tonnes by the year 2047. Moreover, the potential for export expansion appears promising, as the surplus available for export is expected to surge significantly, starting at 26 million tonnes in 2025 and reaching an impressive 40 million tonnes by 2047. This clearly signals a favorable environment for further augmenting the country's rice exports.
- Given India's historical position as a relatively intermittent participant in the global wheat export market, the extent of its wheat export potential remains largely underestimated. Thus, the projected exports for wheat indicate a gradual rise from 3.27 million tons in 2030 to 4.5 million tons in 2047. However, the surplus determined by estimates of demand and supply, is projected to experience modest growth increasing from 11 million tons in 2025 to 42 million tons in 2047.
- The projections indicate that the dairy exports would be less than one million tonnes in terms of milk equivalent. The country has been able to harness approximately 80% of export potential in bovine meat. The bovine meat is expected to hover between 1-1.5 million tonnes. The exports of crustaceans are promising.

7. Projected demand for agricultural inputs

Given the limited scope for area expansion, future growth in food production has to come from intensification of the existing cropland, using more of inputs such as fertilizers, pesticides and quality seeds, and also in improvements in irrigation coverage and its efficiency.

- **Fertilizers:** In the most pessimistic scenario wherein the drivers (i.e., irrigated area, fertilizer price, and output price) of growth in fertilizer consumption are assumed to accelerate by 10%, the demand for fertilizers is expected to increase to 396 lakh tonnes by 2030-31 and 640 lakh tonnes by 2047-48. The corresponding increase in their per hectare consumption will increase from 193 kg by 2030-31 to 300 kg in 2047-48.

  Nevertheless, the Government of India has initiated several schemes (i.e., Soil Health Card, micro-irrigation including fertigation, Neem coated urea, natural farming, biofertilizer, etc.) to reduce the use of chemical fertilizers. Assuming that their successful implementation leads to a deceleration in growth in fertilizer consumption by 50%, while growth in its drivers accelerates by 10%, the demand for fertilizers is projected to be less; 339 lakh tonnes in 2030, and 432 lakh tonnes in 2047-48. Accordingly, their per hectare consumption is expected to be 165 kg in 2030-31 and 202 kg in 2047-48.

- **Pesticides**: In the BAU scenario, the demand for pesticides is projected to increase to 79,233 tonnes in 2030-31 and to 1,18,405 tonnes in 2047-48. The per hectare consumption is estimated at 0.39 kg in 2030-31 and 0.55 kg in 2047-48. Cotton is the largest consumer of pesticides. In recent years, cotton area, however, has stagnated. On the assumption of a decline of 10% in the growth in cotton area, the demand for pesticides will be less; 68,062 tonnes in 2030-31 and 83,209 tonnes in 2047-48. Accordingly, their per hectare consumption is projected at 0.33 kg in 2030-31 and 0.39 kg in 2047-48.

- **Seeds:** Given the projected seed replacement rates (SRR) for different crops, the demand for certified seeds is estimated at 34,068 thousand quintals in 2030-31 and at 49,701 thousand quintals in 2047-48. The corresponding requirement for foundation seeds will be 1030 and 1531 thousand quintals, and for breeder seeds 37,649 quintals and 55,483 quintals in 2030-31 and 2047-48, respectively.

  By 2030, if the SRR reaches 100%, then the demand for certified seeds will increase to 78,571 thousand quintals, and further to 92,335 thousand quintals in 2047-48. Accordingly, the foundation seed requirement is projected at 2509 thousand quintals in 2030-31 and 2981 thousand quintals in 2047-48, and the breeder seed requirement at 97,589 quintals and 1,17,669 quintals.

- **Credit:** With moderate growth in credit supply, the total credit (short-term and long-term) requirement in agriculture is estimated at Rs 42,60,769 crores

in 2030-31 and Rs 1,31,51,319 crores in 2047-48. The demand for long-term credit will increase faster, consolidating its share in the total credit from 64% in 2030-31 to 81% in 2047-48 from its current share of 45%.

Recommendations

Owing to the sustained rise in per capita income, changing lifestyles, and increasing consumer preferences for nutritious foods, the consumption basket has been diversifying away from staple cereals towards high-value food commodities. This shift is likely to be more prominent in future, propelling a disproportionately high growth in their demand. In view of this, the following recommendations merit attention.

1. **Land use planning:** Given the disproportionate increase in the demand for fruits, vegetables, pulses, edible oils, nutri-cereals and maize compared to rice and wheat, it is important to evolve economically feasible cropping patterns suited to the resource endowments of different agro-ecological zones. Changing demand preferences and rising surplus might pave the way for diverting some of the rice and wheat acreage towards nutri-cereals, pulses, and oilseeds.
2. **Revisit price policy:** The open-ended procurement of rice and wheat at minimum support prices acts as a disincentive for diversification towards high-value and riskier crops. It is, therefore, important to re-think about the policy of open-ended procurement, and restrict the procurement of rice wheat to the requirements of country's food security and welfare schemes. For the additional marketed surplus, farmers can be compensated through price deficiency scheme. If they diversify away from rice and wheat, they can be compensated for the revenue foregone from these, if any.
3. **Invest in infrastructure and value chains for perishable commodities:** The existing infrastructure for storage, transportation, and processing of perishable commodities is grossly inadequate given their levels of production. It is, therefore, recommended to aggressively invest in infrastructure required for perishable commodities to avoid post-harvest losses and reduce high price volatility. Private investment in value chains can address some of the infrastructural bottlenecks.
4. **Promote millet consumption and production:** Consumption of millets has declined considerably. There is a need to keep the momentum of promotion of millets to create awareness about their nutritional benefits among the masses. There is also a need to accelerate production by increasing area and improving yield, and promote the value chains of millets.
5. **Reduce consumption of edible oils:** Consumption of edible oil is more than its recommended intake, which may adversely affect human health. India imports 60% of its edible oil demand. Hence, creating awareness at recommended level is beneficial for human health, and it will also reduce fiscal burden owing to their imports.

6. **Enhance pulses production:** Pulses will remain one of the key components of Indian diet. Although there has been a significant increase in their production in recent years, it remains short of the demand. There is a need for a technological breakthrough in pulses, and for exploring possibilities of their cultivation in rice-fallow areas.

7. **Establish seed hubs:** Seed is the most crucial input in agriculture. The seed replacement rate need to be enhanced. To produce the required quantity of seed of different food crops, there is a need to establish commodity-specific seed hubs in their niche production regions of different pulse crops.

8. **Rejuvenation of soil health:** There are considerable regional disparities in fertilizer consumption and imbalances in fertilizer nutrients so much so that their adverse effects on soils, water, and the environment have now become visible. Their nutrient use efficiency is also very low. Reducing the fertilizer consumption and improving nutrient-use efficiency requires a multipronged strategy, including the parity in prices of different nutrients, linking their provision with their recommended usage, and promotion of bio-fertilizers, integrated nutrient management, etc. The other option is to link agricultural incentives to the adoption of sustainable agricultural practices that generate ecosystem services and evolve a mechanism for their payment to farmers. The recently announced Green Credit Scheme has considerable potential to incentivize farmers for their adoption of such practices.

9. **Promote climate-resilient technologies and practices:** Climate change is emerging a big threat to agriculture, which, in the absence of adaptation and mitigation, will adversely affect crops yields and food supplies. Although, India is proactive in addressing the climate change issues, the need for a greater policy focus on adaptation and mitigation cannot be discounted.

10. **Improve credit flow for capital investment:** Credit plays an important role in agricultural development. It alleviates liquidity constraints on the farmers' short-term financial requirements for operational expenses and for capital investment in farm assets, mechanization, land management and water conservation, etc. Currently, the flow of short-term credit outweighs the long-term credit flow. Given the low level of gross capital formation in agriculture, there is a need to accelerate the flow of long-term credit for capital investment to introduce private investment.

11. **Invest in agricultural research:** Agricultural research is crucial for addressing the multiple challenges of climate change, resource degradation, environmental pollution, malnutrition and poverty while enhancing agricultural productivity. Although over time, there has been considerable improvement in spending on agricultural research, it remains much less—0.5% of the agricultural gross domestic product—than in several developed and developing countries as well (2-3%). In the absence of adequate funding for agricultural research, its outputs and outcomes may remain muted. Therefore, the need for more allocation of resources for agricultural research should not be discounted.

Note that returns on investment in agricultural research are significantly higher than on the spending on input subsidies.

12. **Expand the extension system:** The future of agriculture will be knowledge and information intensive, leading to an exponential growth in farmers' demand for information on seeds, fertilizers, agronomic practices, weather forecasts, markets, prices, trade, etc. However, currently, the outreach of the formal extension system (including government extension systems, research institutes, agricultural universities, mass media and ICTs) is limited. Hence, there is a need to improve technology, input and information delivery systems and establish a single window for providing all types of information. Notably, the potential of technologies remains unrealized due to information and capital constraints, as is evident from the large yield gap in in many crops.
13. **Improve compliance towards food safety standards for exports:** Food safety standards in the international markets are becoming stringent. To harness the export potential of agricultural commodities, it is imperative to strengthen international market intelligence to identify market destinations, and their tariff and non-tariff measures, and comply with these by promoting good agricultural practices (GAP), good manufacturing practices (GMP), and good handling practices (GHP).
14. **Robust data systems:** Robust data systems have become indispensable in agriculture, providing a comprehensive understanding of the dynamic environmental trends and facilitating in-depth analyses. These systems enable researchers, farmers, policymakers, and other stakeholders to gain valuable insights into the critical aspects of agriculture. Continuously updated and systematic databases on household consumption pattern would be critical in understanding the market signals and analyzing the demand dynamics. The commodity balance sheets from nationally acclaimed institutions like the Ministry of Statistics and Programme Implementation would be instrumental in comprehensively scrutinizing commodity plans and formulating effective strategies.
15. **Upscale digital innovations:** Digital innovations hold the promise of improving efficiency, sustainability and inclusiveness of food systems, and improving transparency and traceability along the food value chains from upstream to downstream. In recent years, several digital innovations have come up for irrigation optimization, aerial application of agro-chemicals, soil and water mapping and testing, forecast and delivery of weather advisories, disease diagnosis, marketing, customized crop insurance, etc. These need to be upscaled incentivizing farmers and other stakeholders.

Chapter 1

Background

Owing to technological advancements and enabling policies and institutions, India has made tremendous progress in food production during the past five decades, making the country self-sufficient in food and even an exporter of food commodities like rice, crustaceans, and bovine meat. In 2021-22, India produced 330 million tonnes of foodgrains, 221 million tonnes of milk, 317 million tonnes of fruits and vegetables, and 16 million tonnes of fish. It also exported agricultural commodities worth US$50 billion. It is important to note that India accounts for 40% of the global exports of rice. During the Covid-19 pandemic, India's exports of food commodities helped several food-deficit countries fight against hunger and manage extreme price rise. Nevertheless, India is deficit in edible oils and pulses, and imports these to meet their domestic demand.

Nevertheless, the need to produce more food remains as urgent as ever. According to the National Family Health Survey 2019-20, about 32% of the children under five years of age are underweight, 35% are stunted, and 19% are wasted. The Government of India is committed to ensure an affordable access to nutritious and healthy food to all to achieve the goal of zero hunger by 2030 as enshrined in the Sustainable Development Goals of the United Nations.

India, by 2047, the centennial year of its independence, is envisioned to enter the league of developed nations. To realize this vision, the economic growth has to be accelerated to about 8% over the next 25 years, from 6.34% in the recent decade. The people, thus, will be more affluent and demand more of nutritious, safe and processed foods. Importantly, India's population will cross 1.6 billion mark by 2047, and about half of it will be living in cities and towns. The growing urbanization, changing demographics, increasing participation of women in workforce, and improvements in storage and logistics will accelerate the pace of diversification of food basket. Additionally, the food commodities will be increasingly used as feed, fibre, fuel, and in nutraceutical & pharmaceutical industries. These trends suggest a significant increase in the demand for food commodities over the next 25 years.

At the same time, enhancing farmers' income remains one of the important goals of India's agri-food policy. Indian agriculture is dominated by small landholdings, with 70% of the holdings not exceeding one hectare, and their further fragmentation is inevitable, restricting realization of the scale economies. Concurrently, the food production system will come under a confluence of biotic and abiotic pressures. For the past three decades, India's net cropped area has been hovering around 139 million hectares; and there is little, if any, scope of bringing additional land under agriculture, except through intensification of the existing cropland. The water resources are limited, and the growing water scarcity

has been posing a serious challenge to the intensification of the existing cropland. Groundwater in the intensively cultivated regions, as in Punjab and Haryana, has been over-extracted. Besides the quantitative limits on the utilization of these resources, their quality has also been deteriorating due to crop intensification. Further, pre- and post-harvest losses in food commodities continue to be large, especially in perishable commodities such as fruits, vegetables and milk. More importantly, climate change has emerged a significant threat to the sustainability of food production systems, and the threat is likely to be more pronounced in the plausible future climate scenarios, which in the absence of adaptation and mitigation, will threaten the food and nutrition security of all from upstream to downstream of the food supply chain. Nevertheless, supported by the enabling policies and institutions on agricultural research offers considerable scope to improve efficiency and resilience of agriculture.

Thus, an assessment of the current and projected demand and supply of food commodities will help policymakers and scientific community to take informed decisions for food management system, in terms of production, trade and distribution, to ensure food and nutrition security of all. In this regard, the NITI Aayog constituted a Working Group to assess the future food demand and the prospects of meeting it through domestic production with the following **terms of reference (ToR)**.

1. To study and analyze the trends in demand and supply of major food commodities and examine the changing consumer preferences for food and related items.
2. To assess the demand and supply of various food commodities and farm inputs namely fertilizer, seeds, credit, feed and fodder for 2025-26, 2030-31, 2035-36, 2040-41, and 2047-48.
3. To estimate the normative requirements of rice, wheat, maize, nutri-cereals, pulses, foodgrains, oilseeds, sugarcane, fruits, vegetables, and animal products viz., milk, meat, eggs & fish.
4. To estimate the feasible level of export of the above-mentioned commodities for the years 2025-26, 2030-21, 2035-36, 2040-41, and 2047-48.

The Report is organized as follows: Chapter 2 presents changing consumers' preferences of food commodities. Past trends and present status of demand and supply of food commodities are discussed in Chapter 3. Projections of the normative requirement of food are presented in Chapter 4. Chapter 5 presents projected demand and supply of food commodities. The estimates of feasible level of exports of selected food commodities are discussed in Chapter 6. Projected demand for key agricultural inputs is given in Chapter 7.

Chapter 2

Changes in Consumer Preferences

Food preferences evolve in response to changes in income, prices, demographics, lifestyles, and the diversity in available foods. This chapter analyzes the changes in food preferences of rural and urban consumers and of different expenditure or income classes, using data from different rounds of the quinquennial 'Household Consumer Expenditure (HCE)' surveys conducted by the National Sample Survey Office (NSSO) of the Ministry of Statistics and Programme Implementation, Government of India. These surveys provide detailed information on the consumption of food and non-food commodities, in quantity as well as value. The latest available HCE survey is for 2011-12. For the later years, the Group has relied on data on private final consumption expenditure (PFCE) from the National Accounts Statistics for extrapolating food demand from 2011-12 onwards.

2.1 Changes in consumption pattern: HCE surveys from 1972-73 to 2011-12

There has been a rising trend in consumption expenditure, and being accompanied by significant changes in its composition (Figure 2.1). The per capita consumption expenditure (at 2011-12 prices) increased by 62.87% between 1972-73 and 2011-12 (Table 2.1), largely driven by non-food commodities. Food accounted for a lion's share (69%) in the total consumption expenditure in 1972-73, but after remaining around 62% between 1977-78 to 1993-94, it declined drastically to 44% in 2011-12. While the total consumption expenditure (in real terms) has grown at an accelerated rate, the food expenditure has not exhibited a similar trend. The food expenditure experienced a negative growth during 1972-73 to 1983, and 1993-94 to 2004-05.

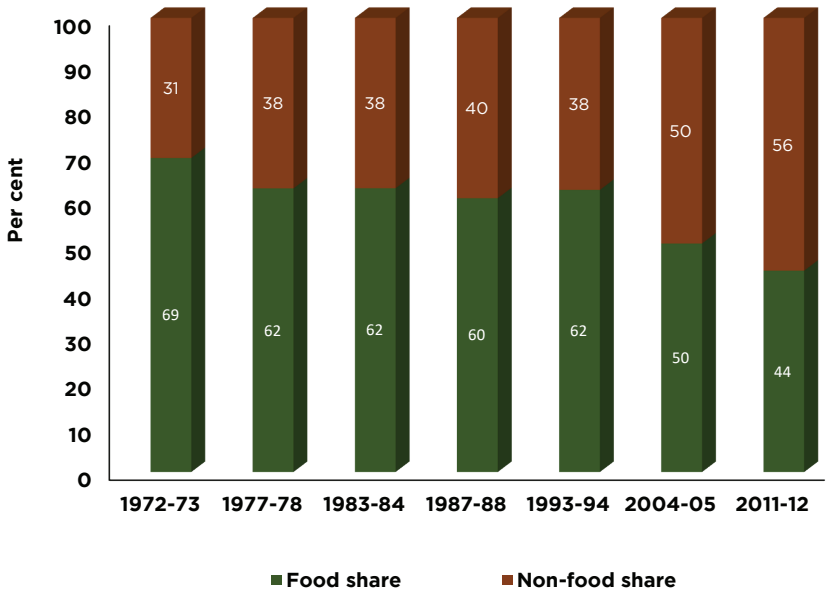


Figure 2.1 Composition of consumption expenditure, 1972-73 to 2011-12

Table 2.1. Trend in household consumption expenditure in India

Rs/capita/month

Year	Total consumption expenditure		Food expenditure (at 2011-12 prices)	Non-food Expenditure (at 2011-12 prices)
	At current prices	At 2011-12 prices		
Expenditure level				
1972-73	51	983	680	303
1977-78	79	975	609	366
1983-84	131	994	621	373
1987-88	178	1044	630	415
1993-94	325	1093	679	414
2004-05	684	1233	618	614
2011-12	1599	1599	708	891
Compound growth (% per annum)				
1972-73 to 1983	9.9	0.11	-0.90	2.08
1983 to 1993-94	10.6	1.07	1.00	1.18
1993-94 to 2004-05	7.7	1.21	-0.90	3.99
2004-05 to 2011-12	12.9	3.79	1.93	5.49

*Current expenditure deflated by consumer price index for agricultural labourers (CPI-AL) for rural sector, and by consumer price index for industrial workers (CPI-IW) for urban sector. To arrive at the average expenditure, rural and urban expenditures were weighted by the number of rural and urban households, respectively. CPI-AL (1987-88=100) and CPI-IW (1987-88=100) were rebased at 2011-12=100.

Source: Consumption Expenditure Surveys

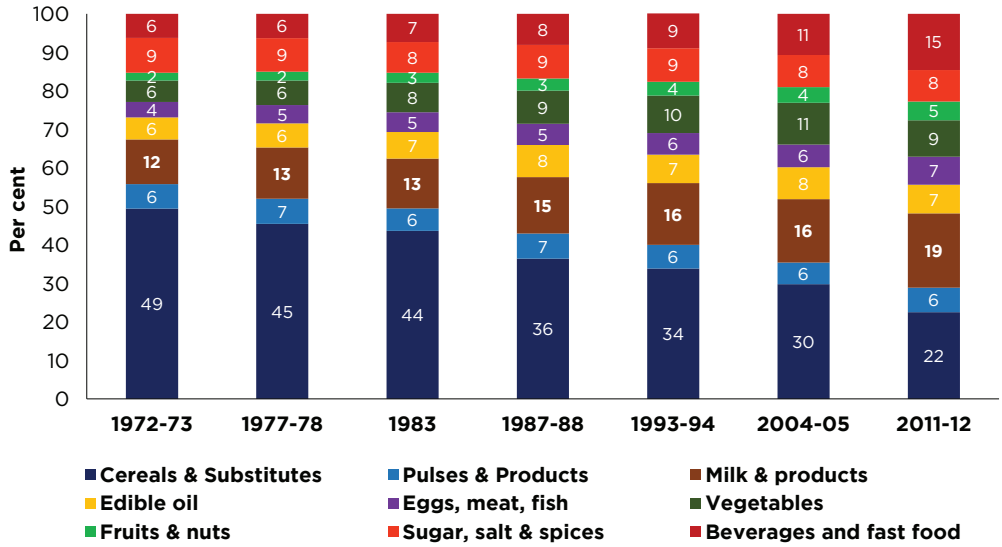


Figure 2.2. Composition of food expenditure

Significant changes have taken place in the food basket. Cereals which accounted for about half of the total food expenditure in 1972-73, have gradually lost their share, declining to 22% in 2011-12 (Figure 2.2). On the other hand, the shares of high-

value commodities, including the fruits, vegetables, milk, meat, fish and eggs, in the food expenditure have increased substantially from 24% in 1972-73 to 40% in 2011-12. Disaggregated by commodity, the share of animal-source foods increased from 16% to 26 %, and of fruits and vegetables from 8% to 14%. Interestingly, there has been a notable surge in the share of processed foods (including beverages and fast foods) from 6% in 1972-73 to 15% in 2011-12.

The other way to examine the change in food preferences is to analyze the change in the food basket in terms of consumption of foods based on the extent of value addition to them. Following Morisse and Kumar (2011), the food basket comprises (i) primary products, (ii) first-processed low value-added products, (iii) first-processed high value-added products, and (iv) second-processed products.

- **Primary products** are consumed as produced without any processing (e.g. fresh fruits, vegetables, eggs, and fluid milk).
- **First-processed low value-added products** are the primary products with minimal level of processing (upto 5%), in terms of shelling, hulling, husking, milling, drying and grinding (e.g. rice, flour, pulses, spices, and dry fruits).
- **First-processed high value-added products** are the primary products that have undergone sophisticated processing in terms of pasteurization, heating, fermentation, slaughtering and crushing, adding 5-15% value to them but without any other ingredient (e.g. butter, curd, meat, fish, and sugar).
- **Second-processed products are the products** manufactured from the first-processed products adding other ingredients such as flavors and preservatives (e.g. biscuits, bread, ghee, ice-cream, and jam).

The food items reported in the NSS-HCE survey 2011-12 have been classified into the above four categories and are listed in Appendix 2.1.

Table 2.2 Changes in food preferences based on value addition to food commodities

Food category	Real expenditure (Rs/capita/month at 2011-12 prices)		Compound growth rate (%)	Share in total food expenditure (%)	
	2004-05	2011-12		2004-05	2011-12
Primary products	82	99	2.9	14	15
First-processed low value- added	241	229	-0.5	42	35
First-processed high value- added	198	237	2.5	34	36
Second-processed products	54	95	9.5	9	14

Source: Estimates based on HCE surveys

Table 2.2 presents the expenditure on different food categories as classified above. The expenditure share of first-processed low value-added foods has declined from 42% in 2004-05 to 35% in 2011-12. While, the expenditure on second-processed, primary, and first-processed high value-added foods have increased at annual growth of 9.5%, 2.9% and 2.5%, respectively, resulting in a decline in the share of first-processed low valued-

added products, and an increase in the share of second-processed foods to 14% in 2011-12 from 9% in 2004-05. This indicates growing preference for second-processed food products, including the edible oils, fats, cold beverages, salted refreshments, cookies, cooked meals consumed outside home, etc. The real expenditure on primary foods has also increased, but the increment is far less than for the second-processed products.

Figure 2.3 presents the changes in food preferences of rural and urban consumers. The rural consumers allocated a higher share of food expenditure to the first-processed high value-added and second-processed foods in 2011-12 than in 2004-05. For urban consumers, the share of second-processed products increased from 14% in 2004-05 to 21% in 2011-12. These changes can be attributed to a sustained rise in per capita income, increasing participation of women in workforce, and changing lifestyles. Nevertheless, this transition in food preferences indicate existence of significant latent demand for high-value and processed foods.

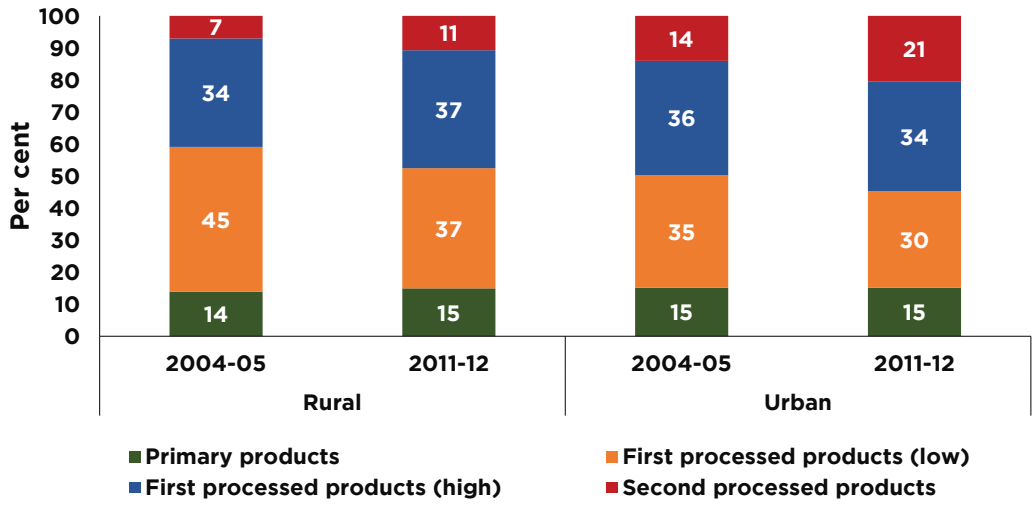


Figure 2.3 Changes in food preferences of rural and urban consumers

Income is one of the key determinants of food consumption and dietary preferences. The data from the HCE surveys reveal a signifcant difference in the dieteray preferences of consumers in different expenditure classes (Figure 2.4). The poor consumers spend proportionately more on first-processed low value-added foods than their rich counterparts. On the other hand, the share of first-processed high value-added, and second-processed foods is signficiantly higher forthe rich consumers.

Nevertheless, share of second-processed foods has increased for all expenditure classes. The share of first-processed high value-added foods has increased but only upto seventh-decile expenditure classes. The dominance of high-value and processed foods in the food basket of the rich consumers indicates their strong positive association with household income.

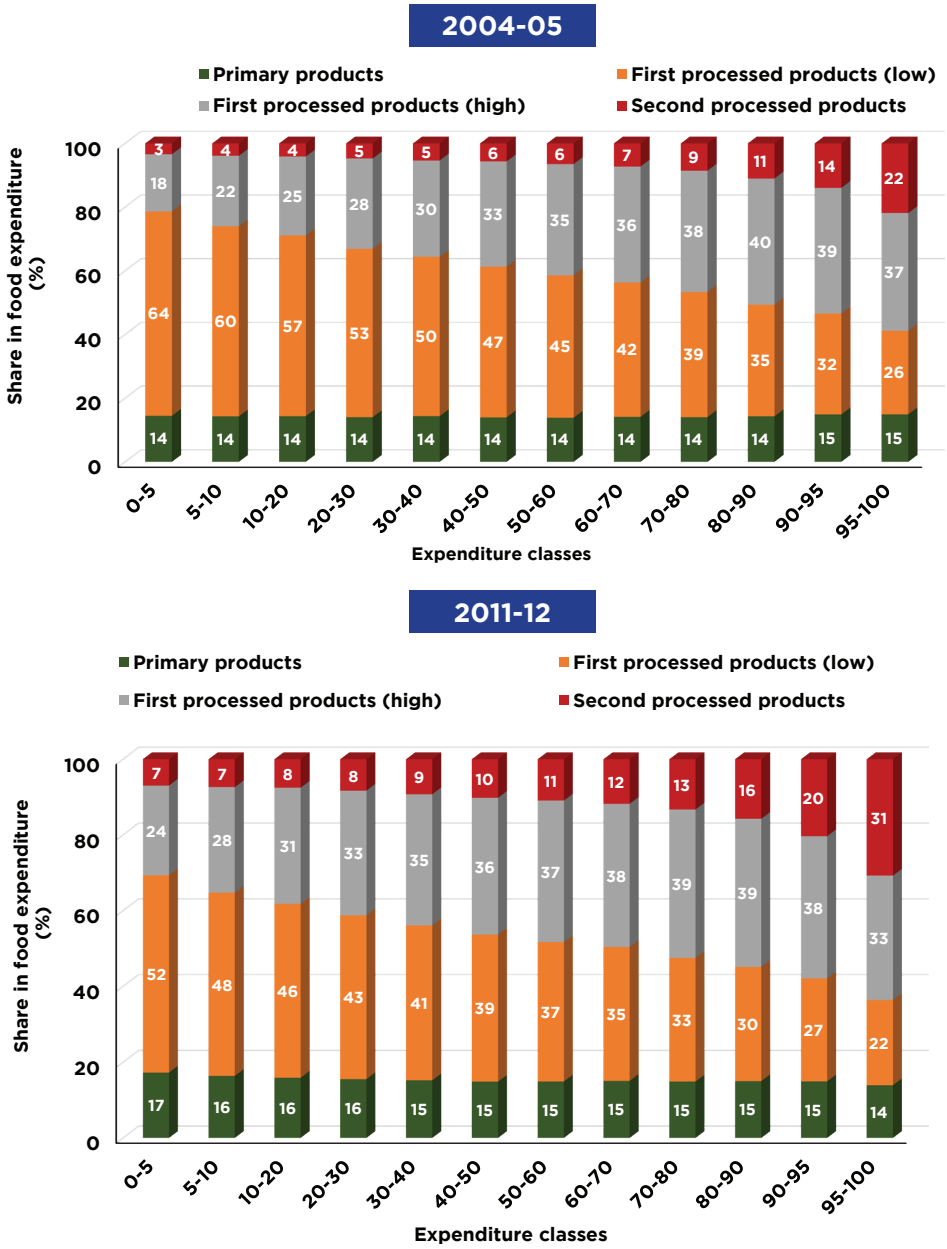


Figure 2.4 Expenditure class-wise consumption preferences

2.2 Changes in food consumption expenditure: PFCE from 2011-12 to 2019-20

Besides the household surveys, the macro estimates of the annual private final consumption expenditure (PFCE) are generated by the Central Statistics Office (CSO) for preparing the National Accounts Statistics (NAS). Both the HCE surveys and NAS provide information on the final consumption of goods and services in resident households. However, due to differences in the methodological approach and coverage of households, there is a divergence in their estimates (GoI, 2015). Yet, the trends are similar (Appendix 2.2). Since, the HCE survey data are not available after 2011-12, the PFCE estimates provide insights into the macro dynamics for recent years.

Between 2011-12 and 2019-20, the total PFCE (at 2011-12 prices) increased at annual rate of 7%. The growth has been higher for the non-food consumption expenditure (7.7%) than the food expenditure (5.1%) (Figure 2.5). The higher growth in non-food expenditure indicates a similar trend as obtained from the HCE data.

Further, the growth in expenditure differs across food groups. It has been the lowest for edible oils. The expenditure on processed foods registered the highest growth (10.2%). The expenditure on food consumed in the restaurants, and also the animal-source foods registered faster growth of 7.4% and 8.1%, respectively. These trends suggest that demand for high value and processed products has been growing faster than for staple foods. The PFCE based post 2011-12 evidence on food preferences are also consistent with those obtained from the HCE until 2011-12.

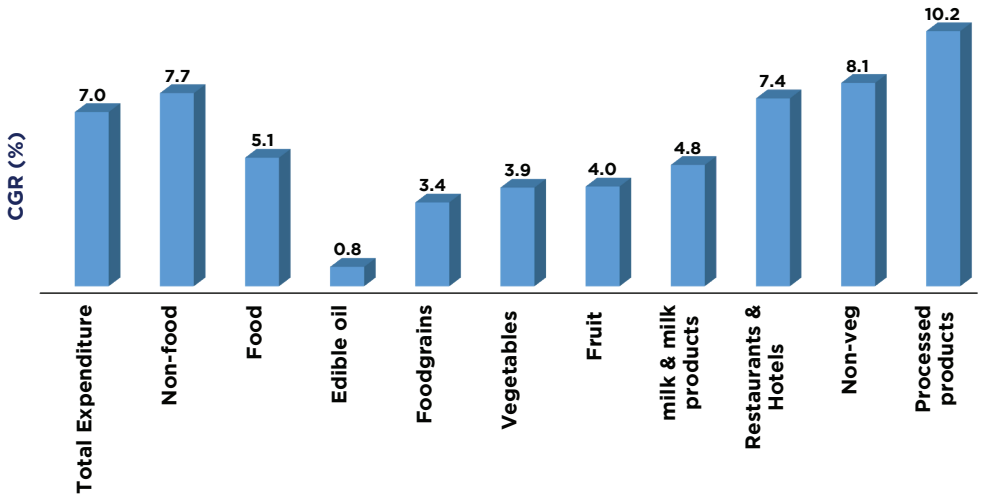


Figure 2.5. Compound growth rate in consumption expenditure (at 2011-12 prices) in India during 2011-12 to 2019-20

HIGHLIGHTS

- The spending of Indian households is increasing over the years and a major part of incremental consumption expenditure is spent on non-food items. Allocation of household budget on food is declining.
- Consumer preferences are changing steadily away from staple to high value added and processed food products in both rural and urban areas and across all the expenditure-classes. This indicate existence of huge demand of these products and market for the food processing industry in the country.
- Rising consumer preferences towards high value food products have become more pronounced in the recent years. The estimates of consumption expenditure based on NSS-HCE surveys and NAS diverge in magnitude due to methodological differences, but both sources provide similar trends in consumption pattern.

Chapter 3

Food Demand and Supply

3.1 Food demand

The total food demand comprises the direct demand for human consumption and the other uses for seed, feed, and non-food (industrial) uses, besides the food loss. It is estimated that 61% of the food demand (at aggregate level) comprises the meals prepared in the household premises and restaurants. The remaining represents the seed, feed, loss/wastages, and raw material for food processing (second-processed products) and industrial uses (pharmaceutical, cosmetic, ethanol, etc.). The pattern, however, varies across food commodities.

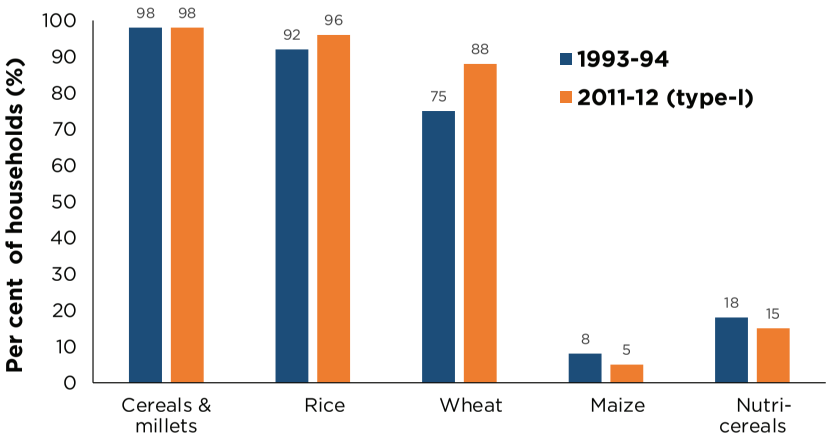
The household food demand dominates the total food demand, but it varies across expenditure classes, and between rural and urban areas. The temporal changes in the household demand of different food commodities have been examined and compared (based on uniform reference period of 30 days) between 1993-94 and 2011-12 using the HCE data.

Foodgrains: Foodgrains include the cereals and pulses. Cereals comprise the main staple food (Figure 3.1). Rice and wheat are the most consumed cereals, accounting for more than 90% of the total cereal consumption. Consumer preference for these cereals appear to have become stronger, as is indicated by an increase in the number of their consumers. The households consuming coarse cereals (millets and maize) have declined between 1993-94 and 2011-12. In 2011-12, the average per capita consumption of cereals (357grams/day) was 27% more than the recommended allowance of 281 grams/capita/day. On account of the dietary diversification and the reduced energy requirement for physical activities, the average per capita cereal consumption has declined by 16%. The decline was significant for maize (70%) and millets (67%), as compared to rice (14%) and wheat (1%).

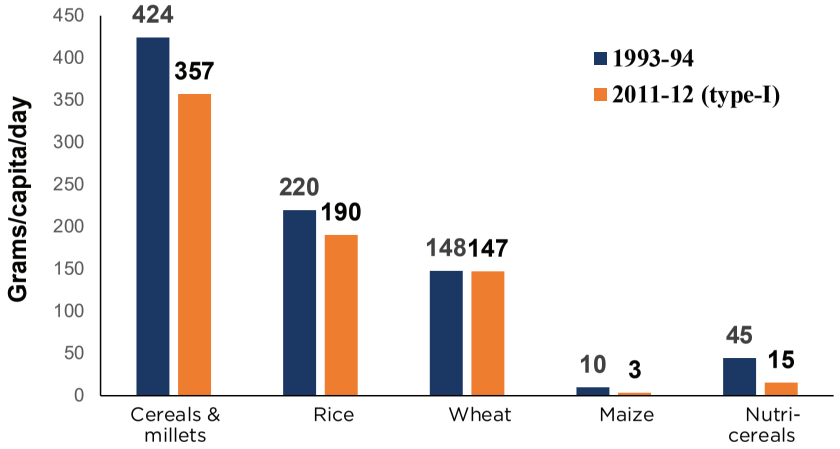
In 2011-12, the consumption of cereals was more in rural areas (Table 3.1). Expenditure class-wise analysis, however, indicates weakening of the positive association between income and cereal consumption, primarily due to a steeper decline in their consumption by the rich (Figure 3.2).These changes, however, differ across cereals.

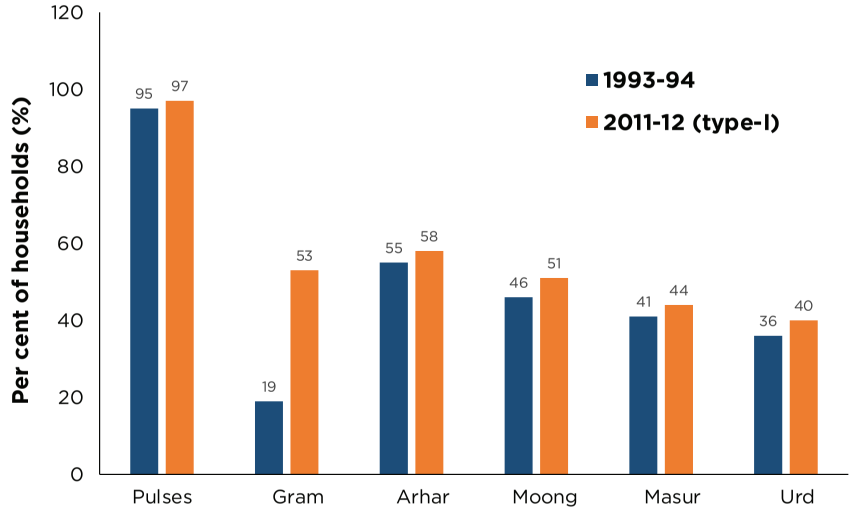
The per capita consumption of rice has increased in the bottom five decile classes, but has declined in the others. Wheat consumption increased in the bottom six decile classes, while it reduced in the top four. The consumption of nutri-cereals was significantly higher among the poor and in the rural areas in 1993-94 (Figure 3.2 and Table 3.1). But thereafter, their consumption declined significantly (upto 93%) among the poor and also in the rural areas (66%). The corresponding changes for higher expenditure classes and urban areas are not so glaring. These evidences indicate a significant negative preference for nutri-cereals, especially in the lower expenditure classes and in the rural areas. The consumption of nutri-cereals appears to be moving towards the rich and urban areas. Nonetheless, in the International Year of Millets 2023, there has been an increasing emphasis on promotion of consumption of nutri-cereals.

Consuming households (%)



Per capita consumption (grams/capita/day)





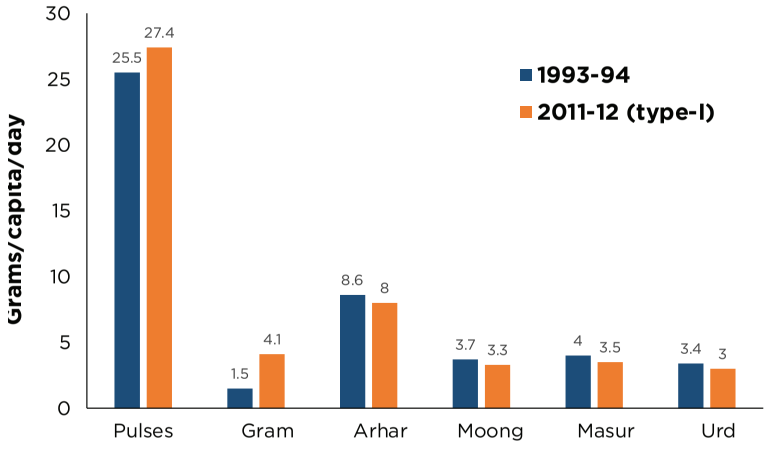
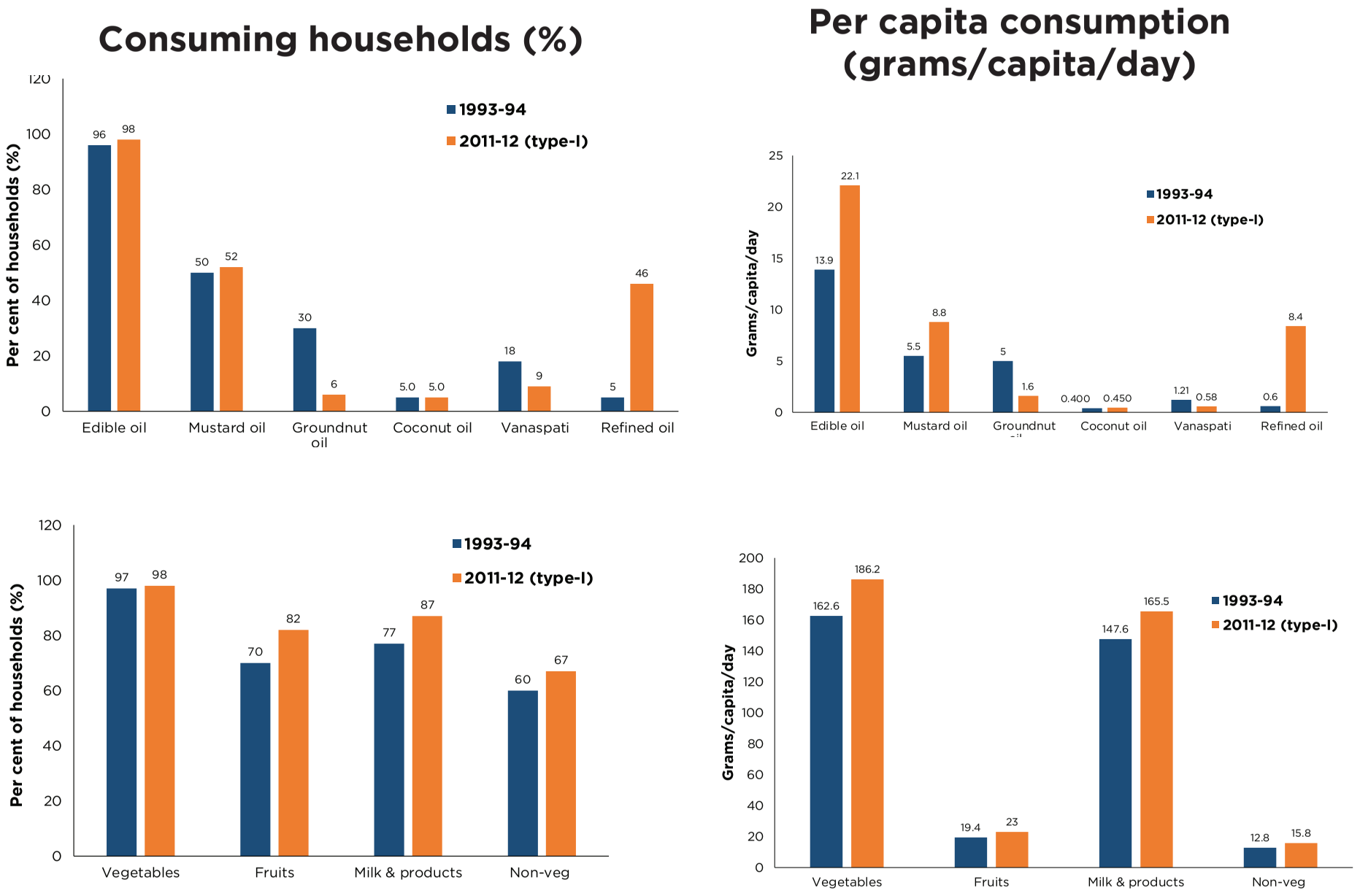


Figure 3.1 Changes in household consumption of different food commodities



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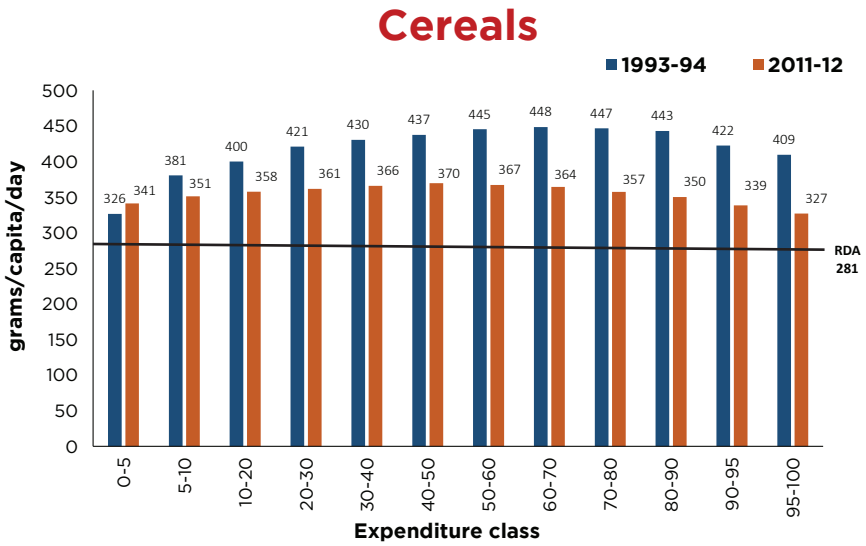
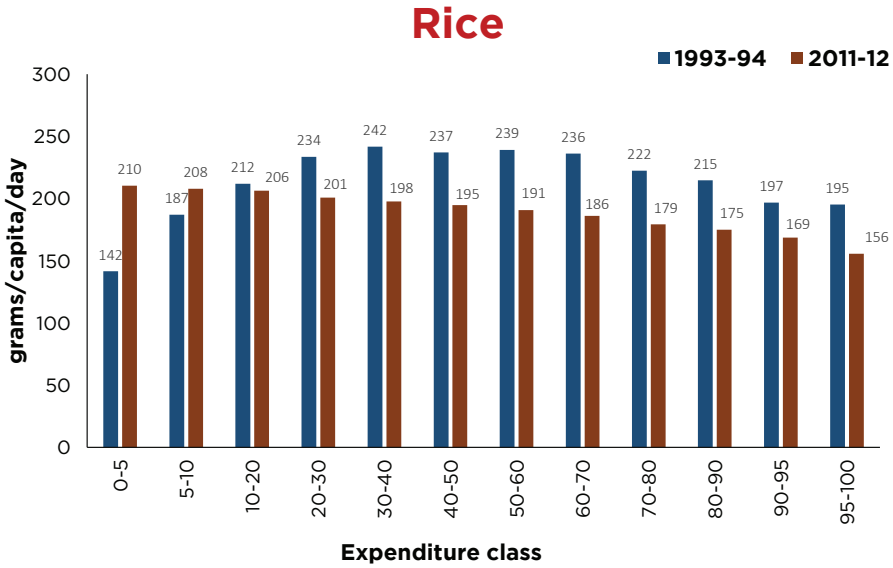




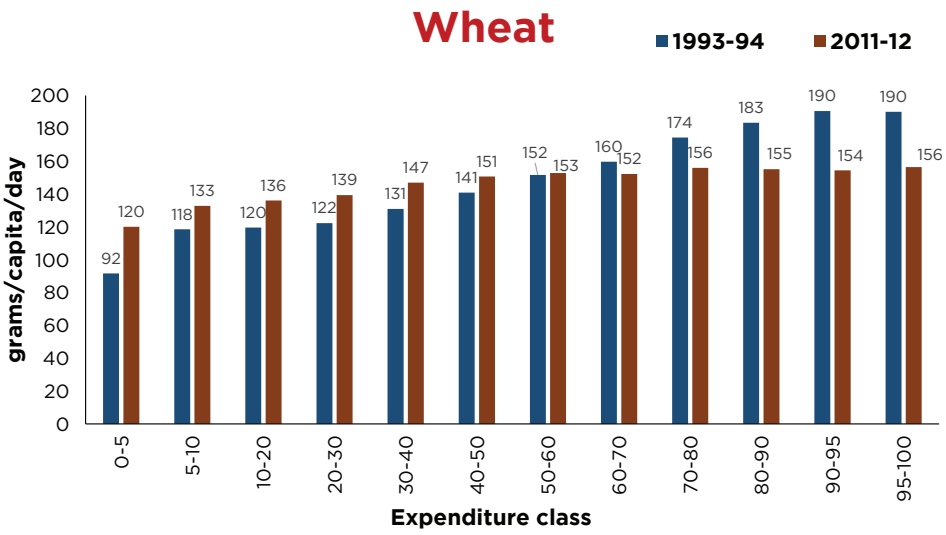
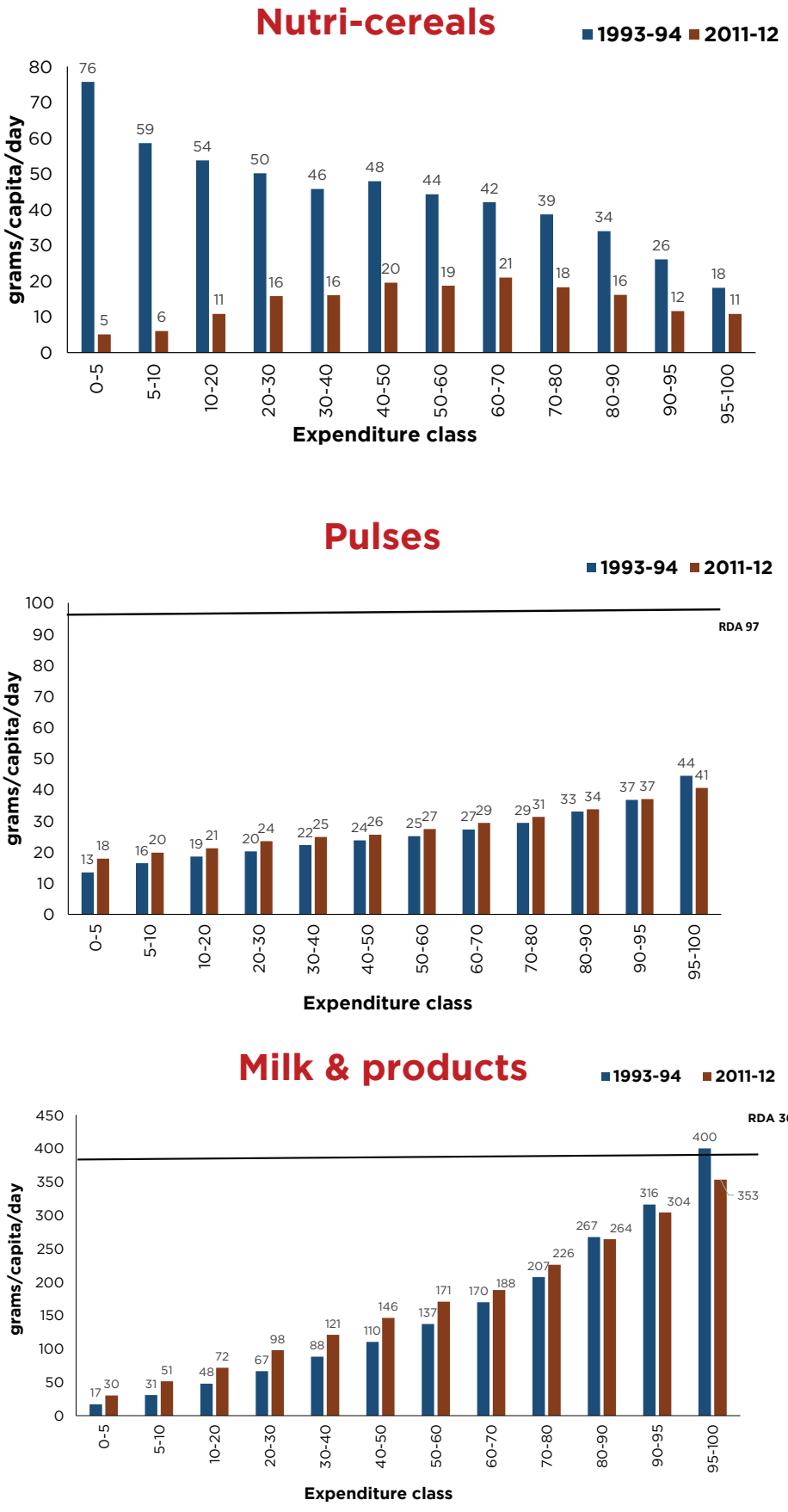


Figure 3.2 Expenditure class-wise changes in consumption of different food commodities



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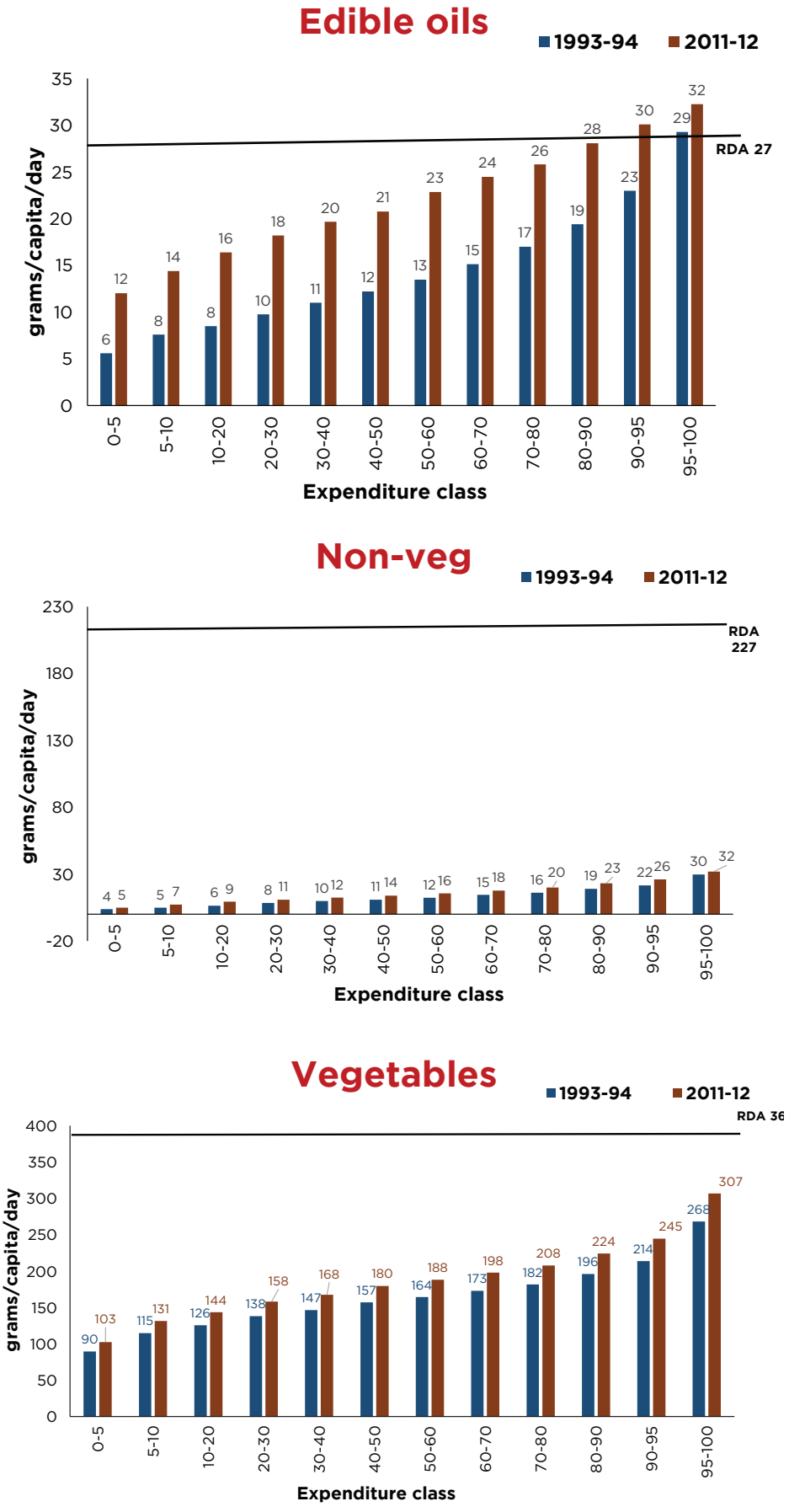


Figure 3.2 Expenditure class-wise changes in consumption of different food commodities

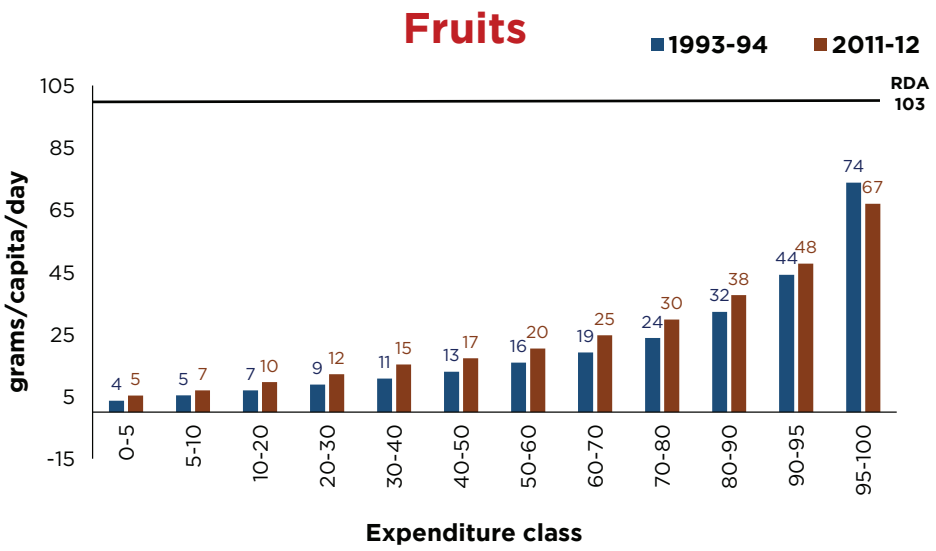


Figure 3.2 Expenditure class-wise changes in consumption of different food commodities

Table 3.1 Trends in household consumption of different food commodities in rural and urban areas

Grams/capita/day

Commodity	1993-94		2011-12		Compound growth rate (%)	
	Rural	Urban	Rural	Urban	Rural	Urban
Cereals	448	351	375	312	-0.98	*-0.65*
Rice	234	176	204	155	-0.76	*-0.70*
Wheat	146	153	148	145	0.08	*-0.30*
Nutri-cereals	53	20	18	10	-5.82	*-3.78*
Pulses	25	28	26	30	0.22	*0.38*
Meat, egg and fish	12	16	15	19	1.25	*0.96*
Milk and products	139	174	154	194	0.57	*0.61*
Vegetables	159	163	186	171	0.88	*0.27*
Fruits	15	31	19	32	1.32	*0.18*
Sugar	26	32	26	29	0.00	*-0.55*
Edible oil	12	19	20	26	2.88	*1.76*

The average per capita consumption of pulses was 27 grams/day in 2011-12, which was far less than their normative requirement of 80-97 grams/day. The consumption of pulses, however, has increased over time. Further, the consumption of pulses is more diversified as compared to that of cereals. Arhar comprises 30% of their total consumption, followed by gram and masoor (15% each), and moong & urd (11% each). Between 1993-94 and 2011-12, the consumption of gram increased the most. The rich and urban households consume more pulses compared to their poor and urban counterparts. Notably, pulses consumption has increased for all, indicating its positive association with income.

Plant-source high-value food commodities: The consumption of fruits and vegetables has also increased. The households consuming fruits increased from 70% in 1993-94 to 82% in 2011-12. Notably, between 1993-94 and 2011-12, the per capita consumption of fruits increased by 21%, more so in the rural areas. Yet their level of consumption has remained far below the recommended allowance of 103 grams/capita/day. Further, there is a significant difference in their consumption across expenditure classes, and also between rural and urban consumers. The rich and urban households consume more than the poor and rural consumers. Thus, there is a strong positive income effect on fruit consumption.

Vegetables are an indispensable component of Indian diet, as every household consumes these. Their per capita consumption increased by 14% between 1993-94 and 2011-12, and the increase was more prominent in rural areas. Yet, their level of consumption has remained below their recommended allowance of 361 grams/capita/day. Notably, their consumption is more in the higher expenditure classes.

Animal-source foods: Between 1993-94 and 2011-12, the proportion of households consuming milk and milk products increased by 10%, and their per capita consumption by 12%. This change is observed in rural as well as urban areas, and in all expenditure classes, except in the top two deciles. The households in the lower expenditure classes consume less. In 2011-12, the average per capita consumption of milk was half of the recommended allowance of 364 grams/capita/day.

The consumption of meat, egg, and fish has been increasing. In 1993-94, about 60% of the households were non-vegetarian, and their proportion increased to 67% in 2011-12. However, the quantity consumed is too less. Further, their consumption is more among the rich and urban households. Nonetheless, their consumption has increased.

Edible oils: Edible oils are an important cooking medium. Notably, there is a noticeable increase in the consumption of edible oils in all the expenditure classes and in both rural and urban areas.Mustard oil, with a share of 40% in the total edible oils, is the most preferred, followed by refined oil (38%), and groundnut oil (7%). The share of vanaspati and coconut oil is less than 5%. Between 1993-94 and 2011-12, the average per capita consumption of edible oils increased by 37%, from 13.9 grams/day to 22.1 grams/day in 2011-12. Surprisingly, there is a significance change in edible oil preference—consumers of refined oil have increased from 5% to 46%, whereas consumers of vanaspati and groundnut oil have declined significantly. The per capita consumption of mustard oil increased by 60%, from 5.5 grams/day in 1993-94 to 8.8 grams/day in 2011-12.

Sugar and sugar products: Sugar is an essential food item being consumed by more than 90% of the households in one or another form. Between 1993-94 and 2011-12, the average per capita consumption of sugar in urban areas declined by 9% and remained almost unchanged in rural areas. Overall, the average per capita consumption of sugar declined by 3.6%.

HIGHLIGHTS

- Food is demanded for human consumption and other uses such as seed, feed, wastages and manufacturing of industrial products. Household demand constitutes the largest share in total food demand in India.
- Household consumption of cereals is declining over time due to evolving consumer preferences and reduced energy requirement. Over the years, fine cereals (rice and wheat) have substituted the coarse cereals (nutri-cereals and maize). Average consumption of cereals in India is higher than the recommended minimum requirements.
- Consumer base of nutri-cereals is changing from rural and poor households to urban and richer households. With the recent focus on nutri-cereals, their demand is expected to increase in future.
- Household consumption of pulses and high value food commodities such as fruits, vegetables, milk and non-vegetarian products is increasing over time. Consumption of these commodities is strongly associated with the income of the households. With the increase in income, their demand is expected to increase at a faster rate as compared to cereals.
- Refined oils have emerged as a major edible oils and have substituted other oils like vanaspati and groundnut oil. The household demand of edible oils is increasing over time.
- Household consumption of sugar decreased over time.
- Total demand of food products in future will depend on change in per capita consumption, population, income, difference between actual and normative requirements, and other uses.

3.2 Food Supply

Food supply comprises the domestic production, net imports (exports minus imports) and available stocks. For about two decades after Independence in 1947, India faced acute food deficit. The onset of green revolution in the late 1960s accelerated food production and made the country self-sufficient in several food commodities, especially wheat and rice. India has also emerged as a net exporter of several agricultural commodities. In 2021-22, it exported agricultural commodities worth US$52 billion. This section discusses the components of food supply by commodity, and assesses their production performance and potential.

3.2.1 Supply/availability of food commodities

Table 3.2 presents the availability of different food commodities in 2019-20. The country produced 298 million tonnes of foodgrains (cereals and pulses), and after accounting for 10.40 million tonnes of exports, 3.43 million tonnes of imports, and 11.23 million tonnes of stocks, their net availability for domestic use was 279 million tonnes. Rice and wheat account for three-fourths of the available foodgrains, followed by maize (10%), pulses (9%), and nutri-cereals (6%). Notably, rice accounts for more than 90% of the foodgrain exports, while pulses are the major imported items.India is the largest producer of pulses, still it imports - in 2019-20 about 11% of their domestic demand was met through imports.

Table 3.2 Availability of major food commodities in 2019-20

Million tonnes

Commodity	Production	Export	Import	Change in stock	Availability
Foodgrains	298	10.40	3.43	11.23	279
Cereals	274	10.17	0.47	11.23	254
Rice	119	9.51	0.01	5.43	104
Wheat	108	0.22	NS	5.68	102
Nutri-cereals	17	0.07	NS	0.12	17
Maize	29	0.37	0.46	-	29
Pulses	23	0.23	2.97	-	26
Fruits	102	0.83	0.99	-	102
Vegetables	188	1.93	0.15	-	186
Edible oils	12	0.98	13.42	-	24
Sugar & products	32	5.80	1.12	-3.84	31
Milk	198	NS	NS	-	198
Eggs	6	NS	NS	-	6
Meat	9	1.17	0.002	-	7
Fish	14	1.33	0.072	-	13

NS: non-significant

The total at aggregate level may not tally due to rounding out of figures

With a production of 102 million tonnes in 2019-20, India was the second-largest producer of fruits. It exported 0.83 million tonnes of fresh fruits, mainly grapes, pomegranates, mangoes, bananas and oranges. Consumer preferences for fresh fruits have also transformed in favour of exotic fruits, leading to a significant rise in their imports, especially apples, oranges, kiwis, avocadoes, cherries, and blueberries. Imports of fruits outweighed their exports.

India is also the second-largest producer of vegetables (188 million tonnes in 2019-20). It exported 1.93 million tonnes of vegetables, much larger than their imports of a mere 0.15 million tonnes.The net availability of vegetables for domestic use was 186 million tonnes in 2019-20.

India produced 12 million tonnes of edible oils in 2019-20 — 68% from the primary sources (i.e. oilseeds) and 32% from the secondary sources (i.e. palm, cottonseed, rice bran, coconut, solvent extracts, and trees and forest products). Their domestic production, however, falls short of their demand, compelling their imports (>50% total supply of 24 million tonnes).

India with a total production of 32 million tonnes of sugar, including jaggery and khandsari in 2019-20 was the largest producer. About 74% of the sugarcane output is used for manufacturing of white sugar and the rest for other products (ISMA, 2022). In 2019-20, it produced 27.4 million tonnes of white sugar and 4.2 million tonnes of gur and khandsari. It exported 5.8 million tonnes of sugar.

India is the largest producer of milk—in 2019-20 it produced 198 million tonnes. The production of fish, meat and eggs was 14, 9 and 6 million tonnes, respectively. A significant amount of fish and meat is also exported.

3.2.2 Production performance of food commodities

Indian agriculture has made a significant progress, leading to manifold increase in production of food commodities. During the last seven decades, the total food production[1] increased 8.5 times, much higher than 3.7 times increase in the population (Figure 3.3). Accordingly, the per capita food production also increased, from 772 grams/day in 1950-51 to 1713 grams/day in 2019-20.

The growth trajectory, however, has not been consistent (Figure 3.4). Before the advent of green revolution (1950-51 to 1966-67), the total food production increased at annual rate of 2.47% as compared to a 2.04% growth in country's population. During 1966-67 to 1996-97, the growth in food production accelerated to 3.27% and remained higher than the population growth (2.19%), resulting in an increase in per capita food production, from 772 grams/day in 1950-51 to 1234 grams/day in 1996-97. Subsequently, the food production came under a pressure of several biotic and abiotic factors, including weather aberrations. The country experienced severe droughts in 1999-00 and 2002-03, causing a deceleration in the growth of food production to 1.67 % during 1996-97 to 2005-06. The per capita food production remained almost stagnant during this period. Since 2005-06, the per capita food production increased faster. Figure 3.5 shows the trends in production of different food commodities since 1966-67.

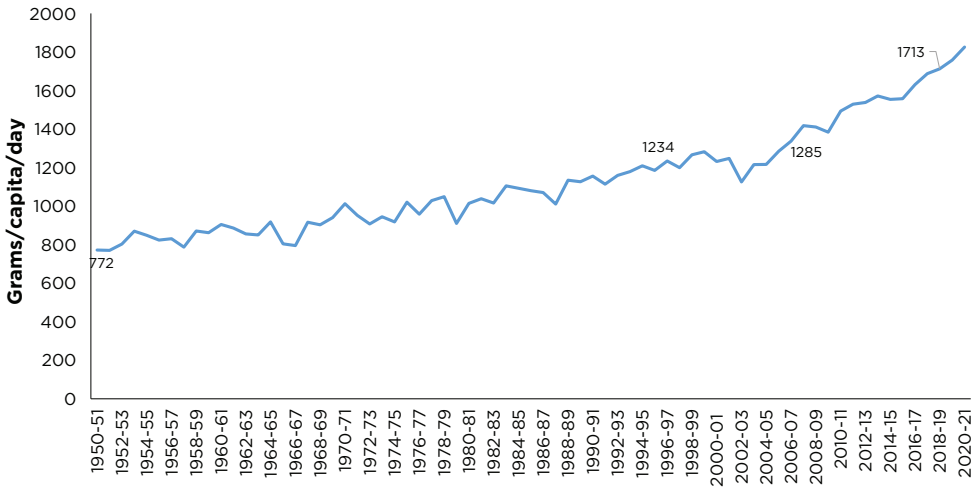


Figure 3.3 Trends in per capita food production

[1] Including cereals, pulses, edible oils, sugar, fruits, vegetables, milk, meat, fish and eggs

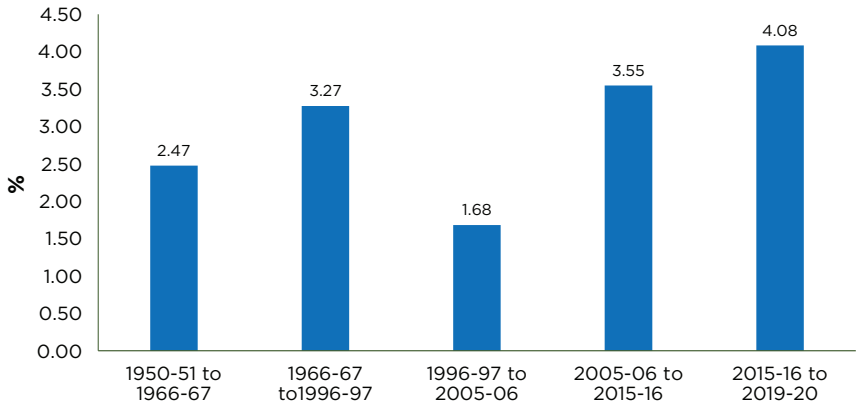


Figure 3.4. Annual growth in food production

Foodgrains: Cereals occupy more than half of the cropped area. In 1966-67, rice accounted for 47 % of the total cereal production, followed by nutri-cereals (26%), wheat (17%) and maize (7%). The production portfolio, however, has changed due to differential rates of growth in the production of different crops (Figure 3.5). Between 1966-67 and 2019-20, the production of wheat, maize, and rice increased 9.5, 5.9 and 3.9 times, respectively. On the other hand, the production of nutri-cereals has remained almost stagnant at 17-18 million tonnes. In 2019-20, the share of wheat increased to 39%, and of maize to 11%, while that of nutri-cereals fell drastically to 6%. Nevertheless, the cereal production has increased 4.2 times since 1966-67.

During the recent decade (2011-12 to 2019-20), the production of cereals increased at an annual rate of 1.63% (Table 3.3). Cereal area either has remained almost constant (e.g., rice and wheat) or even declined (e.g., nutri-cereals). The increase in cereal production has largely been driven by yield improvements. In case of nutri-cereals, even yield growth could not negate the declining production. Maize production registered the highest growth (3.71%), driven by both the area expansion and yield improvement.

On the other hand, pulses production remained almost stagnant for a long period (1966-67 to 2002-03) because of an insignificant increase in their area as well as yield. Rather, their area declined at an annual rate of 0.06%, and the yield improvement happened at an insignificant rate of 0.77%. Nevertheless, in the recent decade (2011-12 to 2019-20), pulses production grew at an appreciable rate of 4.43% a year (Table 3.3), due to growth in area (3% a year) and yield as well (1.39%). Overall, pulses production increased 2.8 times between 1966-67 to 2019-20 which is far less as compared to the increase in the production of cereals.

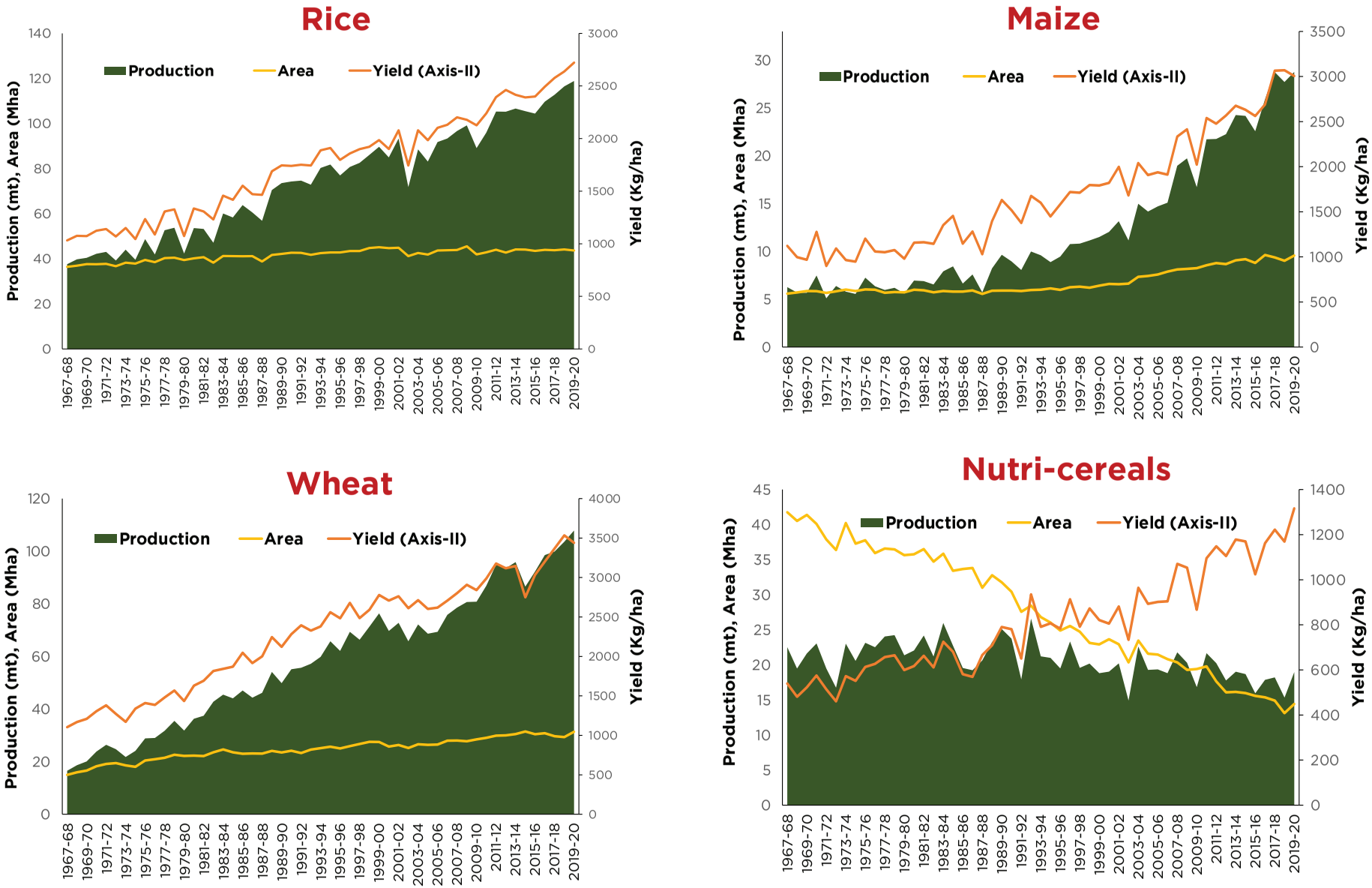


Figure 3.5 Trends in production of food commodities

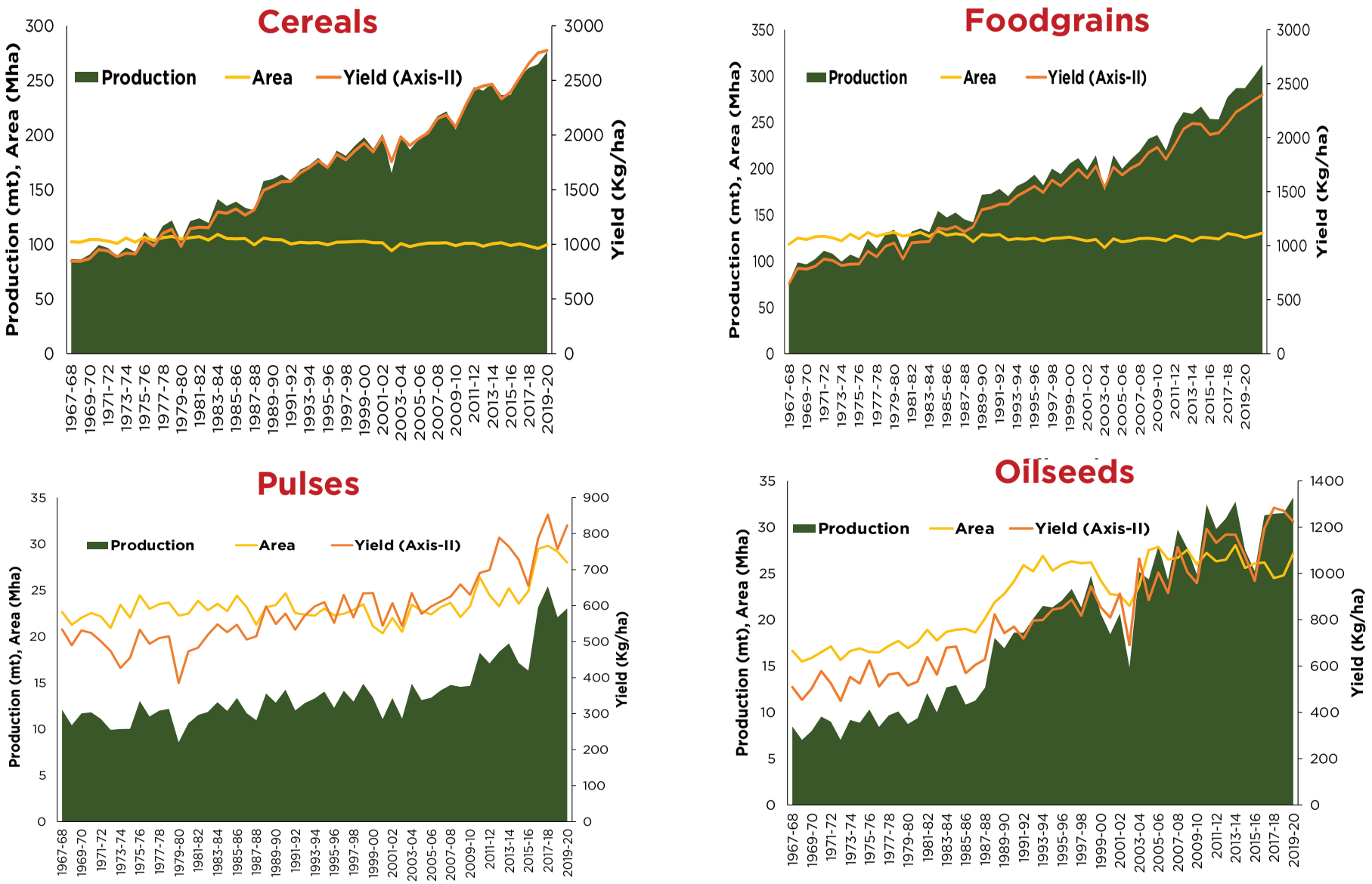


Figure 3.5 Trends in production of food commodities

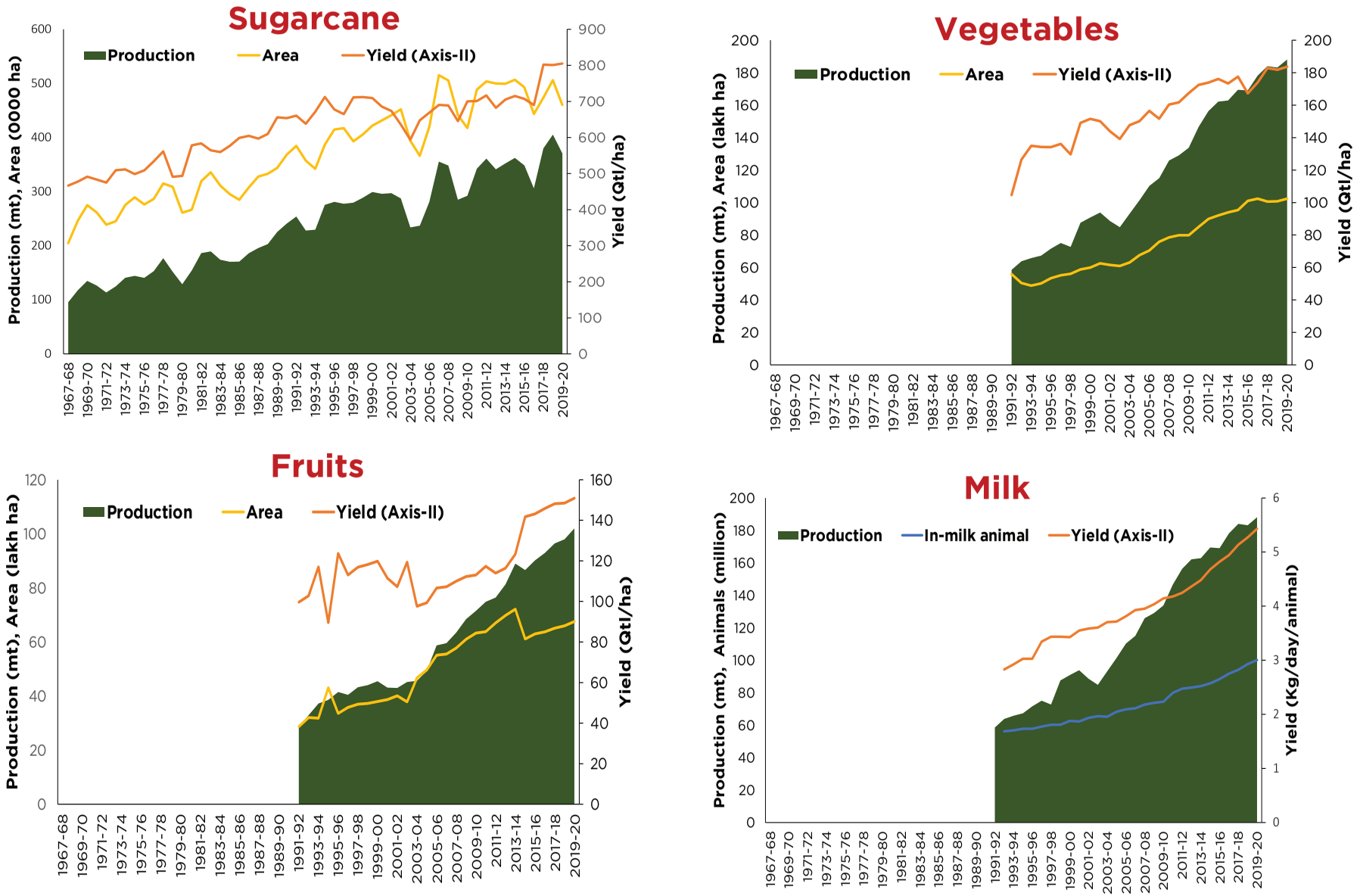


Figure 3.5 Trends in production of food commodities

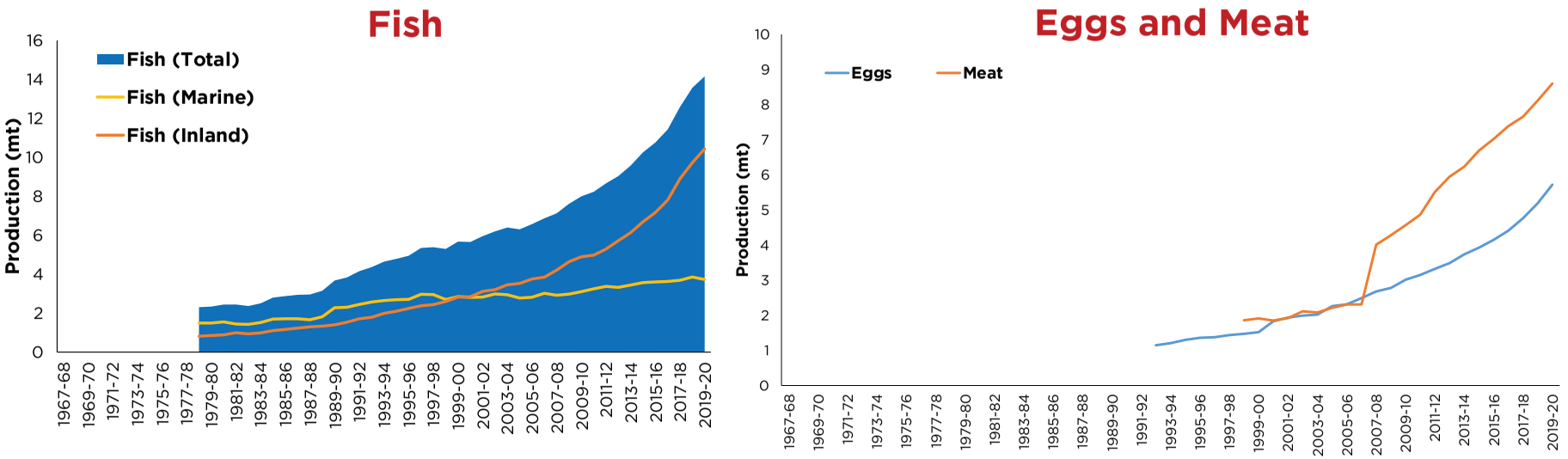


Figure 3.5 Trends in production of food commodities

Table 3.3 Annual growth in area, yield and production of food commodities during 2011-12 to 2019-20

Commodity	Area	Yield	Production
Foodgrains	0.41	1.37	1.79
Cereals	-0.27	1.91	1.63
Rice	0.08	1.50	1.58
Wheat	0.08	1.65	1.74
Nutri-cereals	-2.66	1.31	-1.38
Maize	0.97	2.71	3.71
Pulses	3.00	1.39	4.43
Fruits	-0.50	3.82	3.30
Vegetables	1.68	0.67	2.36
Oilseeds	-0.53	1.44	0.90
Edible oils	-	-	1.70
Sugarcane	-0.93	1.96	1.01
Sugar & products	-	-	1.20
Milk	-	-	5.87
Eggs	-	-	6.83
Meat	-	-	5.51
Fish	-	-	6.61

Fruits and vegetables: The area under fruits increased significantly from 2.8 million hectares in 1991-92 to 6.8 million hectares in 2019-20 at an annual rate of 2.4%. Their yield also grew, but slowly (1.13 %). The production of fruits increased from 29 million tonnes in 1991-92 to 102 million tonnes in 2019-20 at annual growth of 3.4%. In the recent period (2011-12 to 2019-20), the average yield of fruit crops has grown at a rate of 3.82 % a year (Table 3.3), but their area has remained stagnant, slowing down growth in their production.

The production of vegetables increased from 59 million tonnes in 1991-92 to 188 million tonnes in 2019-20 at annual growth of 4.48%. During this period, their area and yield increased at annual rate of 2.99% and 1.51%, respectively. The growth in their production, however, has decelerated to 2.36% during the recent decade (Table 3.3). Comparatively slow growth in their production is due to deceleration in growth of their area and yield as well. Further, the yield has grown much less than the area, indicating that incremental production has largely come from area expansion.

Edible oils: The production of oilseeds increased at annual rate of 3.13%, from 7 million tonnes in 1966-67 to 33 million tonnes in 2019-20. Their area and yield increased at annual rate of 1.41% and 1.97%, respectively. Notably, the oilseeds area increased until 1993-94 (from 15.95 million ha in 1966-67 to 26.89 million ha in 1993-94) and afterwards it has been hovering around 26 million hectares. Their yield growth also decelerated. This has caused a significant deceleration in their production growth, less than one percent (Table 3.3).

Cultivated oilseeds accounted for 76% of the total edible oil production in 2004-05, which fell to 68% in 2019-20 because of the slower growth (1.03%) than the growth in the contribution of secondary sources (1.84%).Currently, India is hugely deficit in edible oils, and imports more than half of their total demand.

Sugar and sugar products: Sugarcane production has increased four-fold, from 93 million tonnes in 1966-67 to 371 million tonnes in 2019-20 at annual growth of 2.48%. The area under sugarcane increased from 2.3 million hectares in 1966-67 to 5.1 million hectares in 2006-07 but has remained stagnant thereafter. Rather from 2011-12 to 2019-20 the sugarcane area experienced a negative growth of 0.93%. Nevertheless, its yield increased at an annual rate of 1.96%. Given the high water use in sugarcane production, the stagnation in its area is desirable from the perspective of water conservation. But the decline in production should be compensated by improvements in yield and sugar recovery rate.

Animal source foods: Between 1992-93 and 2019-20, the total milk production increased from 57.96 million tonnes to 198.44 million tonnes at an annual growth of 4.43%. Changes in herd structure in favour of more productive crossbred or exotic cows is one of the main factors for robust growth in milk production. The population of in-milk crossbred/ exotic cows increased at a rate of 6.21%, much higher than for in-milk buffaloes (2.27%), and indigenous cows (0.97%).The share of crossbred cows in the total in-milk bovines increased from 7% in 1992-93 to 21% in 2019-20, while the share of indigenous cows declined from 50% to 35%. Buffaloes comprise 44% of the total in-milk bovines. Cross-bred cows are high-producing (8.20 kg/day) than indigenous cows (3.08 kg/day) and buffaloes (5.75 kg/day). Overall, the average milk yield increased from 2.83 kg/day/animal in 1992-93 to 5.43 kg/day/animal in 2019-20 at annual growth of 2.19%. The growth in milk production has accelerated in the decade beginning 2011-12.

The production of meat, egg and fish has increased considerably. Between 1991-92 and 2019-20, the production of eggs, fish and meat increased three to five times. In 1991-92, to the total fish production, the marine and inland fish contributed 58.86% and 41.14%, respectively. Over time, the inland fish production has registered a remarkable growth of 6.27% a year, as compared to only 1.38% growth in the marine fish production. This led to a decline in the share of marine fish to 28.32%.

3.2.3 Production potential for major food commodities

India has 180 million hectares of agricultural land. It ranks high in production of several food crops (Table 3.4). The scope for bringing more area under cultivation, is however, limited because of the competing uses of land. Rather, agricultural land area seems to have been diverted to non-agricultural purposes, — the agricultural land between 1991-92 and 2019-20 declined by about 5 million hectares. However, there is scope for intensification of the existing agricultural land through multiple cropping.Currently, only about 51% of the net sown area is cultivated more than once.

Table 3.4 India's position in world production in 2019 and realizable yield potential for major crops

Year	India's rank in world			Average yield@ (kg/ha)	Realizable potential in India (kg/ha)#	Average yield of top 5 producing countries (Kg/ha)$
	Area	Production	Yield*			
Rice	1	2	12	2722	5000	4342
Wheat	1	2	11	3440	4500	5527
Jowar	3	6	18	989	2000	3872
Maize	4	6	19	3006	5500	8512
Gram	1	1	13	1142	2000	1696
Arhar	1	1	16	859	1500	1364
Lentil	2	2	11	847	1400	1584
Groundnut	1	2	9	2063	3000	3158
Soybean	4	5	19	921	2000	3180
Fruits	2	2	12	15090	27150	22638
Vegetables	2	2	16	18373	36090	36266

*In top 20 major producing countries.

Source: @ Directorate of Economics and Statistics, # Indian Council of Agricultural Research, $Food and Agriculture Organization of United Nations (FAO)

Given the limit on area expansion, technological change is the most promising approach to augment food production in future. India, despite being one of the top producers of several food commodities, lags far behind in their yields (Table 3.4). Across 20 major producing countries, India ranks poor in yield of most crops. Also, within the country, their yield is 24-54% less than the potential yield, and 33-74% less than the averages for five major producing countries. This implies existence of a vast potential to improve production by bridging the yield gaps.

HIGHLIGHTS

- Significant progress in agriculture sector over the years has transformed India from a food deficit economy to one which is not only food sufficient but also a net exporter of agricultural commodities at aggregate level.
- India is a major producer of most of the food commodities in the world. Domestic production sufficiently meets the demand of most of the food commodities except edible oils and pulses. There exists large exportable surplus in several commodities such as rice, sugar, fish, meat, etc.
- Rising per capita food production (at aggregate level) indicates improving status of food security in the country. Growth in per capita food production is at historically highest level during the recent years. Trajectories of the production vary at disaggregated level.
- Nutri-cereals have witnessed a sharp decline in their share in cereals production basket during the last five decades on account of steady increase in production of rice, wheat and maize against the decline in nutri-cereals production. Area under the cereals crops except maize has remained either stagnant or declined in the recent years and yield is a main contributor to the incremental production.
- After a long phase of stagnation, pulses production is rising during the recent years, but mainly on account of area expansion. It is essential to sustain the growth in area and accelerate yield of pulses.
- Stagnation in area has reduced positive yield effect and decelerated the growth in oilseed production during the recent years. Efforts are needed to expand area and harness the potential of both primary and secondary sources of edible oils in order to reduce import dependency in edible oils.
- Production of fruits has increased steadily over the years. Area under fruits, however, has become stagnant in the recent years leading to deceleration in the production growth.Amidst the changing consumer preferences towards exotic fruits, efforts are needed to diversify production basket towards these fruits.
- Production of vegetables has increased significantly over the years. The incremental production during the recent years is largely on account of area expansion. Improving yield and sustaining rising diversification towards vegetables are necessary.
- With the increasing production over time, the country has surplus sugar availability. Area under sugarcane is declining in the recent years which can be seen as a desirable trend in the context of water resources sustainability. Any adverse effect of area reduction on production shall be compensated by improving yield and sugar recovery.
- Improving feeding and livestock management, and changing herd composition towards more productive cross-bred/exotic cattle has significantly raised the milk production. The growth in the production of milk and non-vegetarian products such as eggs, meat and fish has accelerated in the recent years.
- India occupies a top position in area and production of several crops, but lags far behind in terms of yield. Food production needs to grow at sufficient pace for meeting the rising food demand by improving land utilization efficiency and harnessing yield potential.

Chapter 4.

Normative Food Requirements

For a healthy and active life, a human being requires a certain minimum consumption of different food commodities, defined as their normative requirements. The normative requirement of a food commodity, however, varies across individuals depending on their age, sex, and physiological and work status. The Indian Council of Medical Research (ICMR) has recently updated the Recommended Dietary Allowances (RDA) of nutrients and has suggested required norms of intake of food commodities for persons by their age, sex (male/female) and activity status (sedentary/moderate) (Appendix 4.1). Using population of each category as weight (Appendix 4.2), the average national level RDA norms for different food commodities have been estimated for the sedentary and moderate activity for 2011 and 2019 (Table 4.1). The share of adults and elderly persons in the total population will increase, and of children will decline. RDA norms for 2025, 2030, 2035, 2040 and 2047 adjusted to these demographic changes are given in Table 4.1

Table 4.1 Population weighted RDA norms for a balanced diet.

Grams/capita/day

Year	Cereals & Millets		Pulses*		Milk	Vegeta-bles	Fruits	Fat/Edi-ble oil
	Seden-tary	Moder-ate	Seden-tary	Moder-ate				
2011	231	281	80	97	364	361	103	27
2019	230	285	79	99	359	366	104	27
2025	228	285	79	99	357	369	105	27
2030	228	285	79	99	356	372	106	27
2035	227	284	79	99	355	374	107	26
2040	226	284	79	99	355	376	108	26
2047	224	283	79	99	354	379	110	26

Notes:*For non-vegetarian persons, 30 grams of pulses may be substituted with 70 grams of meat. 20-30% of cereals intake shall be of nutri-cereals.

The aggregate normative demand for different food commodities has been arrived by multiplying the RDA norms with population (Table 4.2). For 2019-20, the normative demand for cereals has been estimated at 114 and 142 million tonnes for the sedentary and moderate activity status populations, respectively. This is expected to increase to 125-156 million tonnes in 2030 and 133-168 million tonnes in 2047.

Daily required intake of pulses for a person engaged in a sedentary and a moderate activity is 79 and 99 grams, respectively. Accordingly, the normative demand for pulses is estimated at 40-49 million tonnes for 2019, which will increase to 43-54 million tonnes in 2030 and 47-59 million tonnes in 2047.

As per the ICMR, a person to derive same quantity of nutrients from 30 grams of pulses should consume 70 grams of meat. If pulses consumption were to be substituted by meat, then the country would have required 92-115 million tonnes of meat in 2019-20. However, as the Indian population consumes pulses as well as non-vegetarian products, the actual normative demand for non-vegetarian products will be much less.

Table 4.2 Estimated normative requirement of food commodities

Million tonnes

Year	Cereals & Millets		Pulses*		Milk	Vegetables	Fruits	Fat/Edible oil
	Sedentary	Moderate	Sedentary	Moderate				
2011	105	128	36	44	166	165	47	12
2019	114	142	40	49	179	183	52	13
2022	118	146	41	51	184	188	54	14
2025	120	150	42	52	188	195	55	14
2030	125	156	43	54	195	204	58	15
2035	128	161	45	56	201	212	61	15
2040	131	165	46	58	206	219	63	15
2047	133	168	47	59	210	225	65	15

*For non-vegetarian persons, 30 grams of pulses may be substituted with 70 grams of meat.

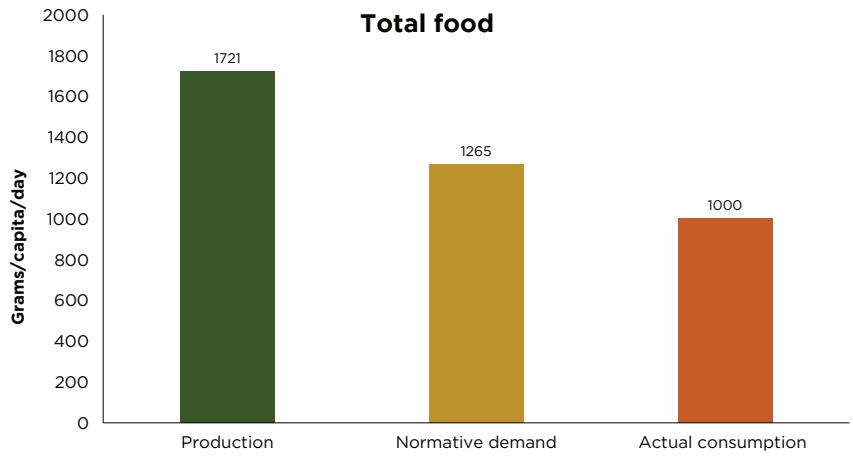
The average daily per capita requirement of milk has been estimated at 364 grams in 2011. Children and elderly persons are required to consume relatively more compared to adults (Appendix 4.3). With an increasing proportion of adults in the total population, the estimated average RDA norm for milk will reduce to 354 grams by 2047. Accordingly, the total normative demand for milk is estimated at 179 million tonnes in 2019, which will gradually increase to 210 million tonnes by 2047. Notwithstanding, the normative requirement of milk represents the liquid milk to be consumed directly by the human beings. It does not include the consumption of processed milk products.

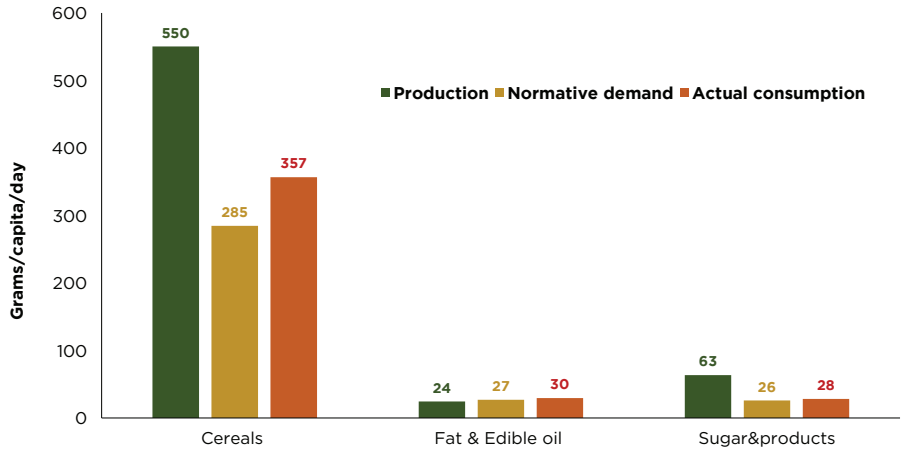
The average daily per capita requirement of vegetables and fresh fruits (pulp portion) respectively has been estimated as 361 and 103 grams for 2011, which is expected to increase over time (Table 4.1). In 2019, this translated into normative demand 183 million tonnes of vegetables, and 52 million tonnes of fruits. By 2047, the normative demand for vegetables will increase to 225 million tonnes, and of fresh fruits to 65 million tonnes.

For a balanced and healthy diet, daily intake of 27 grams of edible oils and fats is recommended per person. Accordingly, the total normative demand for edible oils and fat has been estimated at 12 million tonnes for 2011, which will gradually increase to 15 million tonnes by 2047.

4.1 Normative demand *versus* actual demand and production

For food management, it is imperative to know whether available food is sufficient to meet the normative demand, and to what extent the actual demand deviates from it. Figure 4.1 compares the normative requirement (for moderate activity) of food commodities with that of their production and actual consumption in 2019. A person engaged in a moderate activity requires 1265 grams of food per day. The food produced (1721 grams/capita day) was 36% higher than the required. However, the actual consumption of food





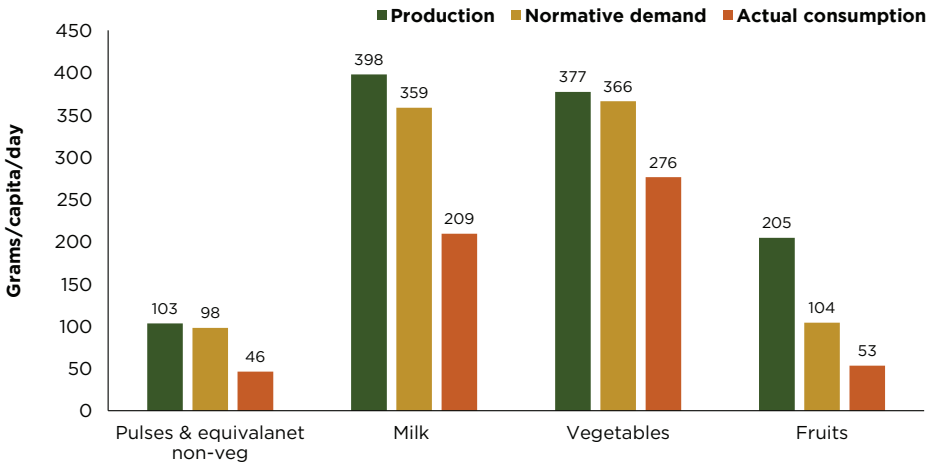


Figure 4.1 Normative requirements versus actual consumption and production in India in 2019

was about 20% less than its requirement possibly due to inefficient distribution and lack of affordability of food.

The consumption of cereals, edible oils/fats and sugar was higher than their requirements, while the consumption of pulses and pulses-equivalent non-vegetarian products, milk, fruits and vegetables was less than their requirements.Overall, these findings suggest that production is a necessary but not sufficient condition to improve the nutrition security of the population.

HIGHLIGHTS

- RDA norms of food varies considerably across age, gender and physical level of activities. With the rising population, total normative food demand is expected to increase in future in the country.
- Food production is sufficient to meet the normative requirement. However, present level of food consumption is inadequate and imbalanced to meet to nutrients' requirement for the healthy life.
- Adequacy of production is a necessary but not s ufficient condition to improve nutritional security. This necessitates strengthening of accessibility and affordability dimensions of food and nutritional security.

Chapter 5

Food Demand and Supply Projections

The estimates of future food demand and supply, guide planning and implementation of the food management strategies. Food demand comprises the direct demand as food and the other uses such as seed, feed, and raw material for processing and other industries.The availability of food comprises domestic production, carry-over stock and imports.

At any point in time, the demand and supply should be equal, and any deviation from the equilibrium is corrected by price changes. In case of demand being more (less) than supply of a commodity, its price is expected to rise (fall) in the absence of any market intervention.

The following procedure has been adopted to project food demand and supply.

i. Construct a food balance sheet and estimate components of demand and supply for the base year, i.e. 2011-12.

ii. Estimate direct demand for human consumption and indirect demand as seed, feed, wastages and other uses for 2019-20.

iii. Compare the projected demand for 2019-20 with the actual availability, and validate accuracy of the estimates.

iv. Project crop area and yield of crops, and derive production estimates for future, i.e., for 2025-26, 2030-31, 2035-36, 2040-41, and 2047-48. Plug these estimates into the demand core system for estimating the demand for seed and feed.

v. Develop future scenarios and project the total demand and production under these scenarios.

vi. Externally validate projected demand by comparing it with normative demand.

vii. Estimate demand-supply balance to estimate potential surplus or short fall.

Direct demand for human consumption is the largest component of the total food demand. The HCE surveys provide estimates of the food consumed by the resident households. The latest HCE data is available for 2011-12; hence it has been taken as the base for projections. The unavailability of the latest estimates, helped in testing the model for its accuracy by comparing the projected food demand for 2019-20 with the actual availability. Further, the projected food demand is compared with the normative requirement for external validation of the projections.

5.1 Food balance sheet for 2011-12

The food balance sheet provides a snapshot of the sources of food and its utilization

(Table 5.1). The availability of a commodity depends on its production, net export and change in stocks. In 2011-12, India produced 261 million tonnes of foodgrains, of which 12 million tonnes were exported and 6 million tonnes were stocked (public). India also imported 3.5 million tonnes of pulses. Thus, the net availability of foodgrains was 246 million tonnes. The production and net availability of different food commodities are given in Table 5.1. Including other foods, a total of 669 million tonnes of food was available in 2011-12.

Table 5.1 Estimated balance sheet of food production for the year 2011-12

Millon tonnes

Food item	Prod-uction	Import	Export	Stock chan-ge	Total avail-ability	Food demand	Seed	Feed	Wastage	Other uses	Total demand
Food-grains	261	3.501	11.947	6.070	246	177	5.71	17	12.96	33.5	246
Cereals	244	0.005	11.772	6.070	226	164	4.90	17	11.73	28.4	226
Rice	105	0.001	7.176	1.940	96	88	1.31	2	4.82	0.1	96
Wheat	95	0.000	0.741	4.130	90	68	2.62	2	4.68	12.9	90
Nutri-cereals	20	-	-		20	7	0.12	1.0	1.14	10.9	20
Maize	22	0.004	3.856		18	1.6	0.09	12	1.01	3.7	18
Pulses	17	3.496	0.174		20	13	0.80	0.30	1.23	5.1	20
Animal products											
Eggs	3	0.000	0.030		3.3	2.0			0.24	1.1	3.3
Meat	5.5	0.002	0.997		4.5	3.2			0.26	1.0	4.5
Fish	9	0.034	0.902		7.8	4.0			0.68	3.1	7.8
Milk	128	0.004	0.000		128	71			1.18	55.3	128
Veget-ables	156	0.005	2.040		154	105			12.79	36.3	154
Fruits	76	0.723	0.488		77	19			7.45	50.6	77
Sugar & products	32	0.100	2.741	0.747	29	12			-	16.9#	29
Edible oil	10	9.943	0.946		19	12	0.24		0.56	6.4	19
Overall	**681**	**14**	**20**	**7**	**669**	**406**	**6**	**17**	**36**	**204**	**669**

* Home food + food away from home (FAFH)

include the seed, wastage, chewing, etc.

The estimates of utilization of food commodities are not readily available, except per capita household home food consumption. The utilization pattern of different food commodities for food, seed, feed, wastages, and other uses has been derived using the available information. Other food uses include raw material for food processing and other industries. These are estimated as residuals, that is, the difference between actual availability and consumption as food, seed, feed and wastages. Accordingly, 61 % of the total available food in 2011-12 was consumed directly as food (Table 5.1).

5.1.1 Estimating components of food demand

The household food demand comprises the demand for home food and food away from home (FAFH), the demand for feed, seed, wastages and other uses.

Seed demand: Farmers use either purchased seeds or seed saved from previous harvests. The seed demand from a home-produced crop depends on its cropped area, seed rate and seed replacement rate. The seed demand is estimated as:

$$Seed\ demand = area \times seed\ rate \times \left\{1 - \left(\frac{seed\ replacement\ rate}{100}\right)\right\}$$

Area under crops has been compiled from the Directorate of Economics and Statistics (DES) of the Ministry of Agriculture and Farmers Welfare (MoAFW). The average seed rate of a crop at national level is weighted average of its seed rate in major producing states with cropped area as weight. The state-wise seed rate has been taken from the cost of cultivation (CoC) scheme for 2011-12. The seed replacement rate (SRR) is the rate at which farmers replace home-grown seeds with certified seeds. The SRR differs across crops, and it has increased over time, meaning a decline in the demand for home-grown seeds. The estimated seed demand for different commodities is presented in Appendix 5.1 and Table 5.1.

Feed demand: Feed consists of green and dry fodders, and concentrates, in varying proportion from 40 to 80% for crop residues, 10 to 30% for green fodder and 10 to 30% for concentrates (Roy et al. 2019). Green and dry fodders, obtained from arable lands, common property lands (permanent pastures, grazing land, etc.), crop residues and by-products, are the main source of energy for animals. Concentrate feed consist of oilseed cakes, crushed pulses, grains, wheat and rice brans, mineral mixtures, etc. The ICAR-National Institute of Animal Nutrition and Physiology (NIANP) estimated demand for concentrates at 56.2 million tonnes for 2011-12, of which grains constituted 30%. Accordingly, 16.9 million tonnes of grains were used as feed. Further, feedgrain comprised 53% of maize, 5% of nutri-cereals, and 2% of rice, wheat and pulses. The contributions of crops to feedgrains in 2011-12 are presented in Table 5.1.

Wastages: Post-harvest loss considered as a component of the total demand. The loss differs across food commodities, depending on their perishability and post-harvest processes of conversion of raw material into final product. The ICAR-Central Institute of Post-Harvest Engineering and Technology (CIPHET) and the NABARD Consultancy Services (NABCONS) have estimated post-harvest loss for various agricultural commodities (Jha et al, 2015; NABCONS, 2022), which are given in Appendix 5.2. Utilizing the loss coefficient, the total output loss in crop has been estimated for 2011-12 (Table 5.1).

Home food and food away from home (FAFH) demand: Food cooked within household premises constitutes the largest component of food demand. The household demand for home food has been estimated using the per capita consumption reported in type-II (mixed recall reference period) schedule of the HCE survey, 2011-12 (Appendix 5.3). The HCE survey also provides expenditure on meals consumed outside the home. In 2011-12, of the total food expenditure, 8.5% was towards the processed foods and the foods consumed outside home. The cost of food cooked at home is approximately 30% of the cost incurred outside. Therefore, to estimate food consumed outside home, the expenditure share of the outside food has been adjusted by a factor of 0.3. Accordingly, the food away from home accounted for 2.59% of the total food consumed. This proportion is close to the estimate of 3.7% on foods taken in restaurants as provided by the Consumer Pyramid Surveys conducted by the Centre for Monitoring Indian Economy

(CMIE) during 2016-2019. It is mentioned that the estimates of consumption outside home is not available for individual food commodities. Therefore, the aggregate estimate of 2.59% has been taken to estimate the food away from home demand for individual food commodities. The estimates of per capita and total household food demand (home food+ FAFH) are presented in Appendix 5.3 and Table 5.1, respectively.

Other demand: The other food demand has been estimated as the difference between the availability of food and its use for food, seed, feed, and wastages (Table 5.1). Notwithstanding the accounting errors, other food demand includes the quantiles used as raw material in food processing and other industries.

5.2 Estimation of total household food demand in 2019-20 and testing the model accuracy

5.2.1 Food demand in 2019-20

Due to unavailability of estimates of the actual food consumption post 2011-12, the total household food demand for 2019-20 has been estimated following the behavioristic approach. This approach assumes income as an important determinant of food consumption and predicts consumer response to changes in income through expenditure elasticities. The elasticity provides for percent change in the quantity consumed due to a one-percent change in the total consumption expenditure (proxy for income).

The coefficients of expenditure elasticities of different food commodities have been taken from the published sources (Appendix 5.4). The expenditure elasticity of a commodity is found to differ across sources due to the differences in estimating methodologies and the datasets used. Since, some existing studies have already estimated expenditure elasticities for food commodities from the latest available Household Consumption Expenditure (HCE) survey data for 2011-12, the same has not been estimated by us. Instead, a meta-analysis of the existing elasticities has been undertaken and the best estimate has been taken for the demand projection. The best estimate is the one which provides the least deviation between projected demand of a commodity and its availability in 2019-20.

There is a biological limit for consumption of a food commodity; hence as a consumer approaches the satiation level, the effect of income on its consumption declines. In other words, the propensity to consume should decline over time. This has been captured by smoothening the elasticity coefficient using rate of reduction in the gap between the actual consumption and normative consumption. This implies that future demand projections be based on varying expenditure elasticity rather than the its constant value. Further, it is also shown in the studies that elasticity does not remain constant over time, and changes due to factors other than income.

The following formulae have been used to compute varying expenditure elasticity (v_{it}).

$$v_{it} = e_i(1 + r_i)^t$$

where, e_i is the elasticity of commodity 'i' obtained either through the meta-analysis of published elasticities, ri = rate of change of elasticity, which is estimated as:

$$r_i = K_1^{\left(\frac{K_2 M}{|2P - M|}\right)}$$

where, K_1 and K_2 are the constants estimated by projecting and matching the household food consumption for 2011-12 and 2019-20. The constants, viz., K1 & K2, are estimated to be 0.5 and 0.025, respectively during this period.

Appendix 5.5 presents the expenditure elasticities of different commodities from different sources, their best estimates (as discussed above) and the smoothened estimate to be used for projecting demand for 2019-20 and onwards.

The demand for a food commodity has been projected as :

$$D_t = D_0 * N_t(1 + y * v_{it})^t$$

Table 5.2 Projected demand and actual availability of food commodities in India in 2019-20

Million tonnes

Food item	Projected demand						Production	Actual availability	Deviation between demand and availa-bility(%)
	Food *	Seed	Feed	Wastage	Others	Total			
Foodgrains	194.8	5.3	25.5	13.8	38.0	277.3	299.2	281.0	-1.3
Cereals	177.9	4.6	25.1	12.3	31.3	251.2	276.2	255.3	-1.6
Rice	93.4	1.3	2.4	5.7	0.1	102.8	118.9	103.9	-1.1
Wheat	76.3	2.4	2.2	4.5	14.2	99.5	107.9	102.0	-2.4
Nutri-cereals	6.6	0.09	1.5	0.98	10.0	19.2	19.0	18.8	1.9
Maize	1.6	0.07	25.5	1.12	5.1	26.9	28.8	28.9	-6.6
Pulses	16.9	0.70	0.5	1.4	6.6	26.1	23.0	25.8	1.3
Animal-source food	14.2	0.32		1.6	7.9	23.7	28.5	26.1	-9.0
Eggs	3.1			0.34	1.6	5.0	5.7	5.7	-12.3
Meat	5.0			0.34	1.6	6.9	8.6	7.4	-7.7
Fish	6.2			0.96	4.7	11.8	14.2	12.9	-8.2
Milk	104			1.7	80.3	186.4	198.4	198.4	-6.1
Vegetables	137.8			14.0	47.2	199.0	188.1	186.4	6.8
Fruits	26.6			9.1	71.8	107.6	102.0	102.2	5.3
Sugar & products	14.1			-	19.4#	33.5	33.7	32.9	2.0
Edible oils	14.0	0.32		0.57	7.5	22.5	11.6	24.1	-6.7
Overall	**506**	**6**	**26**	**41**	**272**	**850**	**862**	**851**	**-0.1**

*includes total household food demand;# includes demand for seed, wastages, chewing, etc.

where, D_t is the food demand in future ('t' period ahead); D0 is the per capita food consumption (home food + FAFH) in 2011-12; y is the rate of growth in per capita income, v_{it} is the expenditure elasticity; t represents the year of projection, and Nt is projected population in year t (Appendix 5.6).

Between 2011-12 and 2019-20, net national income (at constant 2011-12 prices) and population grew at annual rate of 6.34 and 1.12 %, respectively. This resulted in a 5.17% annual growth in per capita income during this period.

The projected food demand in 2019-20 includes the home food as well as FAFH demand. To segregate the food demand into home food and FAFH demand, one can first extrapolate FAFH demand from 2011-12 to 2019-20 at an annual growth of 7.4%. Then, the FAFH demand (for 2019-20) is subtracted from the projected food demand (home food + FAFH) to derive the household food demand. As per the National Accounts Statistics, the private final consumption expenditure (at 2011-12 prices) on hotels and restaurants grew at 7.4% annually during 2011-12 to 2019-20. This approach of first estimating the food demand (household + FAFH) and then segregating it into home food and FAFH addresses an important issue that the consumers forego household food consumption whenever they consume food outside. The projected food demand in 2019-20 is presented in Table 5.2.

5.2.2 Estimation of indirect food demand for 2019-20

Demand for seed in 2019-20 has been estimated using information on area under a crop, its seed rate, and seed replacement rate (Appendix 5.1).

Demand of food for feed purpose is assumed to be dependent on the demand for animal-source foods, (milk, eggs, meat and fish). Between 2011-12 and 2019-20, the demand for animal-source foods grew at an annual rate of 5.33 %. Accordingly, the food demand for feed purpose in 2019-20 has been estimated at 26 million tonnes (Table 5.2). Rice, wheat and pulses each contributed 2 % of their production to feed demand. The use of nutri-cereals as concentrate feed is also estimated using growth in demand for animal-source foods. The rest of the feedgrains come from maize.

The wastage in post-harvest farm operations and marketing of food commodities for 2019-20 has been estimated using their actual production and loss coefficients reported in NABCONS (2022). Accordingly, about 41 million tonnes of total food has been estimated to be lost post-harvest.

The food demand for other indirect uses in 2019-20 has been derived by multiplying the projected household food demand by the ratio of 'other uses to the household demand in 2011-12'. This assumes that demand for other indirect uses remains the same throughout.

5.2.3 Model accuracy

At any point in time, quantity demanded should be equal to its availability. This condition is used to test accuracy of the model used for demand projections. The projected demand for 2019-20 is compared with actual availability. The deviation between the two is less than 10% for most commodities, except eggs (Table 5.2). For foodgrains, projected demand is 1.3% less than their availability—1.1% for rice and 6.6% for maize. For vegetables and fruits, projected demand is 6.8% and 5.3% more than their availability. The deviation is -6.1% for milk and -12.3% for eggs. For sugar, the projected demand is 2% more than its availability, while for edible oils it is 6.7% less. The deviation between projected demand and availability is in a small range, which indicates robustness of the model used for future demand projections.

5.3 Projections for production of food commodities

Production forecasts of food commodities are based on the assumption of continuance of the past trends in their production. In case of crops, the area and yield are forecasted first and then production is estimated by multiplying the two. The data on area, yield, and production of crops from 1966-67 to 2019-20, except fruits, vegetables, eggs, meat, fish and milk, were compiled from the Directorate of Economics and Statistics, MoA&FW, Government of India.Data on fruits and vegetables is available for a shorter period. For animal products, it is the production which is forecasted directly.

Four techniques have been applied viz., Autoregressive Integrated Moving Average (ARIMA), Artificial Neural Network (ANN), Holt's smoothing, and exponential growth rate (during the last 10 years) model; and based on the expert judgement, the best performing has been retained for each commodity (Appendix 5.7).

5.3.1 Production forecast scenarios

Forecast based on time series is termed as the 'Business-as-Usual (BAU)' scenario. High growth in crop yield is taken as an alternate scenario, which assumes closing the gap between the existing and realizable potential yield. The higher of the realizable potential yield at present level of technology adoption, and the average yield of top 5 major producing countries has been taken as the targeted yield to be achieved by 2047-48 (Table 3.4). In this scenario, area forecasted under a crop is assumed to remain same as in the BAU scenario. Thus, a scenario of high crop yield and usual growth in its cropped area is termed as the 'high yield growth (HYG)' scenario.

5.3.2 Crop acreage forecast

Past values of crop acreage along with its projected estimates obtained from the selected model are presented in Appendix 5.7. Table 5.3 presents area forecasts for 2025-26, 2030-31,2035-36, 2040-41 and 2047-48. The cropped area is not expected to increase in future. The gross cropped area (GCA) is expected to increase at annual growth of 0.45 % during 2019-20 to 2047-48. The incremental acreage will come from improvements in cropping intensity.

Table 5.3 Forecast of crop acreage in India under Business-as-Usual (BAU) Scenario.

Million hectare

Crops	2019-20 (actual)	2025-26	2030-31	2035-36	2040-41	2047-48	CGR
Foodgrains	128	128	131	133	133	136	0.23
Cereals	100	98	99	99	98	98	-0.06
Rice	44	44	44	44	44	45	0.08
Wheat	31	31	33	34	34	34	0.28
Nutri-cereals	14	12	11	9	8	7	-2.76
Maize	10	10	11	11	12	13	1.01
Pulses	28	30	32	33	35	38	1.10
Vegetables	10	11	12	13	14	15	1.34
Fruits	7	8	8	9	10	11	1.67
Sugarcane	5	5	5	5	5	5	0.49
Oilseed	27	28	29	30	31	33	0.70
Total *	176	181	186	190	193	199	0.45
GCA#	211	217	222	227	231	239	0.45

*Area excludes crops not listed in the table; #Gross cropped area

Foodgrains occupy more than half of the gross cropped area. In the BAU scenario, the cereal acreage is likely to remain stagnant or even may decline. So is the sugarcane area. Rice and wheat will remain dominant crops. Nutri-cereals will lose a significant area. However, the recent efforts of the Government of India for the promotion of nutri-cereals can arrest the decline. Maize, pulses and oilseeds area will increase. Vegetables and fruits too are expected to gain in their area

5.3.3 Crop yield forecast

Given the limited scope for area expansion, the additional production to meet the domestic demand will come from yield improvements. The likely changes in crop yields in the BAU and HYG scenarios are shown in Table 5.4. In the BAU scenario, the rice yield is expected to increase from 2722 kg/ha in 2019-20 to 3454 kg/ha in 2047-48 at annual growth rate of 0.88 %. However, there exists a large yield gap, which if abridged, the yield may go upto 5000 kg/ha in 2047-48. Wheat yield is forecasted to reach to 4737 kg/ha by 2047-48 in the BAU scenario, and to 5527 kg/ha in the HYG scenario.By 2047-48, the average yield of nutri-cereals will increase to 2001 kg/ha in the BAU scenario and 2801 kg/ha in the HYG scenario. Maize yield will experience a significant increase, reaching to 6355 kg/ha in 2047-48 in the BAU scenario and to 8512 kg/ha in the HYG scenario. Pulses yield in India is currently low, which is projected to increase to 1258 kg/ha in the BAU scenario and 1485 kg/ha in the HYG scenario. The average yield of vegetables and fruits was 18373 and 15090 kg/ha in 2019-20, respectively, which is projected to increase to 25039 and 20182 kg/ha by 2047-48 in the BAU scenario, and to 36266 and 27150 kg/ha in the HYG scenario.

Sugarcane yield will increase to 100000 kg/ha by 2047-48. By 2047-48, the average yield of oilseeds is expected to increase to 1776kg/ha in the BAU scenario, and to 2706 kg/ha in the HYG scenario.

Table 5.4 Forecast of yield under Business-as-Usual (BAU) and High Yield Growth (HYG) Scenario in India

Kg/ha

Crops	2019-20 (Actual)	Business As Usual (BAU)						High Yield Growth (HYG)					
		2025-26	2030-31	2035-36	2040-41	2047-48	CGR*	2025-26	2030-31	2035-36	2040-41	2047-48	CGR*
Rice	2722	3019	3274	3394	3438	3454	0.88	3101	3457	3853	4295	5000	2.19
Wheat	3440	3716	3948	4180	4412	4737	1.19	3808	4144	4510	4909	5527	1.71
Nutri-cereals	1316	1387	1526	1666	1806	2001	1.56	1547	1771	2027	2319	2801	2.73
Maize	3006	3529	4034	4611	5270	6355	2.81	3757	4525	5449	6562	8512	3.79
Pulses	823	901	972	1049	1131	1258	1.58	934	1038	1153	1281	1485	2.13
Vegetables	18373	20026	21165	22305	23444	25039	1.15	21254	23999	27097	30596	36266	2.46
Fruits	15090	16167	17080	17992	18905	20182	1.08	17194	19169	21372	23828	27150	2.20
Sugarcane	80497	83995	87404	90813	94223	98995	0.77	84327	87658	91121	94721	100000	0.78
Oilseed	1224	1358	1453	1548	1643	1776	1.39	1451	1672	1926	2219	2706	2.87

*Compound growth rate between 2019-20 and 2047-48

Overall, even if the past trends were to continue, crop yields will improve significantly. However, there exist considerable yield gap in most crops, which offer scope to accelerate growth in the yield of most crops.

5.3.4 Production Forecast

The estimates of the forecasts of production of crops and animal food products under the BAU and HYG scenarios are presented in Table 5.5.

Foodgrains: India produced 299 million tonnes of foodgrains in 2019-20, which by 2047-48 is projected to increase to 457 million tonnes in the BAU scenario and 594 million tonnes in the HYG scenario.Production of rice will increase to 154 million tonnes and 223 million tonnes in the BAU and the HYG scenarios, respectively. Wheat production is expected to increase to 160-187 million tonnes by 2047-48. Production of nutri-cereals is projected to decline in the BAU scenario, and also in the HYG scenario. This necessitates arresting area decline under nutri-cereals through diversification. Maize production is projected to increase to 80 million tonnes in the BAU scenario and to 107 million tonnes in the HYG scenario. By 2047-48, pulses production is likely to be more than double to 47-56 million tonnes.

Plant-source high-value food commodities: In the BAU scenario, production of fruits and vegetables by 2047-48 is projected to grow at an annual rate of 2.50% and 2.78 %, respectively, reaching to 214 and 367 million tonnes. However, in the HYG scenario, their production can grow by 4% per annum.

Sugar and products: Production of sugar and other products depends on cane production and sugar recovery rate. According to the Indian Sugar Mills Association, in 2019-20 about 74% of the sugarcane output was utilized for manufacturing white sugar, and 11% for gur, khandsari, etc (ISMA, 2022). With an average recovery rate of 10.1%, in 2019-20 the estimated production of sugar, and other products was 27.4 million tonnes and 6.3 million tonnes, respectively. Since 2001-02, the sugar recovery rate has increased at an annual rate of 0.15%, and it is expected to improve to 11.15% by 2047-48. Using the projected production of sugarcane and sugar recovery rate, the total production of sugar and sugar products is likely to increase to reach 50 million tonnes in 2047-48.

Edible oils: Production of edible oils (from primary and secondary sources) is projected to double to 24 million tonnes in 2047-48 in the BAU scenario. An average recovery of 24% is assumed for forecast of the edible oils from the oilseed crops. The edible oil from the secondary sources is assumed to grow at an annual rate of 3.76%; the rate at which it increased during 2011-12 to 2019-20. Relatively higher growth in oilseeds yield (2.87%), and oils from secondary sources (4.51%) is assumed in the HYG scenario. Accordingly, edible oil production may increase to 33 million tonnes by 2047-48.

Animal-source foods: In the BAU scenario, milk production is projected to increase to 478 million tonnes by 2047-48 as compared to 198 mt in 2019-20. If the past yield trends were to continue, the average milk yield is likely to increase from 5.4 kg/day in 2019-20 to 8.32 kg/day in 2047-48. In the BAU scenario, the number of in-milk animals is forecasted at 157 million in 2047-48 from the current 100 million. In the HYG scenario, milk yield may increase to 10.11 kg/day in 2047-48, and accordingly the total milk production to 581 million tonnes.

By 2047-48, in the BAU the production of eggs, meat and fish is forecasted to grow at annual growth of 4.56, 2.71 and 3.66% respectively. As for crops and milk, it is difficult to arrive at the targeted yields of these commodities.

Table 5.5 Forecast of production under Business-as-Usual (BAU) and High Yield Growth (HYG) Scenario in India

Million tonnes

Crops	2019-20 (Actual)	Business As Usual (BAU)						High Yield Growth (HYG)					
		2025-26	2030-31	2035-36	2040-41	2047-48	CGR*	2025-26	2030-31	2035-36	2040-41	2047-48	CGR*
Foodgrains	299	332	368	396	417	457	1.58	343	392	444	500	594	2.57
Cereals	276	305	337	361	378	409	1.47	315	359	405	455	538	2.50
Rice	119	133	145	150	153	154	0.97	137	153	171	191	223	2.36
Wheat	108	117	131	141	147	160	1.48	120	138	153	166	187	2.06
Nutri-cereals	19	17	16	16	15	14	-1.23	19	19	19	19	19	0.00
Maize	29	36	43	51	62	80	3.84	38	48	61	77	107	4.98
Pulses	23	27	31	35	40	47	2.70	28	33	39	45	56	3.33
Animal source food	28	38	46	55	63	74	3.62	40	49	63	78	100	4.76
Eggs	6	9	11	13	16	19	4.56	10	12	15	18	21	5.00
Meat	9	10	12	14	15	18	2.71	11	14	18	23	30	4.71
Fish	14	19	23	27	32	37	3.66	19	23	30	37	49	4.70
Milk	198	258	308	358	408	478	3.31	253	310	375	452	581	4.06
Vegetables	188	224	254	285	318	367	2.50	238	288	346	415	531	3.92
Fruits	102	122	141	161	182	214	2.78	130	158	191	229	287	3.91
Sugar & products	33.7	42	43	45	49	50	1.50	43	43	45	49	51	1.78
Edible oils	12	14	15	18	20	24	2.69	14	17	21	24	33	3.97
Overall	**862**	**1030**	**1175**	**1316**	**1457**	**1664**	**2.47**	**1059**	**1254**	**1479**	**1721**	**2174**	**3.50**

*Compound growth rate between 2019-20 and 2047-48

For fish, the HYG scenario has been constructed by fixing the potential marine fish production at 5.3 million tonnes (GoI, 2020), and the inland fish production at a one-percent higher growth over the existing growth of 4.24%. Based on these assumptions, the targeted growth in fish production in the HYG scenario is estimated at 4.70% (as compared to 3.66% in the BAU scenario) until 2047-48. Accordingly, the fish production has been estimated to reach 49 million tonnes in 2047-48.

The number of eggs per layer is 104 under the backyard and 286 under the commercial production system. Nevertheless, there is a potential to obtain140 eggs/layer under the backyard system and 300 under the commercial system. Harnessing this potential by 2047-48 will require the egg yield to grow at an annual rate of 0.43 %. This has been added to the expected growth of 4.56% in the egg production. Thus, with a growth rate of 5.0%, the total egg production in the HYG scenario will increase to be 21 million tonnes by 2047-48.

Considering the rising demand for meat and its exports, a 2% higher growth is assumed over the expected growth of 2.71% in the BAU scenario. The meat production, thus, can be increased to 30 million tonnes in 2047-48.

5.4 Food demand projections

This section presents the projected household food (home food and FAFH) demand. The home food and FAFH demand has been projected in the Business-as-Usual (BAU) and the High Income Growth (HIG) scenarios. For projecting indirect demand, that is seed and wastages, the projected area and production of food crops have been plugged into the demand core system. Feed demand has been projected based on the growth in the projected direct demand for animal-source food. Similarly, the demand for other uses depends on the projected household demand.

5.4.1 Alternate scenarios for direct food demand

Using the expenditure elasticities of food commodities, their demand in base year and the projected population, the direct demand for food commodities has been projected for different income growth scenarios (Table 5.6). During 2011-12 and 2019-20, gross value added (GVA)/net national income (NNI, at constant prices) increased at annual rate of 6.34%, which is used to project food demand in a BAU scenario. Food demand has also been projected for HIG scenarios, i.e., 7% and 8%. These scenarios are relevant in the context of India being envisioned to become a developed country by 2047-48. The projections indicate that to achieve the status of a developed country, India must target accelerating its economic growth to 7.6 to 9.0% (RBI, 2023, PTI, 2023). The demand projections in this scenario will help understand implications of high economic growth for food management. It is to be noted that food demand for 2019-20 has been projected at actual economic growth of 6.34% during 2011-12 and 2019-20.

5.4.2 Projections of direct and indirect food demand

5.4.2.1 Household food demand

Projected household demand for food commodities for 2025-26, 2030-31, 2035-36, 2040-41 and 2047-48 in the BAU and HIG scenarios is given in Table 5.7 and 5.8. Varying expenditure elasticities have been employed for projecting demand to account for diminishing propensity to consume food over time (Appendix 5.5).

Table 5.6 Alternate scenarios for food demand projections

Particulars	2011-12 (Base year)	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48
Population (million)*	1250	1366	1445	1504	1554	1593	1629
Growth in population over 2019-20	1.12		0.94	0.87	0.81	0.73	0.63
Growth in GVA/NNI during 2011-12 and 2019-20 (%)	6.34						
Growth in per capita income over 2019-20 (%)							
BAU (6.34%)#	5.17		*5.35*	*5.42*	*5.49*	*5.57*	*5.67*
HIG(7%)#			*6.07*	*6.14*	*6.22*	*6.33*	*6.33*
HIG (8%)#			*7.06*	*7.14*	*7.21*	*7.32*	*7.32*

* United Nations (2022) (as on 1st July) # Business-as-Usual, High Income Growth

Foodgrains: Given the declining trend in per capita foodgrain consumption, but it remaining higher than the normative requirement, the per capita consumption of cereals is not expected to increase significantly. The demand growth will primarily be driven by population. In the BAU scenario, direct demand for rice will increase to 100 million tonnes in 2030-31, and further to 106 million tonnes in 2047-48. Note that the expenditure elasticity for rice is negative. The household demand for wheat will be 86 million tonnes in 2030-31, and 96 million tonnes in 2047-48. The per capita consumption of nutri-cereals has declined significantly over time. If these trends were to continue, their total direct demand will gradually decline to 4.1 million tonnes by 2047-48.

However, with the increasing awareness of their health effects and the government's focus on their promotion, the declining demand can be reversed. Therefore, a positive elasticity with small incremental change over time has been taken to project the direct demand for nutri-cereals. Accordingly, their demand for human consumption is projected to be 10.8 million tonnes in 2047-48. In the HIG scenarios, the demand of nutri-cereals is expected to be more.The demand for maize for direct food consumption is expected to grow slowly and will remain less than 2 million tonnes. Pulses demand for direct consumption is projected to double from 17 million tonnes in 2019-20 to 34 million tonnes in 2047-48 in the BAU scenario. On the whole, direct demand for foodgrains is expected to be 248-254 million tonnes in 2047-48.

Table 5.7 Projected household food demand (home food + FAFH) in India under Business-as-Usual (BAU) scenario

Million tonnes

Commodity	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	CGR#
Foodgrains	195	208	219	229	238	**248**	0.90
Cereals	178	188	195	202	208	214	0.69
Rice	93	97	100	102	104	106	0.46
Wheat	76	82	86	90	93	96	0.85
Nutri-cereals*	6.5 (6.6)	6.1 (7.0)	5.7 (7.5)	5.2 (8.2)	4.7 (9.2)	4.1 (10.8)	-1.71 (1.84)
Maize	1.6	1.6	1.7	1.7	1.7	1.7	0.26
Pulses	17	20	23	27	30	34	2.60
Animal source food	14	19	24	30	37	46	4.48
Eggs	3	4	5	7	8	10	4.48
Meat	5	7	9	11	13	16	4.48
Fish	6	8	11	13	16	20	4.48
Milk	104	136	166	198	230	276	3.67
Vegetables	138	166	190	213	236	263	2.43
Fruits	27	34	41	47	54	62	3.18
Sugar & products	14	15	16	17	18	18	0.96
Edible oil	14	16	17	18	20	21	1.45
Overall	**506**	**595**	**673**	**753**	**831**	**935**	**2.30**

*Figures within parentheses are projections using positive incremental expenditure elasticities

Compound growth rate between 2019-20 and 2047-48

Plant-source high-value food commodities: Fruits and vegetables are more responsive to income changes, and by 2047-48 their demand for direct consumption is likely to increase at a much faster rate; 2.43% and 3.18% respectively in the BAU scenario. Their direct demand will be higher in the HIG scenarios. By 2047-48, India's demand for vegetables will be in the range of 263-302 million tonnes, and fruits in the range of 62-75 million tonnes.

Sugar & products: Direct demand for sugar and sugar products is expected to grow slowly due to rising health consciousness. Growth in direct demand for sugar and products is expected to be 18-19 million tonnes with different income scenarios.

Table 5.8 Projected household food demand (home food +FAFH) in India under High Income growth (HIG) scenario

Million tonnes

Commodity	High Income Growth Scenario (7%)							High Income Growth Scenario (8%)					
	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	CGR#	2025-26	2030-31	2035-36	2040-41	2047-48	CGR#
Foodgrains	195	208	220	230	239	250	0.93	209	220	232	242	254	0.99
Cereals	178	188	195	202	208	214	0.69	188	195	202	208	215	0.70
Rice	93	97	99	102	103	105	0.43	96	99	101	103	104	0.40
Wheat	76	82	87	91	94	96	0.87	83	87	91	94	97	0.91
Nutri-cereals*	6.6	7.0	7.5	8.3	9.4	11.2	1.98	7.0	7.6	8.4	9.7	11.9	2.18
Maize	1.6	1.6	1.7	1.7	1.7	1.7	0.21	1.6	1.6	1.7	1.7	1.7	0.15
Pulses	17	21	24	28	31	36	2.83	21	25	29	33	39	3.17
Animal source food	14	20	26	32	40	52	4.92	21	28	36	46	62	5.59
Eggs	3	4	6	7	9	11	4.92	5	6	8	10	13	5.59
Meat	5	7	9	11	14	18	4.92	7	10	13	16	22	5.59
Fish	6	9	11	14	17	23	4.92	9	12	16	20	27	5.59
Milk	104	140	173	210	248	303	4.02	145	185	230	277	347	4.55
Vegetables	138	169	195	221	246	278	2.63	173	203	234	264	302	2.94
Fruits	27	35	42	50	57	67	3.48	36	45	54	63	75	3.92
Sugar & products	14	15	16	17	18	18	0.99	15	16	17	18	19	1.04
Edible oil	14	16	17	19	20	21	1.54	16	18	19	21	22	1.68
Overall	**506**	**603**	**689**	**779**	**869**	**989**	**2.51**	**615**	**715**	**822**	**930**	**1080**	**2.85**

*Figures within parentheses are projections using positive incremental expenditure elasticities

Compound growth rate between 2019-20 and 2047-48

Edible oils: Direct demand of edible oils is projected to increase at annual growth rate of 1.45% in the BAU scenario, and 1.54% to 1.68% in the HIG scenarios.Accordingly, the direct demand for edible oils is expected to be 21-22 million tonnes in 2047-48.

Animal-source foods: Animal-source foods have a strong positive association with income; hence their direct demand is expected to increase at an annual growth of 3.67% to 5.59% in different income growth scenarios over the next 25 years (Table 5.7 & 5.8). For 2047-48, in the BAU scenario, direct demand for milk is projected at 276 million tonnes, which could reach to 303-347 million tonnes if the economy grows faster. Direct demand for meat is expected to be a minimum of 16 million tonnes, and a maximum of 22 million tonnes.

Demand for eggs will lie between 10-13 million tonnes, and for fish between 20-23 million tonnes.

On the whole, between 2019-20 and 2047-48 the direct demand for food is projected to increase at annual growth of 2.30% in the business as usual scenario, and 2.51 to 2.85 % in high income growth scenarios.

5.4.2.2 Other food demand

The projected demand of food for other uses including seed, feed, wastages, and others is presented in Table 5.9. Projected area/production/direct food demand in the BAU scenario has been used to project indirect uses of food.

5.4.2.3 Total food demand (household + other demand)

The estimates of the total demand for food commodities in different income growth scenarios are presented in Tables 5.10 and 5.11.

Foodgrains: Total demand for foodgrains is projected at 326 million tonnes in 2030-31, which will gradually increase to 402 million tonnes in 2047-48 in the BAU scenario. In the HIG scenarios, it is expected to reach 415 to 437 million tonnes by 2047-48. Amongst foodgrains, the growth in demand for maize, pulses and nutri-cereals will be significantly higher than the growth in demand for rice and wheat. Nevertheless, rice and wheat will remain the main constituents of diet. If the declining trend in consumption of nutri-cereals is reversed, their demand may go upto 33 million tonnes in 2047-48. Demand for maize, on account of its increasing use in feed and starch industries, is expected to increase to 45 million tonnes in 2030-31 and 86 million tonnes in 2047-48 in the BAU scenario. In the HIG scenarios, it may blow up reaching to 94 to 109 million tonnes.

Pulses demand is projected at 35 million tonnes in 2030-31 and at 49 million tonnes in 2047-48 in the BAU scenario. In the HIG scenario, it will increase to 52 to 57 million tonnes in 2047-48.

Plant-source high value foods: In the BAU scenario, total demand for vegetables is projected to be 270 million tonnes in 2030-31 and to 365 million tonnes in 2047-48. In the HIG scenarios, it may be as high as 385 to 417 million tonnes in 2047-48. Similarly, demand of fruits is expected to be 160 million tonnes in 2030-31 and 233 million tonnes in 2047-48 in the BAU scenario. In case of high income growth, their demand will be 252-283 million tonnes in 2047-48.

Table 5.9 Projections of other demand for food under BAU scenario

Year	Foodgrains	Cereals	Rice	Wheat	Nutri-ce-reals	Maize	Pulses	Eggs	Meat	Fish	Milk	Vege-tables	Fruits	Sugar	Edible oil
Seed															
2019-20	5.3	4.6	1.3	2.4	0.09	0.07	0.70								0.32
2025-26	5.21	4.49	1.22	2.41	0.06	0.09	0.73								0.35
2030-31	5.03	4.31	1.16	2.36	0.05	0.09	0.72								0.37
2035-36	4.76	4.03	1.09	2.19	0.04	0.09	0.73								0.39
2040-41	4.40	3.66	1.02	1.96	0.03	0.08	0.74								0.42
2047-48	3.84	3.09	0.90	1.59	0.02	0.08	0.75								0.44
Feed															
2019-20	25.50	25.10	2.40	2.20	1.50	19.10	0.50								
2025-26	34.30	33.76	2.66	2.34	2.00	26.76	0.54								
2030-31	42.88	42.27	2.89	2.62	2.50	34.25	0.62								
2035-36	57.51	56.81	3.01	2.83	3.06	47.91	0.70								
2040-41	63.14	62.34	3.06	2.93	3.68	52.67	0.80								
2047-48	79.08	78.14	3.08	3.20	4.61	67.24	0.95								
Wastages															
2019-20	13.8	12.3	5.7	4.50	0.98	1.12	1.40	0.34	0.34	0.96	1.70	14.0	9.1		0.57
2025-26	14.13	12.60	5.91	4.50	0.84	1.28	1.53	0.47	0.38	1.22	2.19	15.91	10.55		0.62
2030-31	13.60	12.09	5.64	4.33	0.75	1.30	1.51	0.52	0.38	1.30	2.50	16.62	11.36		0.62
2035-36	12.41	10.95	5.05	3.90	0.67	1.28	1.45	0.52	0.36	1.33	2.78	17.13	12.06		0.61
2040-41	12.41	10.82	4.92	3.80	0.62	1.42	1.59	0.58	0.38	1.48	2.99	18.85	13.51		0.66
2047-48	12.47	10.69	4.66	3.79	0.56	1.63	1.78	0.66	0.39	1.69	3.21	21.34	15.65		0.74
Others															
2019-20	37.95	31.34	0.09	14.21	9.97	5.08	6.61	1.60	1.56	4.70	80	47	72	19.43	7.55
2025-26	41.58	33.69	0.09	15.02	10.30	6.43	7.89	2.17	2.11	6.35	104	56	91	21.95	8.39
2030-31	45.36	36.39	0.09	15.47	10.76	7.82	8.98	2.72	2.65	7.97	126	64	108	23.23	8.97
2035-36	49.37	39.36	0.09	15.62	11.41	9.51	10.02	3.34	3.26	9.79	149	70	124	24.35	9.39
2040-41	53.55	42.61	0.09	15.37	12.26	11.57	10.95	4.02	3.92	11.78	171	76	139	25.26	9.58
2047-48	59.11	47.18	0.08	14.15	13.36	15.23	11.93	5.03	4.90	14.73	200	81	155	26.18	9.36

Table 5.10 Projected total food demand (household + other demand) in India under Business-as-Usual (BAU) scenario

Million tonnes

Commodity	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	CGR#
Foodgrains	277	303	326	353	371	402	1.39
Cereals	251	272	290	313	327	353	1.27
Rice	103	107	110	111	113	114	0.40
Wheat	100	106	111	115	117	119	0.65
Nutri-cereals	19	20	22	23	26	29	1.60
Maize	27	36	45	60	67	86	4.39
Pulses	26	31	35	40	44	49	2.38
Animal source food	24	32	40	49	59	74	4.29
Eggs	5.0	7	8	10	12	16	4.32
Meat	7	9	12	14	17	21	4.31
Fish	12	16	20	24	29	37	4.27
Milk	186	243	294	349	405	480	3.56
Vegetables	199	238	270	301	330	365	2.28
Fruits	108	136	160	184	206	233	2.90
Sugar & products	34	37	39	41	43	44	1.05
Edible oil	22	25	27	29	30	31	1.23
Overall	**850**	**1014**	**1157**	**1305**	**1445**	**1630**	**2.44**

Compound growth rate

Table 5.11 Projected total food demand (household + other) in India under High Income growth (HIG) scenarios

Million tonnes

Commodity	High Income Growth Scenario (7%)							High Income Growth Scenario (8%)					
	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	CGR#	2025-26	2030-31	2035-36	2040-41	2047-48	CGR#
Foodgrains	277	305	329	359	379	415	1.51	307	334	370	393	437	1.70
Cereals	251	273	293	318	334	363	1.38	275	296	326	344	381	1.55
Rice	103	107	109	111	112	114	0.37	106	109	110	112	113	0.34
Wheat	100	107	112	115	118	119	0.67	107	112	116	119	120	0.71
Nutri-cereals	19	20	22	24	27	31	1.79	20	22	25	28	33	2.09
Maize	27	37	47	65	73	94	4.75	39	50	72	82	109	5.32
Pulses	26	32	36	41	46	52	2.60	32	38	43	49	57	2.93
Animal sourcefood	24	33	42	52	64	82	4.73	34	45	58	73	98	5.39
Eggs	5.0	7	9	11	14	18	4.75	7	10	12	16	21	5.41
Meat	7	9	12	15	19	24	4.75	10	13	17	21	29	5.42
Fish	12	16	21	26	32	41	4.70	17	22	29	36	48	5.36
Milk	186	249	308	371	436	527	3.92	258	329	406	489	606	4.47
Vegetables	199	242	277	312	345	385	2.48	247	288	329	368	417	2.78
Fruits	108	139	166	193	220	252	3.20	144	176	209	242	283	3.64
Sugar& products	34	37	40	42	43	45	1.08	38	40	42	44	45	1.13
Edible oil	22	25	28	29	31	32	1.32	26	28	30	32	33	1.47
Overall	**850**	**1030**	**1189**	**1358**	**1519**	**1739**	**2.69**	**1054**	**1240**	**1444**	**1641**	**1921**	**3.07**

Compound growth between 2019-20 and 2047-48.

Sugar & products: Total demand for sugar and its products is projected at 39-40 million tonnes in 2030-31 and 44-45 million tonnes in 2047-48 for different income growth scenarios.

Edible oils: In the BAU, total demand for edible oils is expected to increase to 27 million tonnes in 2030-31 and not much after that (31 million tonnes in 2047-48). In case of high economic growth, it will be slightly more.

Animal-source foods: In the BAU scenario, demand for milk will increase to 294 million tonnes in 2030-31 and further to 480 million tonnes in 2047-48. In case of high income growth, it is projected to be 308-329 million tonnes in 2030-31 and to 527-606 million tonnes in 2047-48.

Over the next 25 years, the demand for other animal-source foods is expected to grow at an annual rate of 4.3 to 5.4 %. In the BAU scenario, by 2047-48 the demand for eggs, meat and fish is estimated at 16, 21 and 37 million tonnes, respectively. In the HIG scenarios, it is expected to be 18-21, 24-29 and 41-48 million tonnes in 2047-48.

Overall, by 2047-48 food demand is expected to grow at an annual rate of 2.44%.Further, If the economy grows at a faster rate, the growth in demand will be higher, from 2.69 to 3.07%.

5.5 External Validation

Given the non-availability of reliable data required for demand estimation, and other uncertainties, it becomes imperative to externally validate the demand projections. Consumption of food is not expected to increase exponentially, and after meeting the certain minimum dietary requirements, a rational consumer should reduce the intake of a food commodity. Therefore, the demand estimates can be considered robust if these are not significantly higher than the recommended dietary allowances.

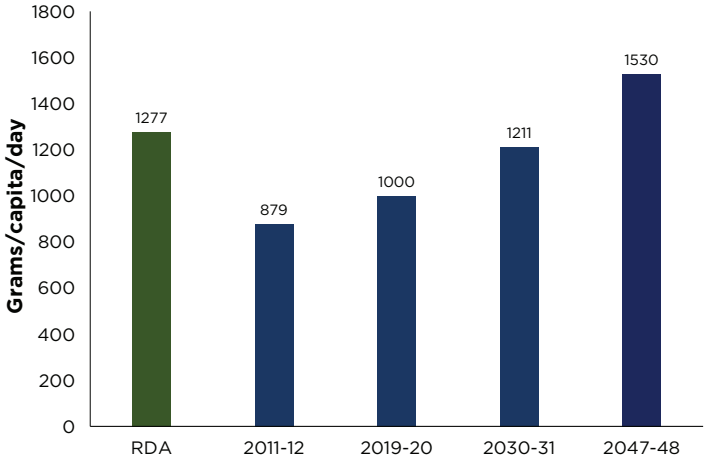


Figure 5.1 Comparison of projected food consumption and normative requirement (moderate activity) at aggregate level.

The aggregate normative daily requirement of food has been derived by summing the intake of individual food commodities required for a balanced healthy diet for a moderate activity, adjusting for the expected demographic changes by 2047 (Table 4.1). This is then compared with projected food consumption in the BAU scenario (Figure 5.1). The quantity of daily food intake in 2011-12 was 31% less than the recommended dietary allowance, and in 2019-20 it reduced to 22%. Projected per capita food demand (direct) in 2030-31 is at par with the normative requirement. In 2047-48, it is expected to be 20% more. As projected food demand falls within the realistic range of normative requirement, the demand estimates can be considered robust.

At commodity level, per capita consumption of cereals, edible oils, and sugar in 2030-31 is estimated higher than their normative requirement, while of pulses (and equivalent non-veg), fruits, vegetables, it remain lower. However, by 2047-48, the consumption of all food commodities is expected to be either at par or higher than their normative requirement.

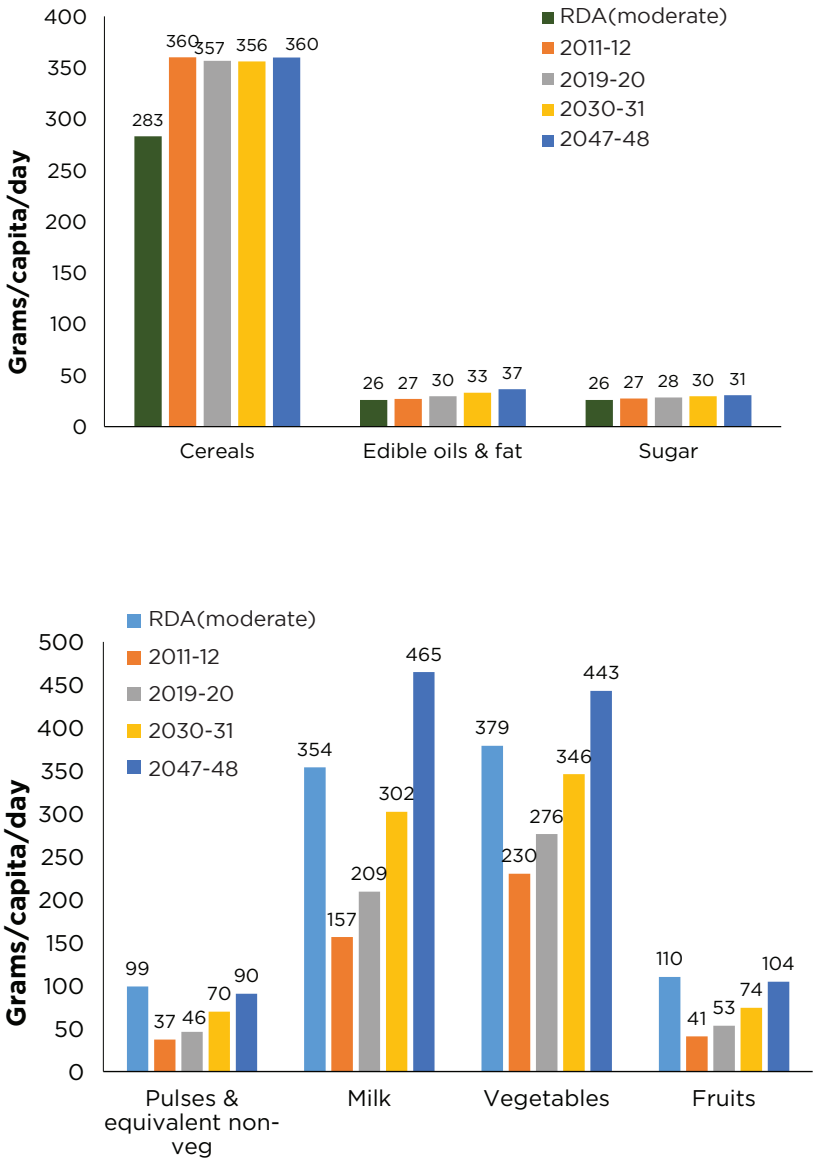


Figure 5.2 Comparison of projected per capita food consumption and normative requirement (moderate activity) at disaggregate level

5.6 Demand-Supply Gap

This section compares the projected demand and production to assess the extent of surplus or deficit. It provides feedback for devising an effective food management strategy.

Foodgrains: Total demand for foodgrains in 2030-31 is estimated between 326 to 334 million tonnes, and in 2047-48 between 402 to 437 million tonnes. The projected production in the BAU scenario is 10-13 % (34-42 million tonnes) more than the demand in 2030-31, and 5-14% (22-55 million tonnes) more in 2047-48. In the high yield growth scenario, there will be large surpluses, which can be disposed offshore to earn foreign exchange (Figure 5.3a).

In 2019-20, India produced 276 million tonnes of cereals, 25 million tonnes more than the projected demand. The surplus is likely to remain in future as well.

Rice production in 2019-20 was sufficient to meet the domestic demand. Its demand is expected to be 110 million tonnes in 2030-31 and 114 million tonnes in 2047-48 as against the projected production of 145 million tonnes and 154 million tonnes in the BAU scenario (Figure 5.3b).

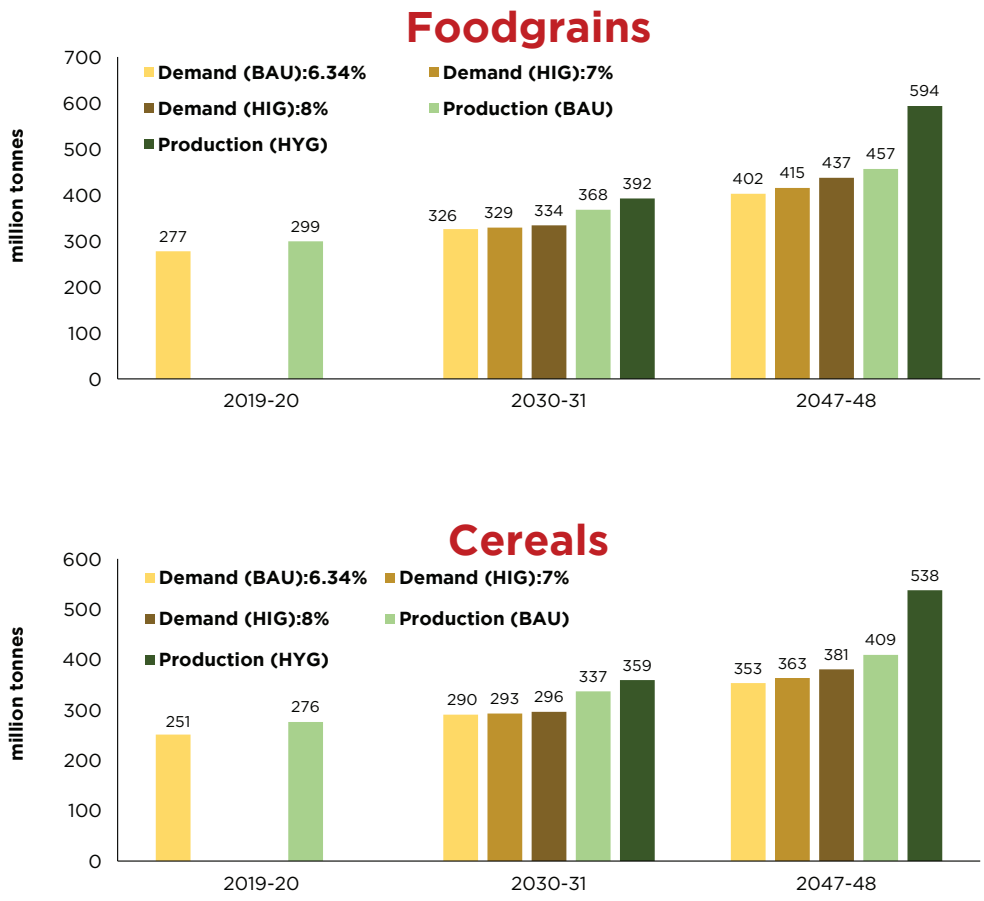


Figure 5.3a Demand-supply gap: Foodgrains and Cereals

Likewise, wheat production is expected to be sufficient to meet the future demand, leaving a surplus of 19-26 million tonnes in 2030-31 and 40-67 million tonnes in 2047-48. This suggests the need for reallocation of area from rice and wheat to other crops.

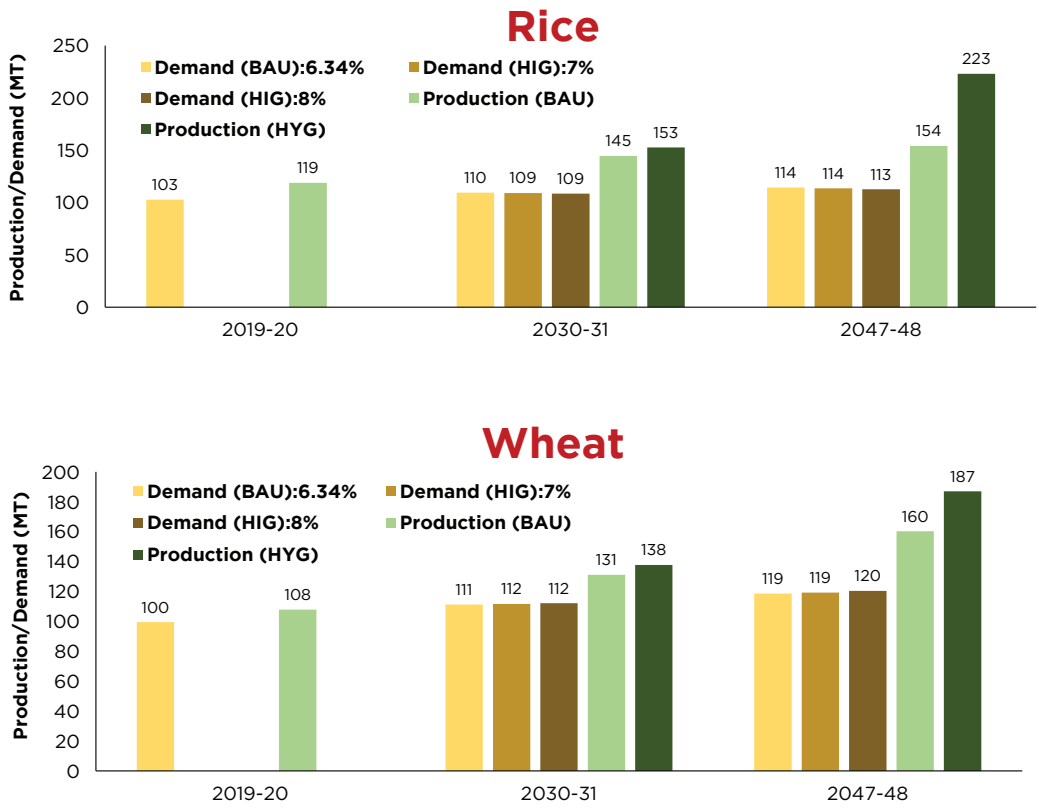


Figure 5.3b Demand-supply gap: Rice and wheat

Given the declining trend in consumption of nutri-cereals, their demand is projected to decline to 18 million tonnes in 2030-31 and 14 million tonnes in 2047-48 (Figure 5.3c). Nevertheless, with the growing consumer awareness and the government efforts to promote nutri-cereals, their demand can go up to 33 million tonnes by 2047-48. And, their production is expected to fall short of their demand because of the decline in their area (Table 5.3). To meet their domestic demand, there is a need to expand their area and improve yields.

Demand for maize has been growing fast in response to its growing demand in feed and starch industries. Its demand as biofuel is also expected to increase. Maize demand is expected to be 45-50 million tonnes in 2030-31 and further to 86-109 million tonnes in 2047-48. In the BAU scenario, maize production will fall short by 2 million tonnes in 2030-31 and 6 million tonnes in 2047-48. However, in the HYG scenario, its production is expected to be sufficient to meet the demand. This implies a need to harness its yield potential, and allocate more area to its cultivation.

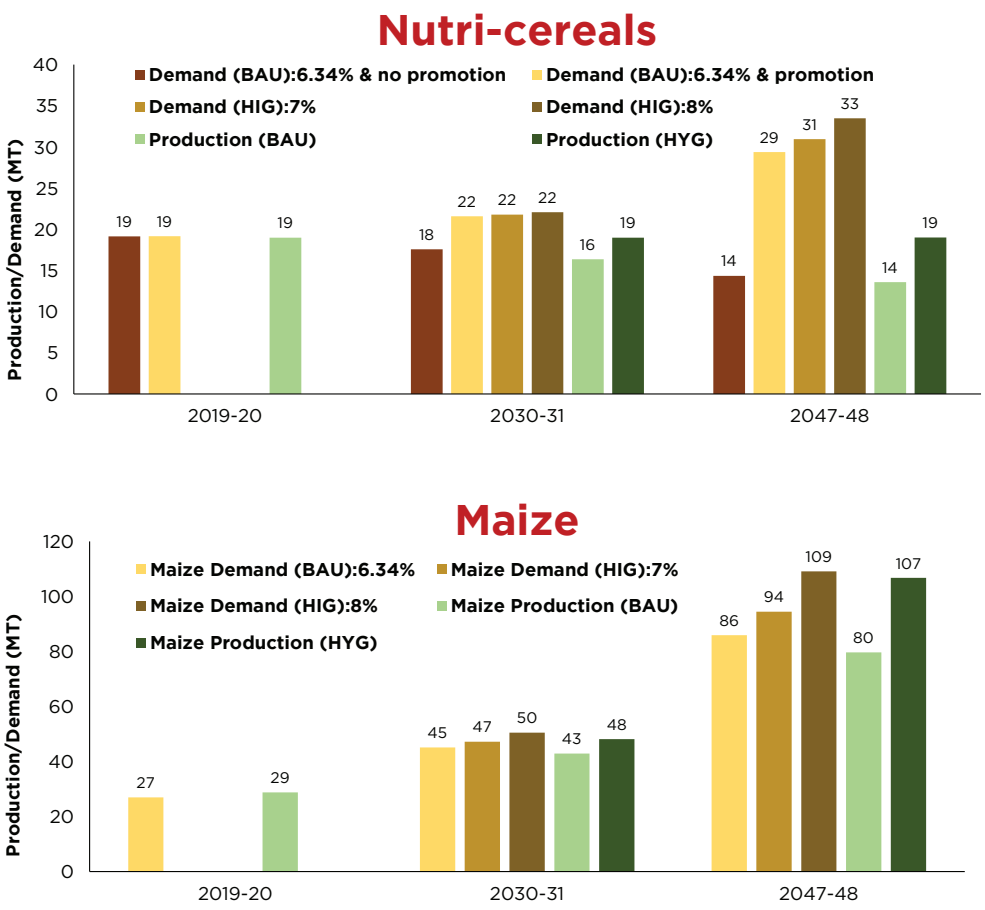


Figure 5.3c Demand-supply gap: Nutri-cereals and Maize

Pulses demand is projected at 35 to 38 million tonnes in 2030-31 and 49-57 million tonnes in 2047-48 (Figure 5.3d). Their present production is insufficient to meet the demand. This gap may remain in future in the absence of yield improvements and acreage allocation to them. In the HYG scenario, pulses production will suffice to meet the growing demand. The area under pulses is projected to increase at 1.10 % per annum growth (Table 5.3) as compared to 1.69 % growth during 2011-12 to 2019-20. If the current trend in pulses area continues, and yield growth accelerates there is likelihood of achieving self-sufficiency in pulses.

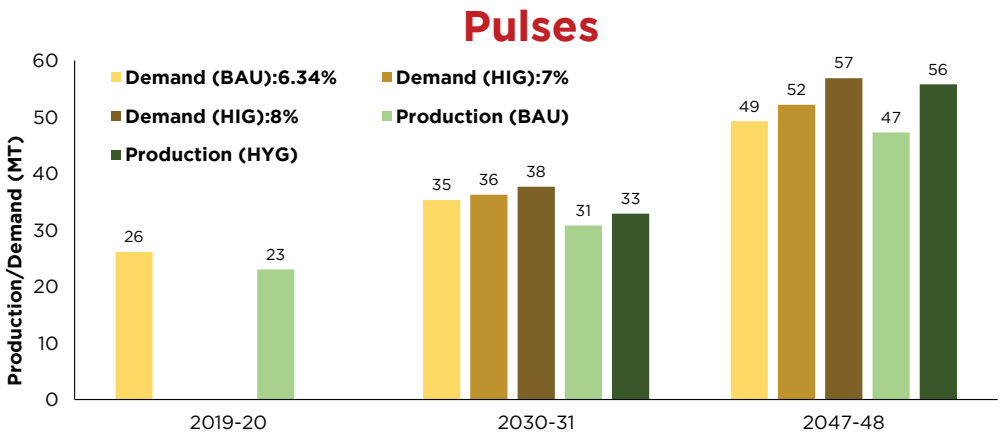


Figure 5.3d Demand-supply gap: Pulses

Plant-source high value foods: Production of vegetables was slightly less than their demand in 2019-20. Without acceleration in growth in their area and yield, vegetable supplies will be short of demand by 6-12% in 2030-31 (Figure 5.3e). However, in the HYG scenario, their production will be sufficient to meet the demand. It is, therefore, imperative to accelerate their yield, which has slowed down in recent years (Table 3.3). In 2047-48, their production will be sufficient to meet their demand in the BAU scenario. Nevertheless, with acceleration in economic growth, their production need to increase at an accelerated rate. Note, there exists significant yield potential in most vegetables, which need to be harnessed.

As for vegetables, the production of fruits was short of their demand in the year 2019-20. The shortfall is likely to remain in future as well. However, in the HYG scenario, their production may meet the demand in 2047-48.

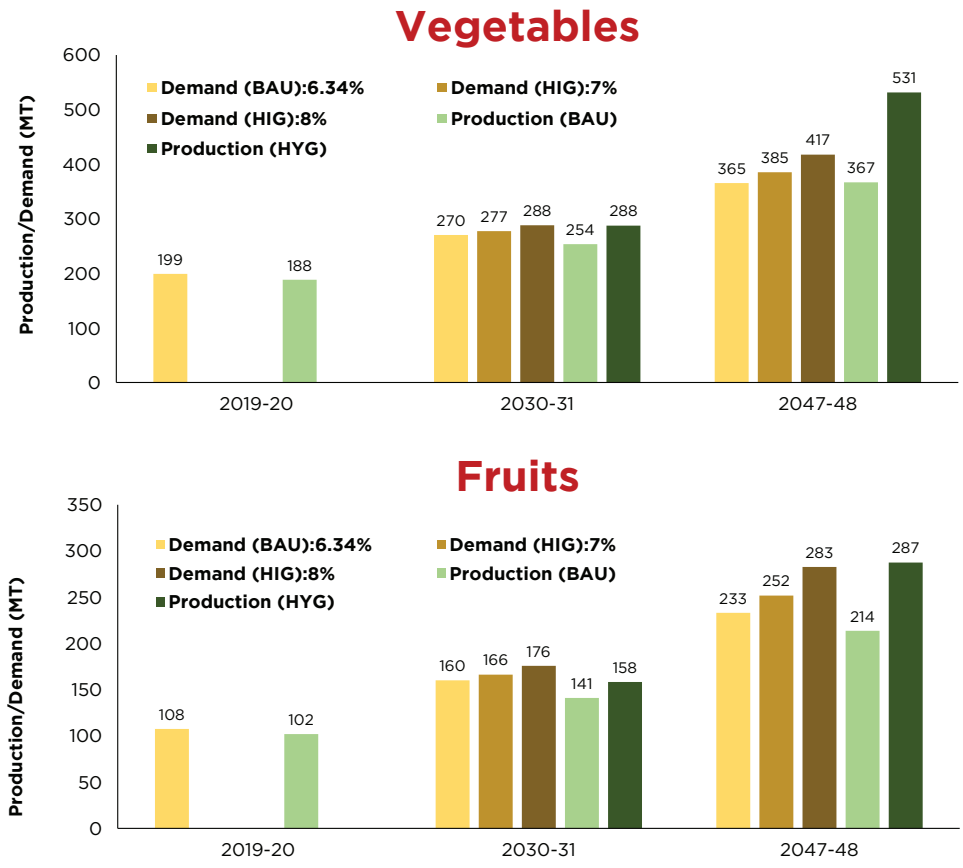


Figure 5.3e Demand-supply gap: Vegetables and Fruits

Sugar & products: Production of sugar and its products is expected to remain higher than their demand throughout (Figure 5.3f), leaving a surplus of 3 million tonnes in 2030-31 and 6 million tonnes in 2047-48. The surpluses can be exported, and/or used for ethanol production for blending with diesel and petrol.

Edible oils: In 2019-20, production of edible oils was about half of their demand (Figure 5.3f), and this is expected to continue in 2030-31 as well. Augmentation of oilseeds yield, and production from secondary sources can reduce the gap in the short-run, and achieve self-sufficiency in the long-run. Nevertheless, it will require significant technological intervention.

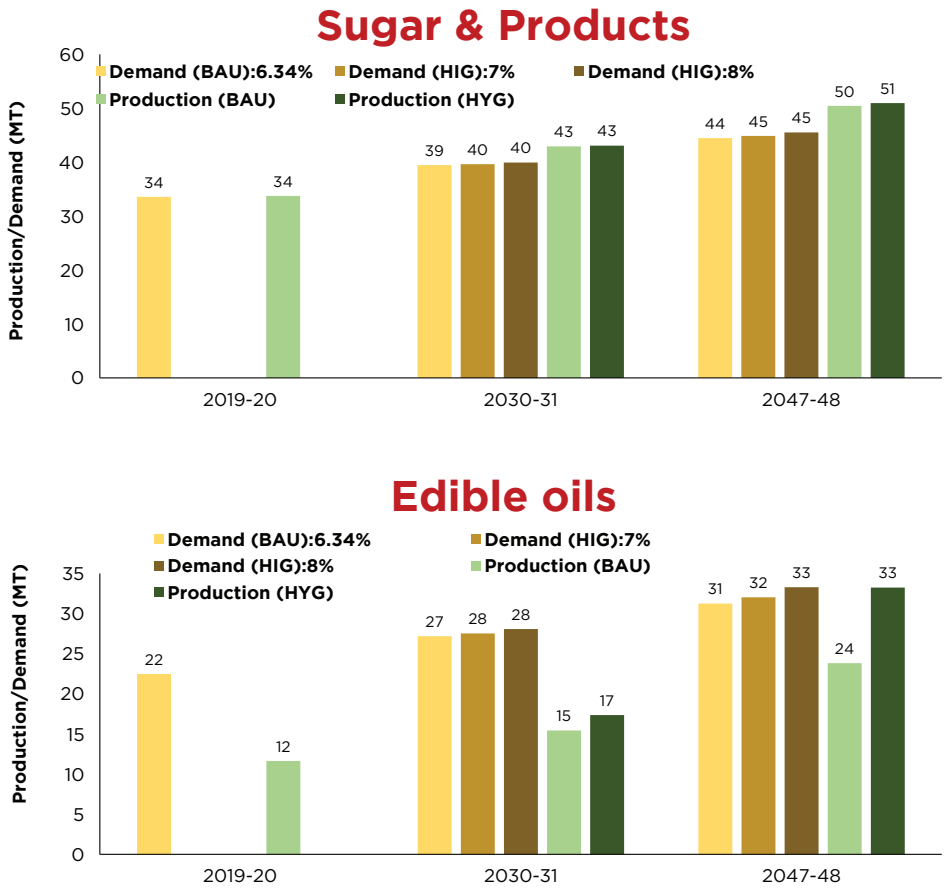


Figure 5.3f Demand-supply gap: Sugar & Products and Edible Oils

Animal-source foods: In 2019-20, production of milk was sufficient to meet the domestic demand. In 2030-31, the demand is likely to be met from domestic production (Figure 5.3g). However, if the economic growth accelerates, the production will be insufficient to meet the demand.

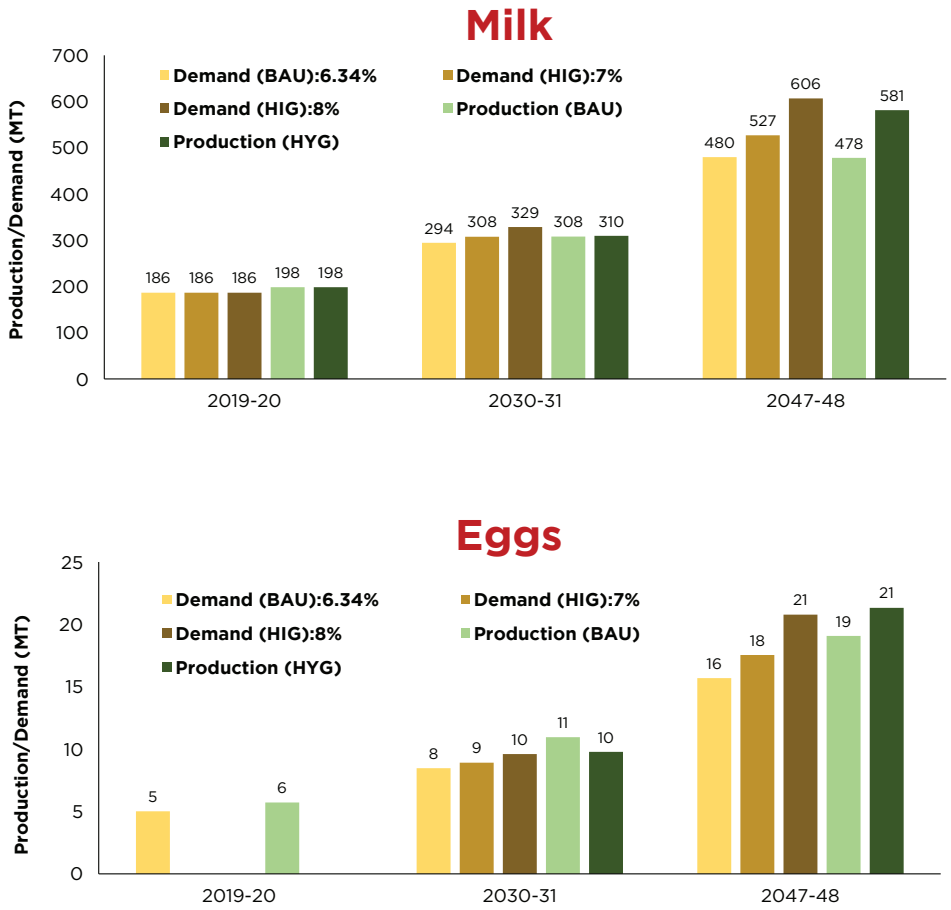


Figure 5.3g Demand-supply gap: Milk and Eggs

Egg production in the BAU scenario will exceed the projected demand in 2030-31(Figure 5.3g), and it may continue by 2047-48. However, the country may feel a shortage if economic growth accelerates to 8%.

Presently, meat production surpasses its demand (Figure 5.3h). However, with increase in income, its demand will increase faster than production. Production of meat in the BAU scenario will be sufficient to meet the demand in 2030-31, but is likely to fall short in 2047-48. However, in the HYG scenario, meat production in 2047-48 may surpass its demand.

Fish demand is likely to be met by domestic production in 2030-31. But in the long run, the growth in production needs to be augmented to meet the rising demand and generate surpluses for exports.

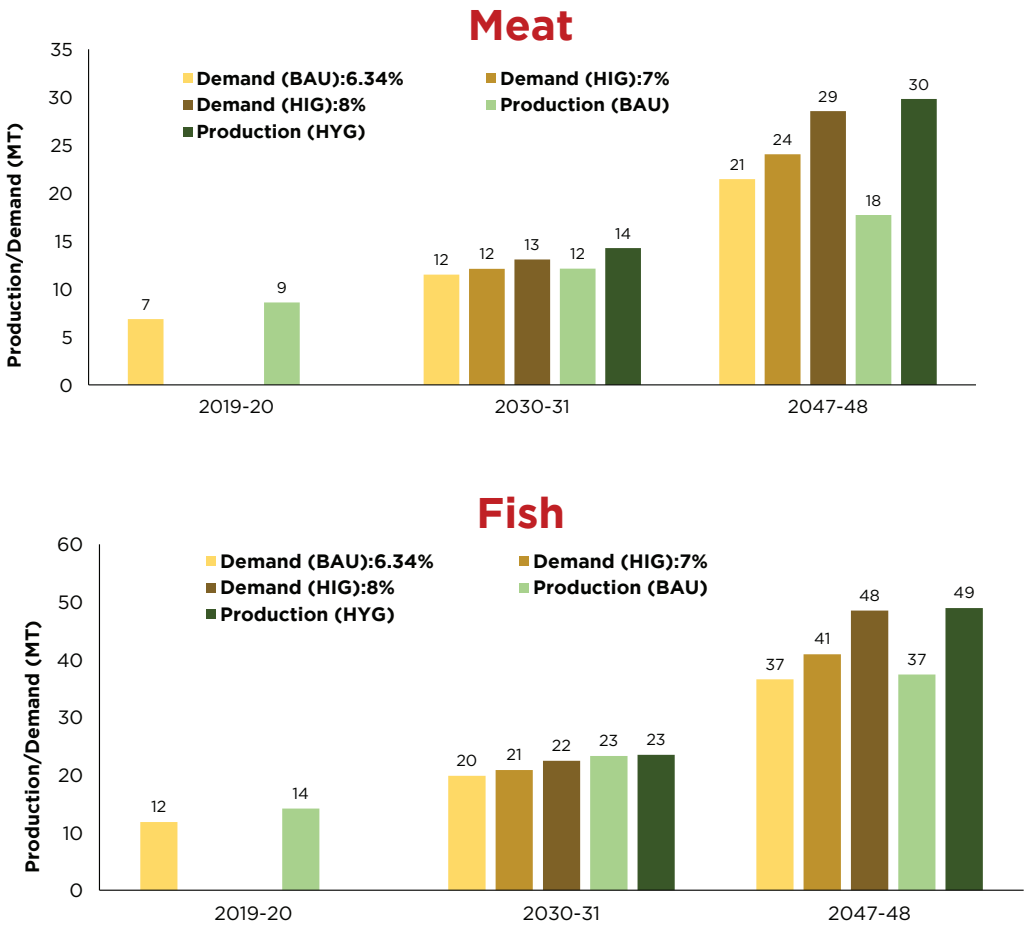


Figure 5.3h Demand-supply gap: Eggs and Meat

HIGHLIGHTS

- Food demand comprises the household demand and food away from home (FAFH) demand, the demand for feed, seed, wastages and other uses. Food cooked within household premises constitutes the largest component of total food demand.
- Overall food demand is expected to grow at an annual rate of 2.44% between 2019-20 and 2047-48. The growth will accelerate to 2.69 to 3.07% if the economy grows at a faster rate. The growth would vary across the food commodities i.e 0.34% for rice to 5.42% for meat.
- Total demand for foodgrains is projected at 402 million tonnes (mt) in 2047-48 under BAU scenario and 415-437 mt under HIG scenarios. Amongst foodgrains, the growth in demand for maize, pulses and nutri-cereals will be significantly higher than the growth in demand for rice and wheat. Pulses demand is projected at 49-57 mt in 2047-48 under varied income growth scenarios. The demand for vegetables and fruits is expected to be 365 mt and 233 mt, respectively in BAU and 385-417 mt and 252-283 mt in HIG scenarios. The demand for sugar and

products is expected to remain at 44-45 mt in 2047-48. The demand for edible oils is projected at 31-33 mt. The milk and milk products demand is projected at 480 mt in BAU scenario and 527-606 mt in HIG scenarios in 2047-48. In the BAU scenario, by 2047-48 the demand for eggs, meat and fish is estimated at 16, 21 and 37 million tonnes, respectively. In the HIG scenarios, it is expected to be 18-21, 24-29 and 41-48 million tonnes in 2047-48.

- At aggregate level, the quantity of daily food intake in 2011-12 was 31% less than the recommended dietary allowance and the gap reduced to 22% in 2019-20. By the year 2030-31, average daily food intake is likely to be at par with the normative requirement and in 2047-48 it is expected to be 20% more. Intake of few commodities like pulses, fruits, and vegetables will be insufficient in 2030-31, whereas by 2047-48, consumption of all food commodities is expected to be either at par or higher than their normative requirement.
- The gross cropped area (GCA) is expected to increase at annual growth of 0.45 % during 2019-20 to 2047-48. The incremental acreage will come from improvements in cropping intensity. Given the limited scope for area expansion, the additional production to meet the domestic demand will come from yield improvements. There exists considerable yield gap in most crops, which offers scope to accelerate growth in the yield.
- The foodgrains production is likely to be more than the demand in 2047-48 in BAU and HYG scenarios and the surplus can be disposed offshore to earn foreign exchange. The surplus grains will be primarily contributed by rice and wheat. With the growing consumers' awareness and government focus, demand of nutri-cereals is likely to go up and production will fall short of the demand until area expansion and yield augmentation take place. In the BAU scenario, maize production will fall short of their demand. However, in the HYG scenario, its production is expected to be sufficient to meet the demand. This necessitates harnessing yield potential in maize. Similarly, pulses production is insufficient to meet the demand and the gap is expected to remain in BAU scenario. Self-sufficiency in pulses is likely to be achieved if the current trend in pulses area continues, and yield growth accelerates.
- Presently production of fruits and vegetables fall short of their demand which is expected to continue until acceleration in existing yield growth takes place. Similarly, shortfall in the production of edible oils is expected to continue in short run. Augmentation of oilseeds yield, and production from secondary sources can reduce the gap in the short-run, and achieve self-sufficiency in the long-run. Production of sugar and its products is expected to remain higher than their demand. Domestic production will meet the demand of all animal-source food except meat in BAU scenario. However, it will fall short of demand if economy grows at higher than the usual rate.

Chapter 6

Export Potential

The recent period has observed a remarkable expansion in global agricultural trade, signaling significant growth potential. This notable surge in agricultural trade holds the promise of yielding substantial benefits, encompassing the facilitation of agricultural development, alleviation of poverty, stabilization of prices, improvement in nutritional outcomes, and optimization of resource utilization. The "Agricultural Export Policy 2018" is oriented towards broadening the spectrum of the country's export portfolio by fostering the promotion of novel, indigenous, organic, and culturally distinctive agricultural products. This policy has established the ambitious goal of achieving agricultural exports amounting to US$60 billion by 2022 and further escalating to US$100 billion by 2025. As of 2021, India had already surpassed the US$50 billion milestone in agricultural exports.

The earlier sections highlighting estimations of supply and demand suggest a probable surplus that can be utilized to bolster exports. These projections outline diverse supply possibilities across various scenarios, encompassing both business-as-usual conditions and conditions fostering rapid growth. Within these scenarios, the potential for a surplus supply beyond current demand exists, which could be channelized towards exports. To examine the export prospects in rice and wheat, we have included the business-as-usual (BAU) approach for assessing the available surplus for exports. Remaining surplus scenarios are given in Appendix 6.1 to 6.5.

Table 6.1 Export surplus assessment (Food demand: Business as usual (6.34%) & Production: Business-as-usual)

Surplus (Supply-Demand), Million tonnes

Product/ Commodities	2011-12	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	Hypothesis
Foodgrains	17	22	28	42	43	46	54	Exportable
Cereals & Millets	18	25	32	46	47	50	56	Exportable
Rice	9	16	26	35	39	40	40	Exportable
Wheat	5	8	11	20	27	29	42	Exportable
Nutri-cereals	0	0	-3	-5	-8	-11	-16	Importable
Maize	4	2	0	-2	-9	-6	-6	Importable
Pulses	-3	-3	-4	-4	-4	-4	-2	Importable
Animal Food	2	5	6	7	6	4	1	Exportable
Eggs	0	1	2	2	3	3	3	Exportable
Meat	1	2	1	1	0	-2	-4	Transitioning
Fish	1	2	3	3	3	2	1	Exportable
Milk	0	12	15	14	9	3	-2	Transitioning
Vegetables	2	-11	-14	-17	-16	-13	1	Importable
Fruits	0	-6	-13	-19	-23	-24	-19	Importable
Sugar & products	3	0	5	3	3	6	6	Exportable
Edible oil	-9	-11	-12	-12	-11	-10	-7	Importable

Amid the ongoing emphasis on bolstering exports, significant shifts in the composition of agricultural exports have emerged, driven by evolving global dietary preferences. The categories experiencing steady expansion comprise rice, shrimps, prawns, cane sugar, cotton, spices, among others. These commodities have not only demonstrated consistent export growth over time but also hold a significant share in the global export market.

Conversely, nutri-cereals, maize, and pulses are likely to fall into the category of importable commodities due to changing consumer preferences favoring healthier and more nutritious diets. Oilseeds will fall under importable hypothesis under all possible scenarios. Eggs and fish also align with the exportable hypothesis. Fruits and vegetables, driven by increasing demand, tend to be classified as importable commodities. Dairy products also exhibit surplus in the business-as-usual scenario. Finally, sugar and its derivatives emerge as commodities with long-term export potential. These insights are examined in the subsequent sections, which delve into the export potential of key agricultural commodities.

6.1 The Approach

1. The historical exports of selected commodities have also been modelled to provide the futuristic trends in exports, if existing trends would prevail. Stochastic models such as the autoregressive integrated moving average (ARIMA) model, and machine learning techniques such as the artificial neural network (ANN) method, have been employed for projecting the export trends[2] . For rice and wheat, the projections are based on historical data on quantity from 1961 to 2021 from FAOSTAT. The projections of dairy and bovine meat are based on historical data from 2001 to 2022 sourced from International Trade Statistics (INTRACEN). ARIMA, being a linear time series model, is limited in its ability to effectively capture the intricate nonlinear patterns present in a series. In contrast, ANN, a data-driven machine learning technique, can comprehend the nonlinearity inherent in the series[3]. Given the presence of such complexity and nonlinearity within the export data, ANN has demonstrated superior performance in most instances. Notably, ANN can be utilized for long-term forecasting as well[4] .

2. Export potential for selected commodities was drawn from the Export Potential Map of the International Trade Centre (ITC). These assessments are based on an

[2] Stationary of the series was checked by means of augmented dickey fuller (ADF) test. The series which were nonstationary at level were undergone differencing to make them stationary. The order of auto regression (AR) and moving average (MA) in ARIMA model have been selected based on the partial autocorrelation function (PACF) and autocorrelation function (ACF) plots respectively. The best model was selected using the minimum information criterion value i.e. minimum value of Akaike Information Criterion (AIC) and Baysian Information Criterion (BIC).

[3] A series of algorithm is used to form a neural system of networks to act upon vast amount of data and process the data like a human nervous system does. A multilayer ANN model consists of input, one or more hidden layer and output layer. Data is fed to the input layer. By adjusting the connection weights between the input and hidden nodes data recess at hidden nodes. After processing the data in hidden node, processed data is transferred to the output nodes through similar kind of inter-connected network. From the output node final value is achieved. This is called feed-forward mode of the neural network model. Thereafter, Back-Propagation Algorithm (BPA) starts to adjust the weight matrix between the input and hidden layer and the hidden and output layer so that the output received from the whole ANN model meets our desired goal with minimum error.

[4] For ANN technique, the hyper parameter tuning was carried out to reach to the optimum combination resulting minimum value of Root Mean Square Error (RMSE). Number of input lags in ANN has been decided using the autocorrelation structure of the series. For the both the techniques, the residual diagnostic was carried out to check for adequacy of fitted model. The assumptions of normality and independence of residuals have been checked.

export potential assessment[5] methodology developed by the ITC. The Export Potential Indicator (EPI) signifies the total export potential for a given commodity along with the potential harnessed. It helps countries to enhance exports in existing markets and tap new markets. The facilitative measures for export by the Government of India are anticipated to elevate the scale of exports and unlock further levels of untapped potential. It is assumed that an additional 5 to 20% of export potential will be harnessed between 2025 and 2047.

3. With the ongoing implementation of trade facilitation measures, a comprehensive assessment of expected exports involves a calculation that combines the projected exports with the additional potential that has been successfully realized and harnessed. This calculation takes into account not only the anticipated or projected export figures but also the capacity to unlock and capitalize on additional export potential. It accounts for the potential growth and expansion in exports that can be achieved by leveraging various trade facilitation strategies and initiatives.

4. Anticipating an expansion of the surplus in the future, it is plausible that there will be increased potential for further exports. Consequently, an evaluation of this additional potential has been conducted by deducting the projected exports from the projected surplus. Additionally, calculations have been made to determine the extent to which the country will be able to utilize its potential by the year 2047.

5. The product mapping was done based on the Trade Balance Index (TBI) and Revealed Symmetric Comparative Advantage (RSCA) of selected commodities. The comparative advantage for a given product is based on the premise that the trade pattern reveals the changes in relative price and non-price factors and is indicative of the trade advantage and disadvantage. The revealed comparative advantage (RCA) indices for selected commodities were calculated as

$$\mathrm{RCA_{ij}} = \frac{\left(\frac{\mathrm{X_{ij}}}{\sum_{j=1}^{k} \mathrm{X_{ij}}}\right)}{\left(\frac{\mathrm{X_{wj}}}{\sum_{j=1}^{k} \mathrm{X_{wj}}}\right)}$$

Where

$\mathrm{RCA_{ij}}$ = Revealed comparative advantage for i[th] country in j[th] product,

X_{ij} value of export of j[th] product from i[th] country,

$\sum_{j=1}^{k} X_{ij}$ = value of agricultural export of ith country,

X_{wj} = value of global export of jth product, and

$\sum_{j=1}^{k} X_{wj}$ = value of agricultural export globally.

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[5]Export potential assessments infer potential export values at *ijk* level from a multiplicative model based on two-dimensional data:

$$V_{ijk} = \alpha_{ik}\beta_{ij}\vartheta_{jk} = \frac{\vartheta_{ik}}{\vartheta_{k}} \cdot \frac{\vartheta_{ij}}{\sum_{k}\left(\frac{\vartheta_{ik}}{\vartheta_{k}}\vartheta_{jk}\right)}\vartheta_{jk}$$

where α_{ik} corresponds to the exporter i's world market share in product k. The term β_{ij} is a measure of bilateral trade relative to what trade would be if the exporter had the same share in world markets as it has in market j, while ϑ_{jk} reflects the total imports indicating that potential exports correspond to actual exports without friction (ITC, 2020).

RCA value lies between 0 and ∞. An i^{th} country is said to have a comparative advantage in the production of j^{th} product if the value of exceeds '1.' The revealed symmetric comparative advantage ($RSCA_{ij}$) index can be calculated as:

$$RSCA_{ij} = (RCA_{ij}-1) / (RCA_{ij}+1)$$

The $RSCA_{ij}$ index varies from '-1' to '+1.' An $RSCA_{ij}$ value of "more than zero" indicates that ith country has a comparative advantage in jth product. In contrast, an $RSCA_{ij}$ value of "less than zero" indicates a comparative disadvantage.

The TBI helps analyze whether a particular country specializes in exports or imports for a given crop or category. TBI is formulated as:

The TBI helps analyze whether a particular country specializes in exports or imports for a given crop or category. TBI is formulated as:

$$TBI_{ij} = (x_{ij}-m_{ij}) / (x_{ij}+m_{ij}),$$

Where,

TBI_{ij} denotes a trade balance index of i^{th} country for j^{th} product,

x_{ij} represents exports of j^{th} product from i^{th} country, and

m_{ij} represents imports of j^{th} product by i^{th} country.

TBI values range from '-1 to +1.' If the country is only importing, TBI is '-1.' In contrast, if a country only exports, TBI is '+1.'

The selected products were mapped based on the RSCA and TBI, and classified into four quadrants (Box 1). Quadrant I, Group A comprises products with positive trade balance and comparative advantage. This is the most favorable quadrant and represents commodities highly suitable for exports. Quadrant II, Group B includes products with a comparative advantage but without exportable surpluses (indicated by the negative trade balance). Quadrant III, Group D is the most unfavorable group: it includes products with no comparative advantage along with negative trade balance. Finally, Quadrant IV, Group C comprises products with a positive trade balance but no comparative advantage in exports. In the long run, commodity movements may happen from one Quadrant to the other: a shift from Group B to Group A would require generating exportable surpluses with appropriate technological interventions to enhance productivity and product quality. In contrast, a shift from Group C to Group A would require policy facilitation to harness the export potential and enhance comparative advantage.

Box 1. Product mapping scheme

Quadrant II (Group B) TBI<0, RSCA>0 Net importer Comparative advantage	**Quadrant I (Group A)** TBI>0, RSCA>0 Net exporter Comparative advantage
QuadrantIII(Group B) TBI<0, RSCA<0 Net importer Comparative disadvantage	**Quadrant IV (Group A)** TBI>0, RSCA<0 Net exporter Comparative disadvantage

Source: Widodo (2009).

6.2 Commodity Prospects

6.2.1 Rice

India's strategic efforts to expand its rice exports by exploring new opportunities in different countries and markets have begun to yield positive outcomes. Non-Basmati rice exports also demonstrated growth. This remarkable progress can be attributed to the effective synergy and collaboration among various stakeholders, including farmers, exporters, and government agencies, all working together to boost exports.

The worldwide consumption of rice has shown a gradual increase in recent years, reaching approximately 520 million tonnes in 2021-22, up from 437.18 million tonnes in 2008-09. In 2021, the global rice export market was valued at US$ 27.13 billion, with India leading at US$ 9.6 billion, followed by Thailand at US$ 3.3 billion and Vietnam at US$ 3 billion. As the premier exporter, India has experienced a remarkable growth of 14% in volume from 2017 to 2021, coupled with a 7% growth in value. In a historic milestone, India achieved exports of 21.5 million tonnes of rice in 2021, surpassing the combined shipments of the next four major rice-exporting nations: Thailand, Vietnam, Pakistan, and the United States.

The continuous escalation of the revealed comparative advantage in rice exports serves as a testament to India's influential presence in the global market. In the initial stages, these values demonstrated a downward trajectory, experiencing a decline from 7.31 to 4.62 in the year 2010. However, a notable and consistent upward trend has been observed, signifying a substantial resurgence in India's competitive advantage. Remarkably, India's comparative advantage in rice exports surged to an impressive 10.82 by the year 2021.

Table 6.2 Prospects for rice exports

Million Tonnes

Particular	Details		2025	2030	2035	2047
Supply (BAU)	Sourced from computations in previous section	A	133	145	150	154
Demand (BAU)	Sourced from computations in previous section	B	107	110	111	114
Surplus (Supply-Demand)		C=A-B	26	35	39	40
Exports @ BAU Scenario (Projected with NNETAR[6] (9,6,1))	Computed based on machine learning model	D	20.2	27.9	29.5	30.07
Export potential tapped (%)	Sourced from INTRACEN Trade Potential	E				
Tapping the untapped potential (%)	Assumptions	F	5	10	15	20
Potential targetted (%)	Computed	G	60	65	70	75
Expected level of exports	Projected exports+extra potential tapped	H	22.5	32.5	36.4	39.3
Further scope for exports	Computed	I=C-H	3.5	2.5	2.6	0.7
Potential tapped with additional surplus (%)	As % of maximum potential as of 2022 (46.15 million tonnes in this case)	J	56.3	75.9	84.5	86.7

[6] NNETAR is the neural network based autoregressive model used for export projections. The figures in parenthesis represent p, d, q parameters in autoregressive models.

To comprehend India's potential in rice exports, an in-depth analysis was conducted. The surplus, assessed on the basis of projected supply and demand, is poised for significant expansion, surging from 26 million tonnes in 2025 to a formidable 40 million tonnes by 2047 (Table 6.2).

A neural network model has been applied using time series data, incorporating lagged values as inputs, to forecast India's prospects in rice exports within a "business as usual" (BAU) scenario, which assumes the continuity of historical trends in food preferences. The anticipated exports portray a gradual increase, culminating at 30.07 million tonnes by the year 2047. Till date, India has harnessed only 55% of the total export potential in rice. However, the yield advancements will generate huge surpluses to abridge most of this potential by 2047.

While India's recent accomplishments in rice exports are commendable, they raise pertinent questions about the sustainability of rice exports, given the emphasis on a "green supply chain" and diversification of rice for alternative uses. This stresses on the need to explore untapped avenues to unlock India's full export potential in this regard.

6.2.2 Wheat

Wheat stands as one of the most significant and extensively cultivated cereal crops across the globe, serving as a fundamental grain in the diets of numerous nations. Moreover, it ranks among the most traded agricultural commodities. Notably, the global wheat market has experienced substantial growth over the past two decades, with global wheat exports witnessing a remarkable surge of 98 million tonnes from 2003, culminating in substantial export of 211.43 million tonnes in 2022.

A notable contributor to this recent expansion in wheat exports is the emergence of the Black Sea countries, comprising Russia, Ukraine, and Kazakhstan, as key players in the global wheat market. The leading wheat-exporting nations worldwide include Australia, Canada, France, Russia, the United States, and Ukraine, collectively responsible for approximately 77% of the total wheat exports (Table 6.3). Although Russia emerged as a significant exporter post-2015, its export volumes have shown a gradual decline since 2020. Conversely, the USA and Australia have maintained a consistent presence in the global market.

India, despite its status as the world's second-largest wheat producer after China, contributing 13.53% to global wheat production, has held less than a 3% share of the global wheat exports in 2022. Historically, India had played a relatively minor role in the global wheat trade until the period of 2020-21, with wheat exports amounting to less than 0.3 million tonnes between 2016 and 2019. However, subsequent years have seen a notable surge in exports.

This upsurge in India's wheat exports can be attributed to the trade opportunity arising from global uncertainties triggered by the Russia-Ukraine conflict, coupled with surplus production, leading to a significant boost in wheat exports during 2021-22. India, facing the unique challenge of vulnerability to climate aberrations, fluctuates between the roles of a net exporter and a net importer in the global wheat market. Continued global population growth stresses on the pressing need to bolster wheat trade to ensure global food security. In response to heightened international demand for wheat due to the Ukraine conflict, India exported record-breaking quantity of wheat in 2022-23.

Table 6.3 Prospects of wheat exports

Million Tonnes

Particular	Details		2025	2030	2035	2047
Supply (BAU)	Sourced from previous section	A	117	131	141	160
Demand (BAU)	Sourced from previous section	B	106	111	115	119
Surplus (Supply-Demand)		C=A-B	11	20	27	42
Exports @ BAU Scenario (Projected with NNETAR (11,5,1))	Computed based on machine learning model	D	1.44	3.27	1.7	4.5
Export potential tapped (%)	Sourced from INTRACEN Trade Potential	E				
Tapping the untapped potential (%)	Assumptions	F	5	10	15	20
Potential targeted (%)	Computed	G	66	71	76	81
Expected level of exports	Base exports+extra potential tapped	H	2.0	4.3	3.3	6.6
Further scope for exports	Computed	I=C-H	9.0	15.7	23.7	35.4
Potential tapped with additional surplus (%)	As % of maximum potential as of 2022 (10.6 million tonnes in this case)	J	103.4	188.0	253.8	394.8

As far as wheat export prospects are considered, the surplus, determined by estimates of demand and supply, is projected to experience modest growth, increasing from 11 million tons in 2025 to 42 million tons in 2047. A neural network model was employed, utilizing time series data with lagged values as inputs, to project India's wheat export possibilities while accounting for a business-as-usual (BAU) scenario. The anticipated exports, however, suggest fluctuations over time, with estimates indicating a gradual rise in India's wheat exports from 3.27 million tons in 2030 to 4.5 million tons in 2047.

It is established that India has tapped approximately 60% of its potential in wheat exports. Given India's historical position as a relatively intermittent participant in the global wheat export market, the extent of its wheat export potential remains largely underestimated. Moreover, the potential for wheat exports from India is expected to experience a notable upsurge in conjunction with the steady escalation in wheat surpluses within the country. To fully leverage its competitive advantage, India must actively explore untapped avenues to maximize its potential in the global wheat export market.

6.2.3 Dairy

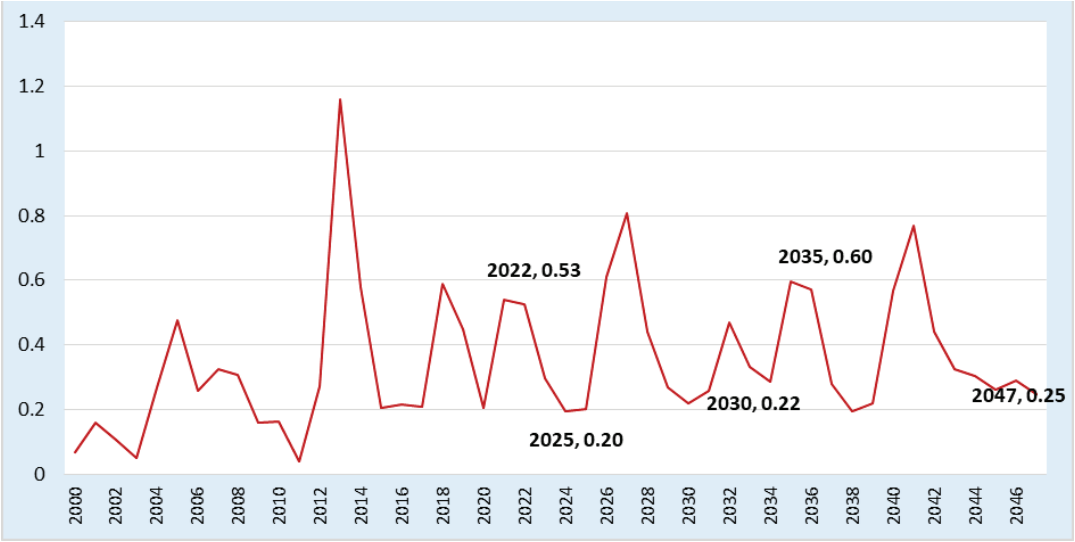
The global dairy export market is highly concentrated. Germany remains the largest exporter of dairy products with a share of 15%, which is followed by France, New Zealand, the Netherlands, Belgium, USA and Denmark. Notably, Germany also holds the position of the world's primary dairy importer, commanding a significant 10% share. India has traditionally focused on exporting skim milk powder, along with butter and fats. However, there has been a recent surge in the export of cheese, indicating a diversification in India's dairy export portfolio.

Despite being the largest producer of milk globally, India's contribution to the skim milk powder market remains minimal, indicating a gap in the country's processing capabilities. The RCA values for skim milk powder have consistently remained below one between 2003 and 2022, highlighting India's lack of competitiveness in this sector. While India maintains a surplus, it has challenges in establishing a strong global competitive position.

The share of butter and fats in exports presents a consistent expansion over the years, covering a major share in 2022 dairy exports. However, the RCA values for butter and fats have consistently remained below one, indicating a lack of comparative advantage for India in this segment.

The dairy exports are highly volatile. The projections indicate that the dairy exports would be less than one million tonne in terms of milk equivalent (Figure 6.1). Expanding into developing economies, comprehending indigenous preferences, and forging global partnerships have the potential to enhance market penetration. Increasing exportable surplus through enhanced breeding and feeding programs is pivotal in maximizing foreign exchange earnings from the dairy sector. Nevertheless, the Indian dairy industry faces constraints such as limited milk processing capabilities, elevated transportation costs, and stringent food safety regulations, which require immediate attention for sustainable growth.

Figure 6.1 Dairy Products, milk equivalent (Million Tonnes)



Note: The projections are based on NNETAR (9,5,1)

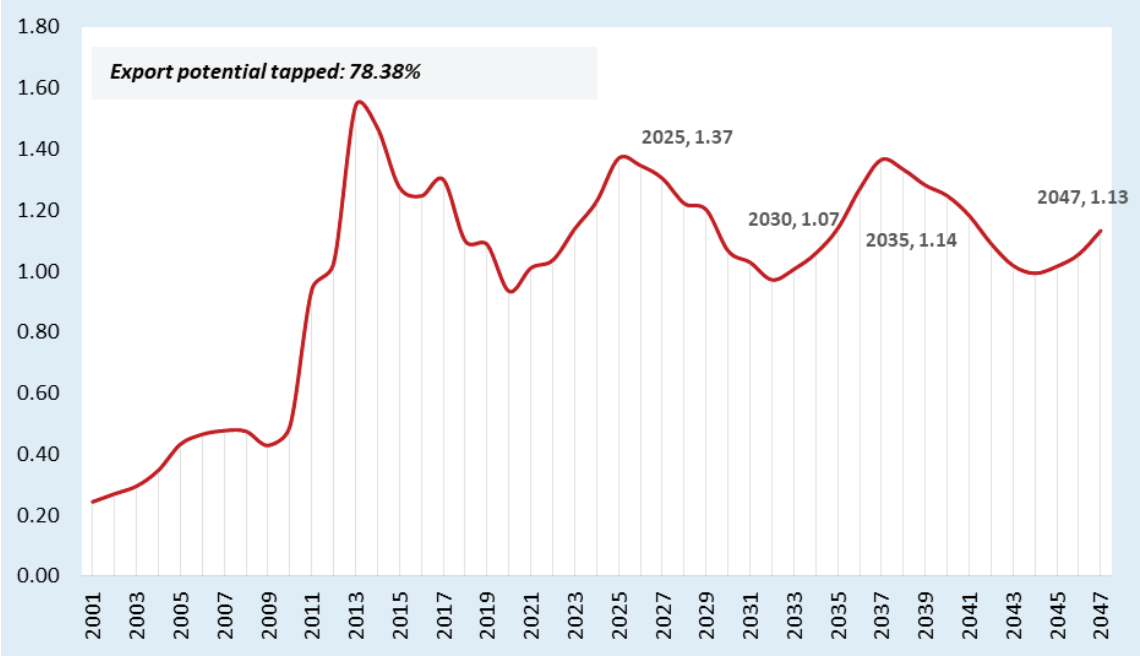
6.2.4 Bovine Meat

India's vibrant livestock sector, buoyed by continual economic growth and a rise in domestic income levels, has propelled the demand for livestock products to unprecedented heights, underlining the country's rich diversity in this domain. This surge in demand has catalyzed a remarkable expansion in livestock production over the last two decades, particularly geared towards meeting the requirements of the global export market. Notably, India has established its position as the largest exporter of buffalo meat globally, signifying its robust competitive advantage in this sector.

India's RCA in the exports of bovine meat on the global stage is quite distinct. In 2000, the world's top five beef exporters were Australia, the United States, the European Union, Canada, and Brazil. However, the landscape has evolved over time, with India progressively overtaking and securing a leading position, alongside Australia, Brazil, and the United States, within the top five exporters. The international market for Indian bovine meat experienced a substantial upswing in exports from 2003 to 2012. However, this growth trajectory was interrupted in 2012, after which they began to decline. The momentum further gained in 2020 indicating an upsurge.

In 2022, global bovine meat production was projected to reach 73.9 million tonnes, with India contributing 1.04 million tonnes. The projections follow the historical cyclical pattern and do not indicate an appreciable increase (Figure 6.2), which may be quite consistent with the domestically induced demand for livestock products.

Figure 6.2 Prospects of bovine meat exports (million tonnes)



Note: The projections are based on NNETAR (5,3,1)

Till date, the country has been able to harness approximately 80% of export potential in this category, which is quite encouraging as compared to other exportable commodities. Sustaining exports in this category would require adherence to improved food safety measures, effective disease management, and more resilient supply chains.

6.2.5 Eggs

Eggs and egg-based products have gained widespread popularity worldwide due to their nutritional value and adaptability. Notably, the top five fresh egg exporters are the Netherlands, Poland, Turkey, Mainland China, and Germany, collectively accounting for 58.6% of the total fresh egg export in 2022. The poultry sector stands as one of India's most promising segments. India's egg production has risen from 78.48 billion in 2014-15 to 129.60 billion in 2021-22.This growth has propelled India to become the world's third-largest egg producer, after China and the USA. Among the poultry products exported from India, whole eggs in their shell occupied a central position, followed by liquid and dried egg products.

India's involvement in global poultry trade has historically been quite limited. In 2003, when worldwide poultry meat exports reached approximately 10 million tonnes, India's poultry exports amounted to just 6.9 thousand tonnes, representing a mere 0.07% of the total global exports. There was sharp decline in the RCA after 2004 signifying the diminishing competitiveness of eggs in the international market.

The mapping of trade balance and comparative advantages exhibits the transition from the first quadrant to the second quadrant. In this quadrant, positive RSCA values indicate a comparative advantage in the global market, but negative TBI values signify a reduction in exportable surplus over time. A holistic approach to improving egg production is crucial to fully harness India's potential in this sector. A concerted effort, leveraging innovation, technology, and strategic policies, is the key to unlocking India's untapped potential in this promising and dynamic sector.

6.2.6 Fish and Crustaceans

India's crustacean sector, particularly its shrimp and prawn exports, has established itself globally leveraging its natural resources and a robust aquaculture industry to meet the international demand. India has made significant strides in crustacean exports, experiencing a remarkable 20% surge in 2022. Frozen shrimp continue to dominate exports, while dried fish items also demonstrating substantial growth. The country now exports seafood to more than 130 countries. Our sustained partners in crustaceans include the USA, China, Japan, the European Union, Southeast Asia, and the Middle East. Indian seafood exports to the United States have witnessed a surge in recent years, capturing a share of approximately 30%.

India's competitive edge in global crustacean exports remains robust, as evidenced by consistently high RCA values surpassing one. Though affected by the disruptions caused by the Covid-19 pandemic, the trajectory has shown resilience, promising a positive outlook in the long run.

Quality issues in India's fish exports have been a concern. Inconsistencies at various stages of the value chains have led to the concerns about the overall quality and safety of the exported fish products. Salmonella remains one of the biggest reasons for export rejection in crustacenas. The presence of veterinary drug residues is found the main cause for the rejection of export consignments of shrimp and prawns. Veterinary drugs are typically used for the treatment and prevention of parasitic and microbial diseases in fishery and aquaculture. Misuse or overuse of these drugs can result in high levels of residues in fishery products, leading to export rejections.

HIGHLIGHTS

- India's prominence in the global market is steadily gaining momentum, as evident from its growing presence in exporting specialized products like Basmati rice, non-Basmati rice, spices, and shrimps. The prevailing scenario stresses the importance of creating an ecosystem that focuses on "market intelligence" tailored for specific sectors and commodities. It is imperative to meticulously evaluate the competitiveness, market dynamics and potential destinations, logistics, and traceability of value chains and supply chains tailored to individual commodities. A meticulous evaluation of competitiveness, market dynamics, potential target destinations, as well as the intricacies of logistics and the traceability of value chains and supply chains for export-oriented commodities, is of paramount importance.
- Rice and wheat emerge as commodities with long-term export potential. These commodities are crucial from food security angle and require strategic handling to fully exploit their export capabilities, given the expected generation of significant export surpluses due to evolving demand patterns and advancements in technology and skills.
- Nutri-cereals, maize, and pulses fall into the category of importable commodities driven by a growing preference for healthier and more nourishing dietary choices. Fruits and vegetables, driven by increasing demand, also fall under importable hypothesis. Dairy products exhibit surplus in the business-as-usual scenario. Sugar and its derivatives emerge as commodities with long-term export potential.
- While India's recent accomplishments in rice exports are commendable, they raise pertinent questions about the sustainability of rice exports, given the emphasis on a "green supply chain" and diversification of rice for alternative uses. The mounting virtual water exports triggered by rice exports underscore the pressing need to devise "regional crop plans" that can unlock India's full export potential in rice.
- Food safety issues are critical in sustaining exports. The rejection rates for agricultural commodities and processed food exports from India to both the USA and European Union (EU) countries, which are our major partners, have displayed an upward trajectory. The major factors leading to the rejection of export consignments include pesticide residues, microbial contaminations, heavy metals, the use of unsafe colors or additives, inappropriate labeling or misbranding, filth, insanitary conditions or controls, and more. Pesticide residues have emerged as a significant factor leading to the rejection of exported shipments comprising rice, seed spices, vegetables, fruits, oilseeds, herbs, etc in both the US and EU markets. The presence of veterinary drug residues has been identified as the primary cause for the rejection of shrimp and prawn exports. Salmonella continues to be a significant contributor to export rejections.
- Sensitization and capacity building at different stages of the value chain would sustain the export trajectory. Research and development institutions can play a vital role in strengthening the capabilities of value chain participants. Concurrently, trade facilitating organizations such as APEDA and EIC must proactively address these quality concerns, ensuring strict compliance with sanitary and phyto-sanitary standards.

Chapter 7

Input Demand Projections

This chapter assesses the future demand for inputs including fertilizers, pesticides, seeds and credit. The projection methods include combination of the univariate time series models (based on exponential growth curves where input demand is modeled as a function of its own lagged values), and the regression-based approach (where input demand is modeled as a function of underlying explanatory variables).

7.1 Fertilizers

Fertilizer demand projections are made for 2025-26, 2030-31, 2035-36 and 2047-48 using the coefficients from Equation (1) given in the Appendix 7.1. Based on the following assumptions four scenarios have been developed:

1. All drivers of fertilizer use (i.e., irrigated area, output prices and fertilizer prices) are assumed to grow at their historical growth rates (2001-02 to 2018-19) (Business as usual scenario).
2. Irrigated area is assumed to grow 10% higher than its historical growth rate (i.e., 1.1*historical growth) and all other variables to grow as usual (Scenario 1).
3. Prices of food articles and fertilizer are assumed to grow 10% higher than their historical growth rate, and all other variables to grow as usual (Scenario 2).
4. All the drivers of fertilizer consumption grow 10% higher than their historical growth rate (Scenario 3).

The Government of India has been implementing several programmes to reduce excessive use of fertilizers. Hence, in addition to the above scenarios, we also look for the likely effect of such programmes on the reduction in fertilizer consumption, and consequently in fertilizer demand.

The estimates of the projected demand are given in Table 7.1.

In the BAU scenario, the fertilizer demand is estimated to increase to 386 lakh tonnes in 2030-31, and further to 604 lakh tonnes in 2047-48. Their per hectare consumption is projected to increase to 188 kg by 2030-31 and to 283 kg in 2047-48.

When the irrigated area increases 10% higher than its historical growth, fertilizer demand increases marginally to 393 lakh tonnes in 2030-31 and 629 lakh in 2047-48. So does their per hectare consumption, 191 kg in 2030-31 and 295 kg in 2047-48. This is because the expansion of irrigation leads to an increase in the cropping intensity, hence more use of fertilizers.

In the scenario when the prices of output and fertilizers are assumed to grow 10% higher than the historical growth rates, the fertilizer demand will be slightly more than that in the BAU scenario. So is their per hectare consumption. This is because an increase in food prices induces more consumption of fertilizers, while an increase in fertilizer prices has an opposite effect.

Further on the assumption that irrigated area, output prices, and fertilizer prices experience a 10% higher growth over their historical growth rates, the estimated fertilizer demand is more than in any other scenario; 396 million tonnes in 2030-31 and 640 million tonnes in 2047-48. Their per hectare consumption is projected to be 193 kg in 2030-31 and 300 kg in 2047-48. This is because while expansion of irrigated area and increase in food prices work in the same direction and reinforce each other, the increase in fertilizer prices has an opposite effect.

Table 7.1: Projected demand for fertilizers

Baseline Scenario (all variables increase at historical growth rates)								
year	Fertilizer demand (Lakh tonnes)				Fertilizer use (kg/ha)			
	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption
2019-20	289				148.4			
2025-26	339	328	323	313	166.8	161.7	159.2	154.3
2030-31	386	365	354	334	188.1	177.6	172.6	162.9
2035-36	440	405	389	357	212.0	195.1	187.1	172.0
2040-41	502	450	426	382	239.0	214.2	202.8	181.6
2047-48	604	522	485	419	282.6	244.3	227.0	196.0
Scenario 1: Irrigation increases at 10% higher growth rate than baseline								
year	Total Fert Cons (Lakh tons)				Fert cons per ha (kg/ha)			
	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption
2019-20	289				148.4			
2025-26	342	331	325	315	168.5	163.1	160.4	155.2
2030-31	393	370	359	338	191.3	180.1	174.8	164.4
2035-36	451	413	395	362	217.2	199.0	190.4	174.3
2040-41	518	462	436	388	246.6	219.8	207.4	184.7
2047-48	629	540	500	428	294.6	252.6	233.9	200.4

Scenario 2: Input and Output prices increase at 10% higher growth rate than baseline								
year	Total Fert Cons (Lakh tons)				Fert cons per ha (kg/ha)			
	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption
2019-20	289				148.4			
2025-26	340	329	324	314	167.5	162.3	159.7	154.6
2030-31	389	367	356	336	189.4	178.6	173.5	163.5
2035-36	445	408	391	359	214.1	196.6	188.4	172.9
2040-41	509	455	430	384	242.0	216.5	204.7	182.9
2047-48	614	529	491	422	287.4	247.6	229.8	197.8
Scenario 3: Irrigation and Prices increase at 10% higher growth rate than baseline								
year	Total Fert Cons (Lakh tons)				Fert cons per ha (kg/ha)			
	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption	No effect of fertilizer reduction programs	20% lower growth infertilizer consumption	30% lower growth in fertilizer consumption	50% lower growth in fertilizer consumption
2019-20	289				148.4			
2025-26	343	332	326	316	169.2	163.6	160.9	155.5
2030-31	396	372	361	339	192.7	181.2	175.6	165.1
2035-36	456	417	398	364	219.4	200.6	191.8	175.2
2040-41	525	467	440	391	249.8	222.1	209.4	186.0
2047-48	640	547	506	432	299.6	256.1	236.8	202.1

The projected demand for fertilizers may change depending on the availability of their substitutes, improvements in nutrient-use efficiency, and government policies and incentives. Nitrogenous fertilizers play a key role in enhancing crop yields, but their excessive use leads to atmospheric pollution, and N2O emission causing global warming. It also causes nitrate pollution in the groundwater and marine ecosystems through runoff. Nitrogen cycle management is, thus, an essential for sustainability of agriculture. To reduce the excessive use of agrochemicals, there is a gradual shift in the policy to reduce fertilizer consumption and improve the nutrient-use efficiency through several nutrient management programmmes as listed in Appendix 7.2.Given these programmes,

including the reduction of subsidies and consequent rise in fertilizer prices, we develop three plausible future scenarios for fertilizer demand with a 20%, 30% and 50% lower growth of their consumption from their historical rates. The fertilizer demands for these scenarios are given in Table 7.1.

• 20 % lower growth in fertilizer consumption

With a 20% lower growth in their consumption, the fertilizer demand is projected at 365 lakh tonnes in 2030-31, and 522 lakh tonnes in 2047-48 in the BAU scenario. The per hectare consumption is estimated at 178 kg, gradually increasing to 244 kg in 2047-48.

If the irrigated area expands at 10% higher growth, then the fertilizer demand increases marginally to 370 lakh tonnes in 2030-31 and 540 lakh tonnes in 2047-48. Accordingly, their per hectare consumption will increase to 180 kg and 253 kg, respectively.

In case, the prices of output and fertilizer increase 10% higher than their historical growth rates, the demand for fertilizers would decline marginally to 367 lakh tonnes in 2030-31 and 529 lakh tonnes in 2047-48, and their per hectare consumption to 179 kg in 2030-31 and 248 kg in 2047-48.

If the irrigated area, food prices and fertilizer prices grow 10% higher than their historical growth, the fertilizer demand is expected to be 372 lakh tonnes in 2030-31 and 547 lakh tonnes in 2047-48; and their per hectare consumption will be 181 kg and 256 kg, respectively.

• 30 % lower growth in fertilizer consumption

In the BAU scenario, further reduction in the growth of fertilizer consumption by 30%, their fertilizer demand declines to 354 lakh tonnes in 2030-31, and gradually to 485 lakh tons in 2047-48. Their per hectare consumption will be 173 kg in 2030-31 and 227 kg in 2047-48.

If the irrigated area were to expand at a 10% higher growth over its historical growth rate, the demand for fertilizers will be slightly more; 359 lakh tonnes in 2030-31 and further to 500 lakh tonnes in 2047-48, and their per hectare consumption will be 175 kg and 234 kg respectively.

When the prices of output and of fertilizers increase at a 10% higher growth over their historical growth rates, fertilizer demand is projected to be slightly less; 356 lakh tonnes in 2030-31 and 491 lakh tons in 2047-48. The per hectare consumption will be 174 kg and 230 kg respectively in 2030-31 and 2047-48.

If the irrigated area, food prices and fertilizer prices were to grow at a rate 10% higher than their historical growth, 361 lakh tonnes of fertilizers will be required in 2030-31 and 506 lakh tonnes in 2047-48. Their corresponding per hectare usage will be 176 kg and 237 kg respectively.

• 50 % lower growth in fertilizer consumption

If the government programmes are more effective in reducing the growth in fertilizer consumption say by 50%, the demand for fertilizers is projected to be 334 and 419 lakh tonnes in 2030-31 and 2047-48 respectively. Their per hectare consumption will be 163 kg in 2030-31 and 196 kg in 2047-48.

If the irrigated area were to increase at a growth 10% higher than its historical trend, the country will require 338 lakh tonnes of fertilizers in 2030-31 and 428 lakh tonnes in 2047-48, their per hectare consumption will be 164 kg in 2030-31 and 200 kg in 2047-48.

In case the prices of output and fertilizers were to increase at a rate 10% higher over their historical rates, the projected demand for fertilizers will be 336 lakh tonnes in 2030-31 and 422 lakh tonnes in 2047-48.

If all the drivers of fertilizer consumption increase at a rate 10% higher over their historical growth rates, the demand for fertilizers will be 339 lakh tonnes in 2030-31 and 432 lakh tonnes in 2047-48.

7.2 Pesticides

The pesticide demand is projected using the coefficients from Equation (2) given in the Appendix 7.1. In the BAU scenario, the demand for pesticides is projected to increase be 79233 tonnes by 2030-31 and 118405 tonnes by 2047-48 (Table 7.2). Accordingly, their per hectare consumption will be 0.39 kg in 2030-31 and 0.55 kg in 2047-48.

Table 7.2 Projected demand of pesticides

Year	Total pesticide use (tonnes)		Pesticide use (kg/ha)	
	Business as usual	Cotton area declines at 10% from its historical trend	Business as usual	Cotton area declines at 10% from its historical trend
2019-20	61097	-	0.31	-
2025-26	70403	64156	0.35	0.32
2030-31	79233	68062	0.39	0.33
2035-36	89170	72205	0.43	0.35
2040-41	100353	76601	0.48	0.36
2047-48	118405	83209	0.55	0.39

However, if the growth in area under cotton, the main user of pesticides, declines by 10% over its historical growth rate, the total consumption of pesticides will fall significantly to 68062 tonnes in 2030-31, and further to 83209 tonnes in 2047-48. Accordingly, there will be a decline their per hectare consumption.

7.3 Seed

Seed demand is projected for each crop using the following formulae:

$$Certified\ seed\ (CS) = \text{Area} \times \text{SRR} \times \text{SR}$$

$$Foundation\ seed\ (FS) = \frac{\text{Area} \times \text{SRR} \times \text{SR}}{\text{SMR}}$$

$$Breeder\ seed\ (BS) = \frac{\text{Area} \times \text{SRR} \times \text{SR}}{(\text{SMR} \times \text{SMR})}$$

Where,

Area = area under the crop; SRR = seed replacement rate; SR = seed rate and SMR = seed multiplication rate

Projections of seed demand for crops are presented in Appendix 7.3a to 7.3e for two scenarios: the current SRR projected into future, and 100% SRR. Table 7.3. summaries the total seed demand. In case of projected SRR, the demand for certified seeds in 2030-31 is expected to be 34068 thousand quintals, which will increase to 49701 thousand quintals in 2047-48. The quantity of foundation seed required is estimated at 1030 thousand quintals in 2030-31, and 1531 thousand quintals in 2047-48.The breeder seed requirement is estimated at 37649 quintals in 2030-31, which will increase to 55483 quintals by 2047-48.

Table 7.3: Seed demand to 2047-48

000' quintals

	Projected SRR			100% SRR		
	Certified	Foundation	Breeder	Certified	Foundation	Breeder
2025-26	30710	925	34	75652	2403	93
2030-31	34068	1030	38	78571	2509	98
2035-36	37863	1151	42	81922	2628	103
2040-41	42213	1291	47	85795	2762	108
2047-48	49701	1531	55	92335	2981	118

With 100% SRR, the seed demand is much larger. The demand for certified seed in 2030-31 at 78571 thousand quintals which will gradually increase to 92335 thousand quintals by 2047-48.The foundation seed requirement will increase to 2509 thousand quintals in 2030-31 and 2981 thousand quintals in 2047-48.The breeder seed demand is projected to be 93 thousand quintals in 2030-31 and 118 thousand quintals in 2047-48.

7.4 Credit

Demand for credit is projected based on its historical growth during 2001-02 to 2019-20. Since, the purpose and drivers of the short-term and long-term credit are different, a regression-based approach may not be appropriate to project their future demand.

Credit demand has been estimated on two assumptions. One, the continuance of the past trend in the future as well. Two, the credit requirements moderate over the next two decades, which is a more realistic assumption given the declining contribution of agriculture to gross domestic product. On the assumption of the continuance of historical trend in credit supply, the total demand for credit (short term plus long term) is estimated at Rs 7022555 crores in 2030-31 and Rs 159936347 crores in 2047-48 (Table 7.4). The demand for short-term credit is projected at Rs 1981457 crores in 2030-31 and to Rs 8228215 crores in 2047-48. The demand for long-term credit is likely to be Rs 5041098 crores in 2030-31 and to Rs 151708132 crores in 2047-48.

These estimates appear too steep after 2040-41 to be realistic. Thus, it is assumed that the growth in credit demand to moderate to 70% of its historical growth between 2030-31 and 2040-41, and later to 50%. Accordingly, the total credit demand (short term plus long term) is estimated at Rs 4260769 crores in 2030-31 and Rs 13151319 crores in 2047-48 (Table 7.4). For 2030-31, the short-term credit demand is projected at Rs 1530225 crores in 2030-31 and to Rs 2593467 crores in 2047-48. The long-term credit demand is estimated at Rs 2730544 crores in 2030-31 and Rs 10557852 crores in 2047-48.

Table 7.4: Credit demand to 2047

Rs crores

Year	At historical rate of growth			At moderating rate of growth		
	Short-term	Long-term	Total	Short-term	Long-term	Total
2019-20	825151	567579	1392730	825151	567579	1392730
2025-26	1325573	1861869	3187442	1325573	1861869	3187442
2030-31	1981457	5041098	7022555	1530225	2730544	4260769
2035-36	2982932	13692362	16675294	2036979	5600437	7637416
2040-41	4525612	37265324	41790936	1937284	5065978	7003262
2047-48	8228215	151708132	159936347	2593467	10557852	13151319

HIGHLIGHTS

- In the scenario of 10% acceleration in the drivers of growth in fertilizer consumption ((i.e., irrigated area, fertilizer price, and output price)), the demand for fertilizers is expected to increase to 396 lakh tonnes by 2030-31 and 640 lakh tonnes by 2047-48. The corresponding increase in their per hectare consumption will increase from 193 kg by 2030-31 and to 300 kg in 2047-48.
- In the scenario of 50% deceleration in the growth of fertilizer consumption on accout of several schemes (i.e., Soil Health Card, micro-irrigation including fertigation, Neem coated urea, natural farming, biofertilizer, etc.) and 10% acceleration in the growth in its drivers, the demand for fertilizers is projected to be less; 339 lakh tonnes in 2030, and 432 lakh tonnes in 2047-48. Accordingly, their per hectare consumption is expected to be 165 kg in 2030-31 and 202 kg in 2047-48.
- In the BAU scenario, the demand for pesticides is projected to increase to 79,233 tonnes in 2030-31 and to 1,18,405 tonnes in 2047-48. The per hectare consumption is estimated at 0.39 kg in 2030-31 and 0.55 kg in 2047-48. On the assumption of a decline of 10% in the growth in cotton area (largest consumer of pesticides), the demand for pesticides will be less; 68,062 tonnes in 2030-31 and 83,209 tonnes in 2047-48. Accordingly, their per hectare consumption is projected at 0.33 kg in 2030-31 and 0.39 kg in 2047-48.
- Given the projected seed replacement rates (SRR) for different crops, the demand for certified seeds is estimated at 34,068 thousand quintals in 2030-31 and at 49,701 thousand quintals in 2047-48. The corresponding requirement for foundation seeds will be 1030 and 1531 thousand quintals, and for breeder seeds 37,649 quintals and 55,483 quintals in 2030-31 and 2047-48, respectively.
- By 2030, if the SRR reaches 100%, then the demand for certified seeds will increase to 78,571 thousand quintals, and further to 92,335 thousand quintals in 2047-48. Accordingly, the foundation seed requirement is projected at 2509 thousand quintals in 2030-31 and 2981 thousand quintals in 2047-48, and the breeder seed requirement at 97,589 quintals and 1,17,669 quintals.
- With moderate growth in credit supply, the total credit (short-term and long-term) requirement in agriculture is estimated at Rs 42,60,769 crores in 2030-31 and Rs 1,31,51,319 crores in 2047.

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Appendix

Appendix 2.1 Classification of products based on value addition

Category	Food items
Primary products	Eggs, Potato, Onion, Radish, Carrot, Pumpkin and Guard, Parwal, Cauliflower, Cabbage, Brinjal, Bhindi, Palak, Beans, Tamato, Peas, Green chilli, Lemon, Other vegetables, Banana, Jackfruit, Watermelon, Pineapple, Guava, Sighara, Orange, Papaya, Mango, Kharbooz, Pears, Berries, Leechi, Apple, Grapes, Other fruits, Garlic, Ginger
First-processed low value-added	Rice, Chira, Khoi, Muri, Other rice products, Wheat,Suji, Sewai, Other wheat products, Jowar and products, Bajra and products, Maize and products, Barley and products, Millets and products, Ragi and products, Other cereal, Cereal substitutes, Arhar, Gramdal, Gramwhole products, Moong, Masur, Urd Peasdal, Khesari, Other pulses, Gram products, Besan, Dry coconut, Groundnut, Dates, Cashew, Walnut, Other nuts, Kishmish, Other dry fruits, Salt, Turnmeric, Blackpepper, Drychilly, Tamarind, Other spices
First-processed high value-added	Milk, Curd, Butter, Mustard oil, Groundnut oil, Coconut oil,Fish Prawn, Goat meat, Beef, Pork, Chicken, Other birds,Sugar products, Gur, Honey, Tealeaf, Coffee powder
Second-processed products	Refined oilVanaspati oil, Bread, Baby food, Condense milk, Ghee, Ice-cream, Candy,Curry powder, Cold beverages, Juice, Other beverages, Prepared sweet, Cake, Biscuits, Papad, Bhujia, Chips, Pickle, Sauce, Jam, Other processed products, Snacks, Cooked meals

Appendix 2.2 Divergence between the NSS and NAS estimates of consumption expenditure and food share

	Consumption Expenditure (Rs/ capita/month)		Food Share (%)	
	NSS	NAS	NSS	NAS
1972-73 (1970-71 base)	49	52	71	67
1977-78 (1970-71 base)	74	83	65	63
1983-84 (1980-81 base)	126	168	64	59
1987-88 (1980-81 base)	184	237	61	55
1993-94 (1993-94 base)	332	537	63	55
1999-00 (1999-00 base)	596	1047	57	51
2004-05 (2004-05 base)	713*	1474	52*	40
2009-10 (2004-05 base)	1466#	2651	49#	37
2011-12 (2004-05 base)	1933#	3530	47#	36
2019-20 (2011-12 base)	-	5164	-	31

* based on Uniform Reference Period (URP); # based on Modified Mixed Reference Period (MMRP)
Data source: Estimated using the data from the Report of the Committee on Private Final Consumption Expenditure, Central Statistics Office, MoSPI, GoI, 2015

Appendix 4.1 Age and gender wise recommended dietary allowance (RDA) for a balanced diet

Grams/capita/day

Food group	Infants 6-12 months	1-3 years	4-6 years	7-9 years	10-12 years		13-15years		16-18 years		Adult Sedentary		Adult Moderate		Elderly (>60 years)	
					Girl	Boy	Girl	Boy	Girl	Boy	Woman	Man	Woman	Man	Woman	Man
Cereals	25	100	160	200	250	290	315	390	330	450	200	270	280	390	140	180
Pulses	12	50	60	65	85	95	105	130	110	150	65	90	95	130	70	80
Milk	597	361	361	412	412	412	412	412	412	412	309	309	309	309	412	412
Roots & tubers	20	50	50	100	100	100	100	100	100	100	100	100	100	100	100	100
Green leafy vegetables	20	50	50	100	100	100	100	100	100	100	100	100	100	100	100	100
Other vegetables	25	100	100	150	200	200	200	200	200	200	200	200	200	200	200	200
Fruits	50	50	75	100	100	100	100	100	150	150	100	100	100	100	150	150
Fat	10	20	20	25	30	30	35	45	30	55	30	25	30	25	15	20

*For non-vegetarian persons, 30 grams of pulses may be substituted with 70 grams of meat.20-30 % of the total cereals intake shall comprise of millets.
Source :ICMR-NIN, 2023. Nutrients Requirements for Indians, ICMR-National institute of Nutrition, Hyderabad.

Appendix 4.2 Age and gender wise distribution of the population in India

Per cent

Population	Infants 6-12 months	1-3 years	4-6 years	7-9 years	10-12 years		13-15 years		16-18 Years		Adult (19-59)		Elderly (>60 years)	
					Girl	Boy	Girl	Boy	Girl	Boy	Woman	Man	Woman	Man
2011	4.7	4.7	5.8	5.2	2.6	2.9	2.6	2.9	4.7	5.3	24.6	25.7	4.5	4.4
2021	4.2	4.2	4.7	4.2	2.1	2.2	2.1	2.2	4.4	4.8	26.9	28.3	5.2	4.9
2026	3.8	3.8	4.5	4.0	1.9	2.1	1.9	2.1	4.0	4.3	27.7	29.0	5.9	5.5
2031	3.4	3.4	4.2	3.6	1.8	2.0	1.8	2.0	3.7	4.1	28.1	29.4	6.8	6.3
2036	3.1	3.1	3.9	3.3	1.7	1.8	1.7	1.8	3.5	3.9	28.1	29.6	7.9	7.1
2040	2.9	2.9	3.7	3.1	1.6	1.7	1.6	1.7	3.4	3.7	28.1	29.9	8.7	7.8
2047	2.4	2.4	3.3	2.6	1.4	1.5	1.4	1.5	3.1	3.4	28.2	30.3	10.2	9.0

Data source: National Commission on Population (NCP), 2019.
Notes:Age wise projected figures are available only up to 2036 (NCP, 2019).For 2040 and 2047, demographic changes are projected based on changes between 2031 and 2036

Appendix 4.3 Population weighted RDA norms for the balanced diet in India

Grams/capita/day

Year	Cereals & Millets		Pulses*		Milk	Vegetables	Fruits	Fat/ Edible oil
	Sedentary	Moderate	Sedentary	Moderate				
2011	231	281	80	97	364	361	103	27
2019	230	285	79	99	359	366	104	27
2025	228	285	79	99	357	369	105	27
2030	228	285	79	99	356	372	106	27
2035	227	284	79	99	355	374	107	26
2040	226	284	79	99	355	376	108	26
2047	224	283	79	99	354	379	110	26

Notes:*For non-vegetarian persons, 30 grams of pulses may be substituted with 70 grams of meat. 20-30% of cereals intake shall be nutri-cereals.

Appendix 5.1 Crop area, seed rate and seed replacement rate in India

Crop	Seed rate (kg/ha): 2011-12	Area (Million ha)							Seed Replacement Rate (%)						
		2011-12	2019-20	2025-26*	2030-31*	2035-36*	2040-41*	2047-48*	2011-12	2019-20	2025-26#	2030-31#	2035-36#	2040-41#	2047-48#
Foodgrains	-	125	128	128	131	133	133	136	-	-	-	-	-		
Cereals	-	101	100	98	99	99	98	98	-	-	-	-	-		
Rice	71	44	44	44	44	44	44	45	36	38	40	43	47	51	56
Wheat	130	30	31	31	33	34	34	34	33	42	41	45	50	56	64
Nutri-cereals	11	18	14	12	11	9	8	7	42	41	55	58	61	65	70
Maize	24	9	10	10	11	11	12	13	57	68	64	66	68	70	73
Pulses	44	24	28	30	32	33	35	38	25	42	44	48	50	51	54
Oilseeds	66	26	27	28	29	30	31	33	48	44	45	45	46	46	47
Sugarcane	2832	5.0	4.6	5.4	5.2	5.1	5.4	5.3	10	10	10	10	10	10	10

*Projected area based on time series analysis (ARIMA/ANN/CGR)
#Project SRR based on CGR between 2011-12 and 2021-22
Seed rate: State area weighted seed rate based on Cost of Cultivation Surveys, DES

Appendix 5.2 Post-harvest losses in farm operations and marketing in India

% of production

Food item	ICAR-CIPHET (2015)	NABCONS (2022)	2025-26	2030-31	2035-36	2040-41	2047-48
Paddy	5.53	4.77	4.44	3.90	3.36	3.22	3.02
Wheat	4.93	4.17	3.84	3.30	2.76	2.59	2.36
Nutri-cereals	5.61	5.15	4.95	4.61	4.28	4.21	4.11
Maize	4.65	3.89	3.56	3.02	2.48	2.30	2.05
Pulses	7.20	6.13	5.68	4.91	4.15	3.99	3.78
Animal Food	6.60	5.61	5.18	4.48	3.77	3.62	3.39
Eggs	7.19	6.03	5.53	4.70	3.88	3.70	3.45
Meat	4.73	3.99	3.67	3.14	2.61	2.44	2.21
Fish	7.88	6.81	6.35	5.59	4.83	4.70	4.51
Milk	0.92	0.87	0.85	0.81	0.78	0.73	0.67
Vegetables	8.18	7.42	7.10	6.56	6.01	5.93	5.82
Fruits	9.74	8.96	8.62	8.06	7.49	7.42	7.32
Oilseeds	5.65	4.88	4.55	4.00	3.45	3.31	3.12

Projected wastages is based on %age change between 2015 and 2022

Appendix 5.3 Per capita consumption of food at household and away from home in India in 2011-12

Kg/capita/month

Food	Consumption
Foodgrains	11.82
Cereals & Millets	10.96
Rice	5.85
Wheat	4.53
Nutri-cereals	0.47
Maize	0.10
Pulses	0.86
Animal Food	0.62
Eggs	0.13
Meat	0.22
Fish	0.27
Milk	4.76
Vegetables	7.00
Fruits	1.24
Sugar and products	0.83
Edible oil	0.78

Data source: NSS-Household Consumption Expenditure Survey, 2011-12 (type-II Schedule)

Appendix 5.4 Estimated expenditure elasticities of food commodities in India from the available studies

Study	Cereals	Rice	Wheat	Nutri-cereals	Pulses	Milk	Non-veg	Edible oil	Vegetables	Fruits
NITI working group (2018)	-0.10				0.49	0.69	0.69	0.72	0.72	0.72
Kumar and Joshi (2016)		0.03	0.08	-0.15	0.21	0.38	0.65	0.26	0.26	0.37
Kumar et al (2011)	0.19				0.72	1.64		0.77	0.82	
Kumar et al (2011)		0.02	0.08	-0.13	0.22	0.43	0.67	0.30	0.26	0.36
Kumar et al (1998)		0.05	-0.07	-0.16	0.28	0.44	0.79	0.35	0.35	0.42
Kumar, P. (2013)	-0.23	-0.18	-0.21	-0.68	0.39	0.74	1.01	0.74	0.78	1.53
Mittal (2006)	0.17				0.59	1.19	1.30	0.55	0.72	0.72
IFPRI (2012)		-0.21	-0.13		-0.24	0.55	1.17	0.90	0.64	
Srivastava and Sivaramane (2020)	0.37				0.53	0.89	0.96	0.42	0.58	1.25
Srivastava et al (2013)	0.21				0.53	0.95	0.96	0.53	0.44	1.25
Radhakrishna and Ravi (1990)	0.40					1.04	0.84	0.68		
Bhalla et al (1999): for 1993-94	0.26					1.37	0.93			
Bhalla et al (1999): for 1987-88	0.29					1.35	0.97			
Bhalla et al (1999): for 1983-84	0.30					1.14	0.65			
Bhalla et al (1999): for 1972-73	0.38					1.43	0.68			

Appendix 5.5 Range of published expenditure elasticities and their smoothen values for future

Commodity	Published elasticities			Selected	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48
	Min	Max	Average							
Rice	-0.21	0.05	-0.08	-0.08	-0.07	-0.06	-0.05	-0.04	-0.04	-0.03
Wheat	-0.21	0.08	-0.06	0.08	0.07	0.06	0.05	0.04	0.04	0.03
Nutri-cereals	-0.68	-0.13	-0.40	-0.40	-0.37	0.00	0.05	0.10	0.15	0.20
Maize	-0.16	-0.16	-0.16	-0.16	-0.13	-0.11	-0.10	-0.09	-0.08	-0.07
Pulses	-0.24	0.72	0.48	0.48	0.44	0.41	0.39	0.37	0.35	0.33
Non-veg (Eggs, meat, fish)	0.65	1.30	0.98	0.90	0.84	0.79	0.75	0.72	0.69	0.65
Milk	0.79	1.64	1.2	0.79	0.72	0.67	0.63	0.59	0.55	0.51
Vegetables	0.26	0.82	0.54	0.54	0.45	0.41	0.38	0.36	0.33	0.30
Fruits	0.44	1.53	0.98	0.75	0.66	0.60	0.56	0.52	0.48	0.43
Sugar & products	0.2	-	0.20	0.20	0.17	0.08	0.07	0.06	0.06	0.05
Edible oil	0.26	0.90	0.58	0.26	0.22	0.20	0.18	0.17	0.15	0.13

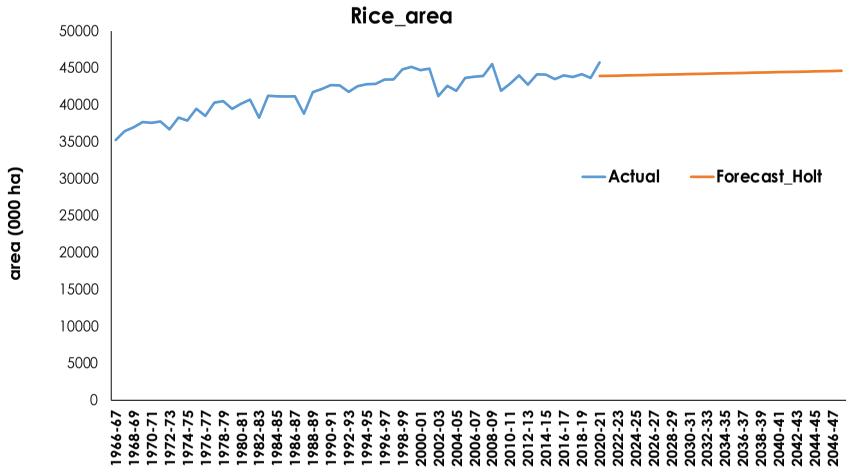
Appendix 5.6 Population estimates used to project food demand

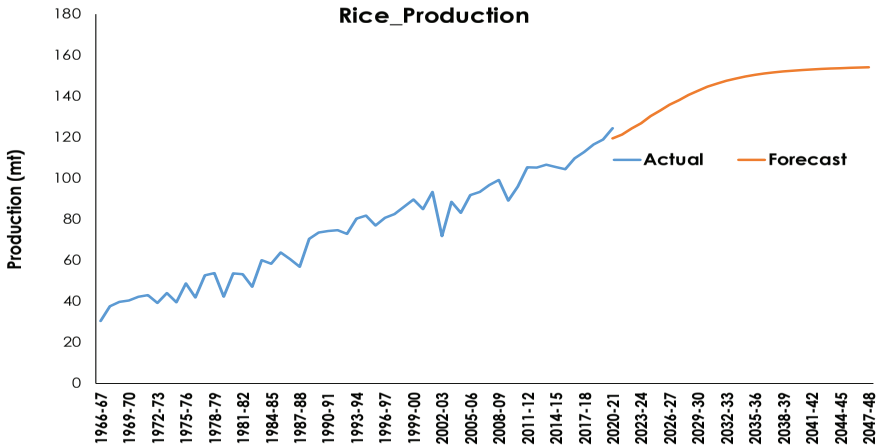
Million

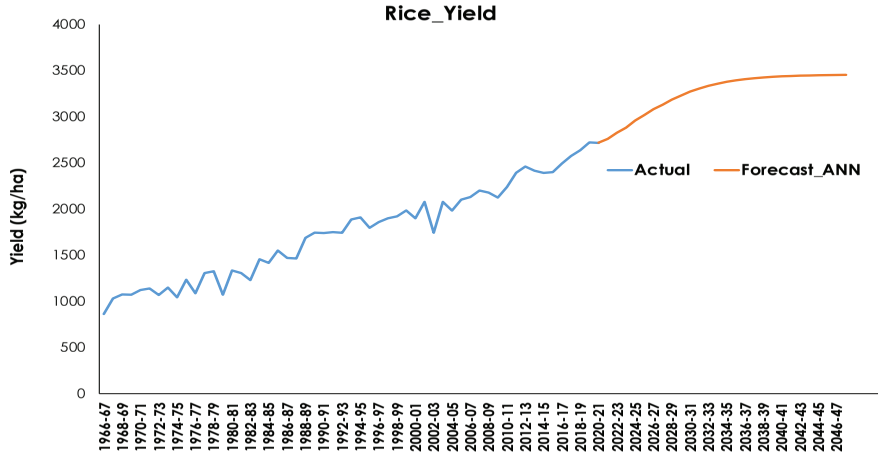
Particular	2011-12 (Base year)	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48
Population	1250	1366	1445	1504	1554	1593	1629

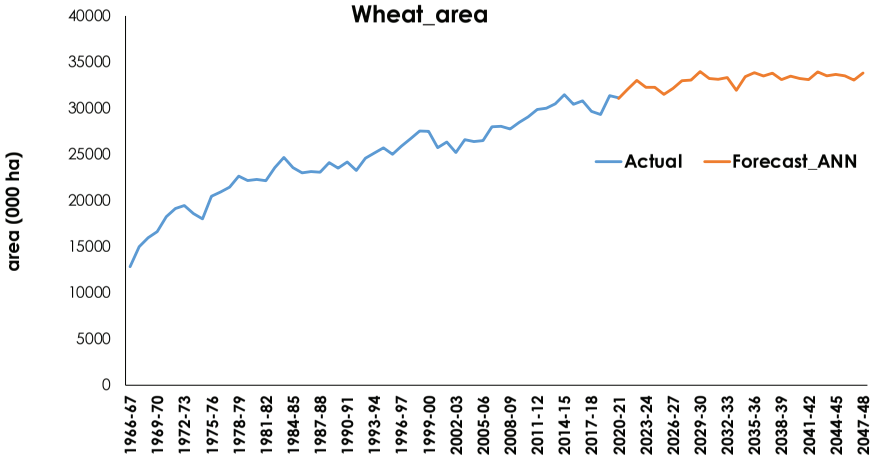
Data source: United Nations (2022)

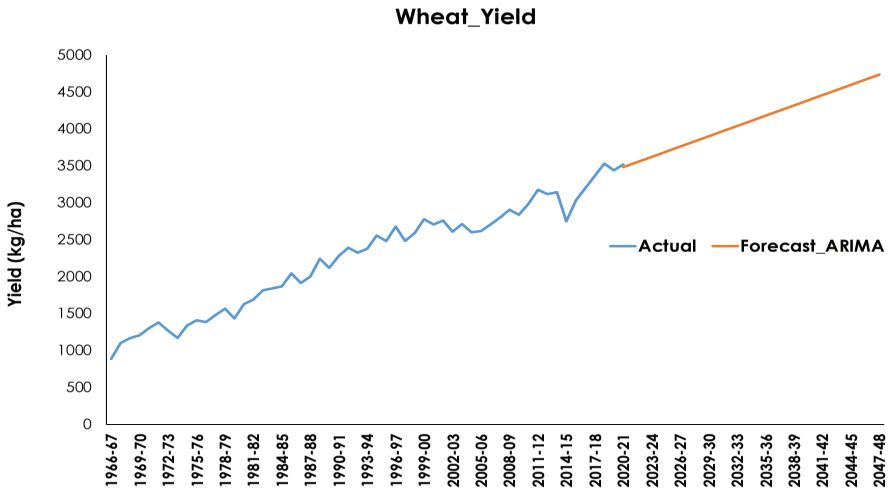
Appendix 5.7 Actual and forecasted values of area, yield and production of food commodities in India

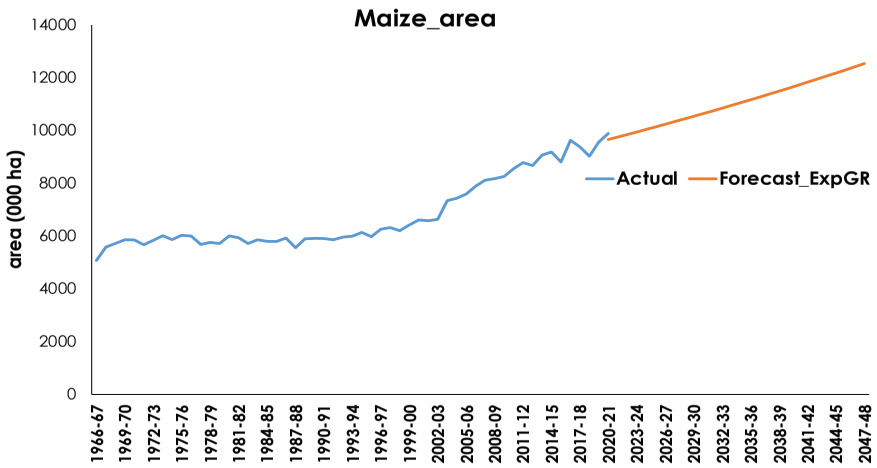


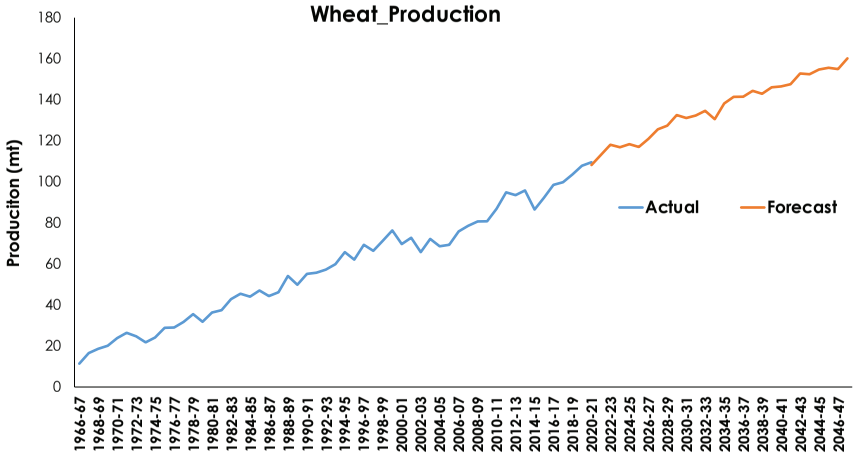


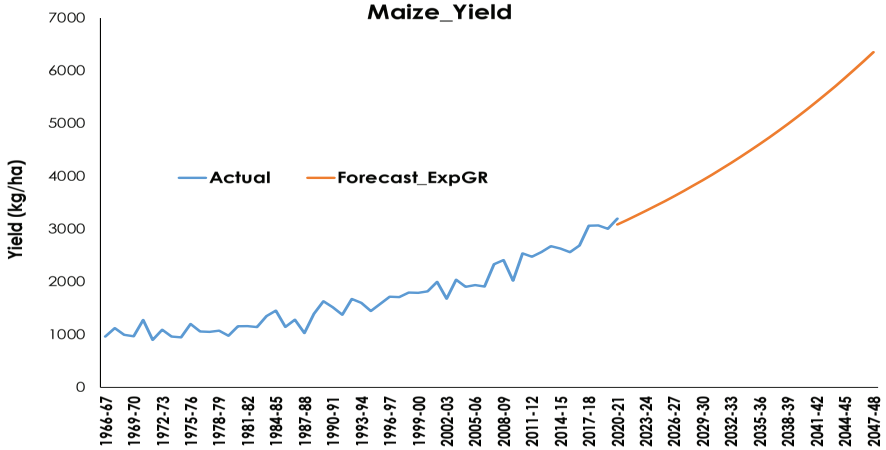


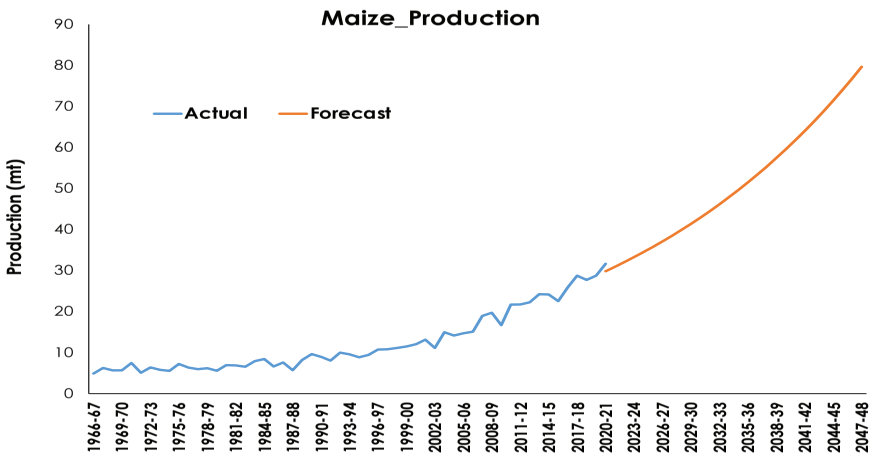


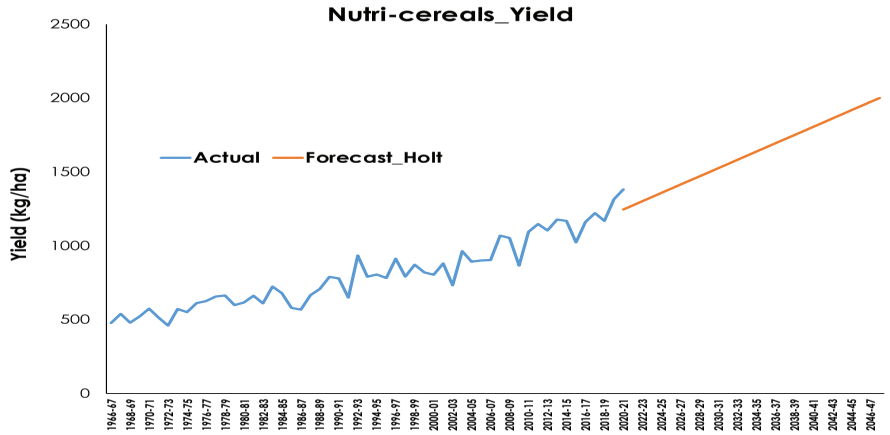

Wheat_Yield
Yield (kg/ha)
Actual
Forecast_ARIMA

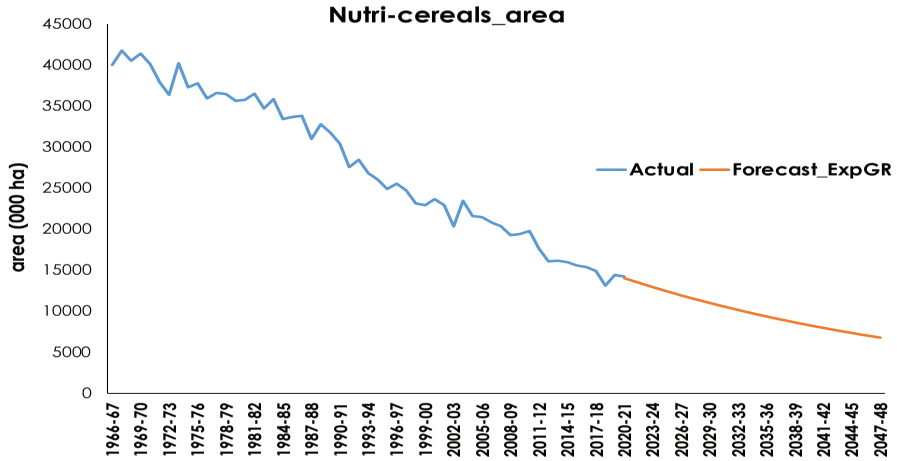

Maize_area
area (000 ha)
Actual
Forecast_ExpGR

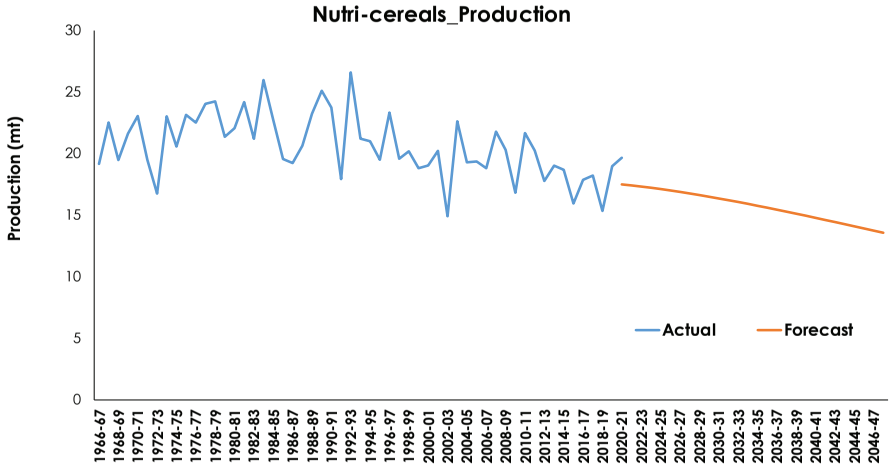

Wheat_Production
Produciton (mt)
Actual
Forecast

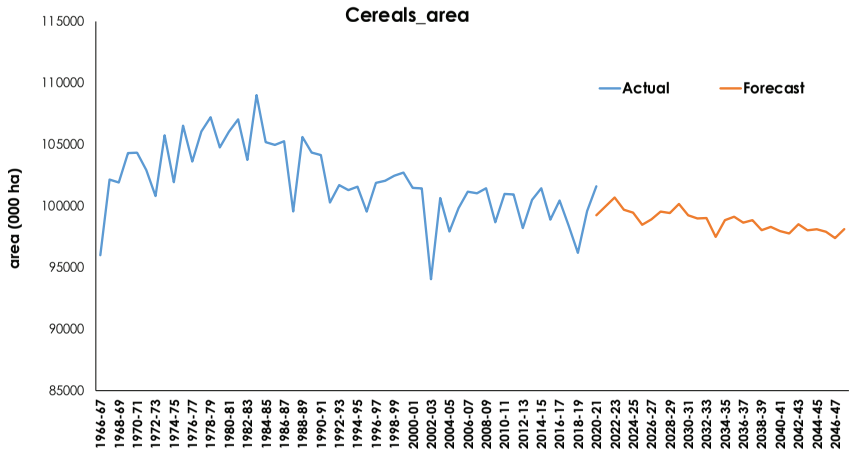

Maize_Yield
Yield (kg/ha)
Actual
Forecast_ExpGR

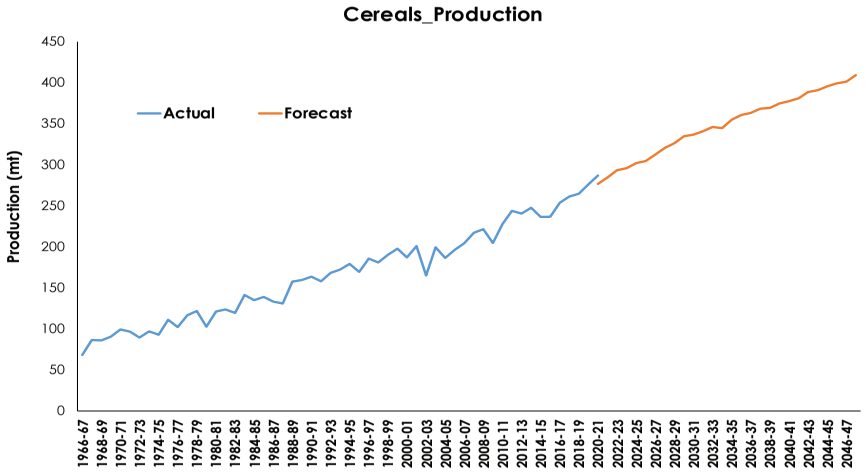

Maize_Production
Production (mt)
Actual
Forecast

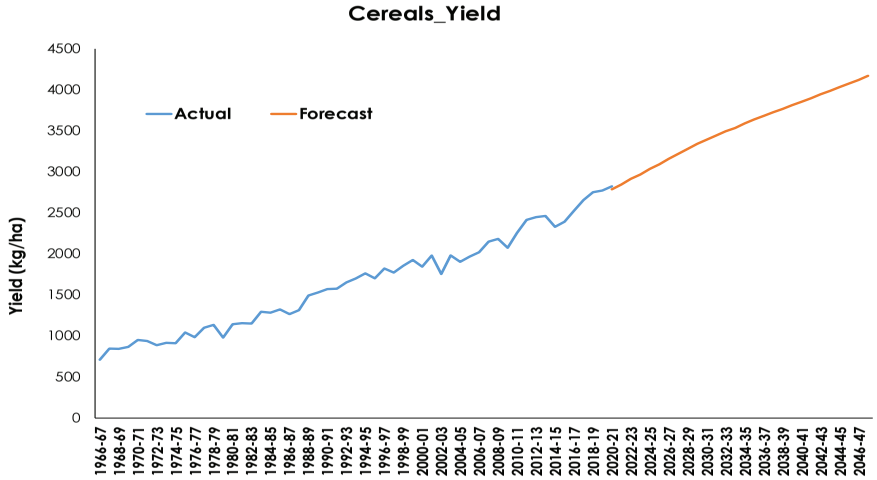

Nutri-cereals_Yield
Yield (kg/ha)
Actual
Forecast_Holt

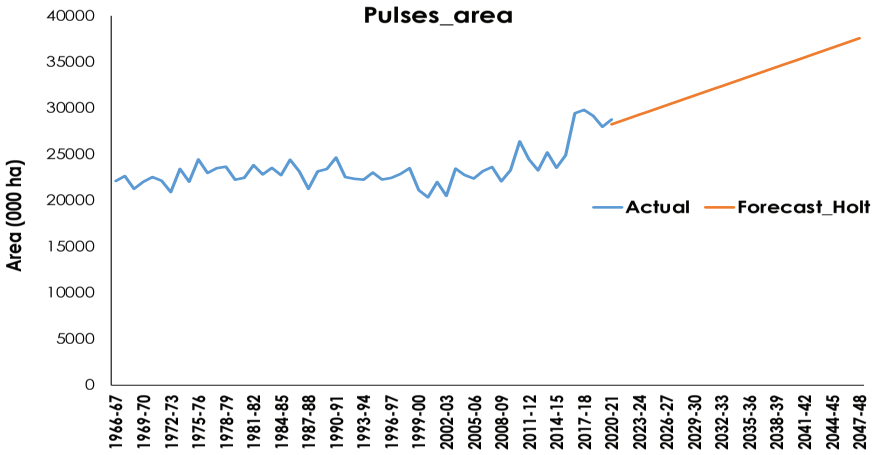

Nutri-cereals_area
area (000 ha)
Actual
Forecast_ExpGR

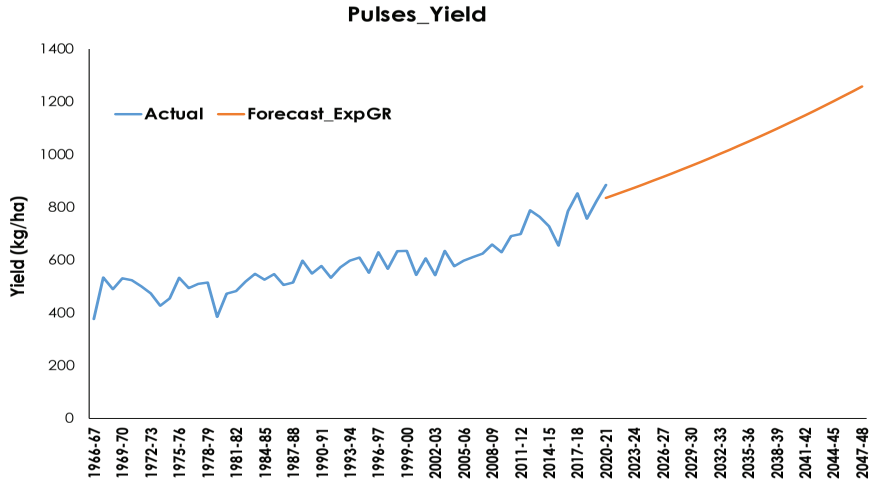

Nutri-cereals_Production
Production (mt)
Actual
Forecast

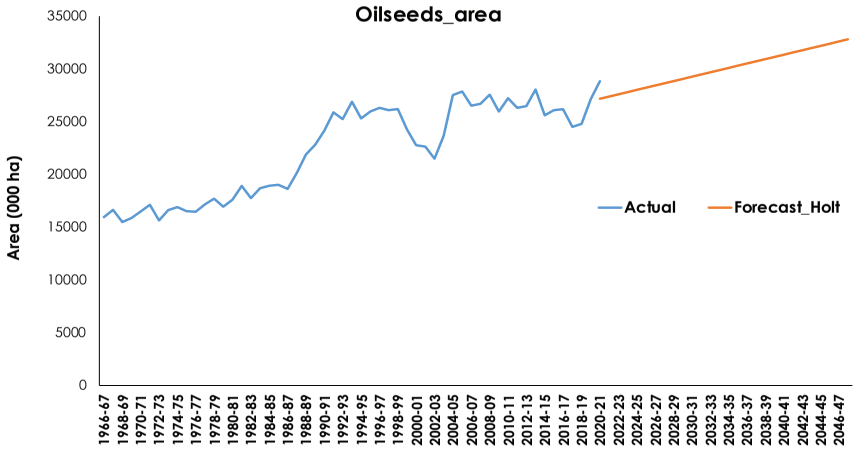

Cereals_area
area (000 ha)
Actual
Forecast

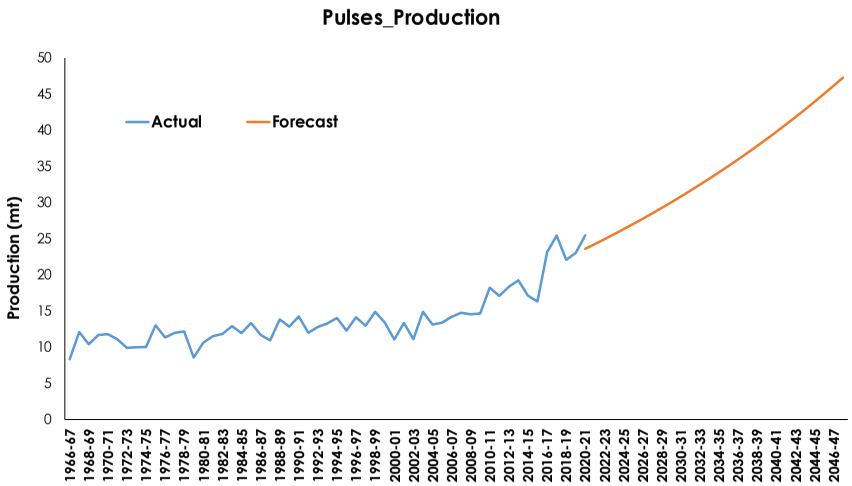

Cereals_Production
Production (mt)
Actual
Forecast

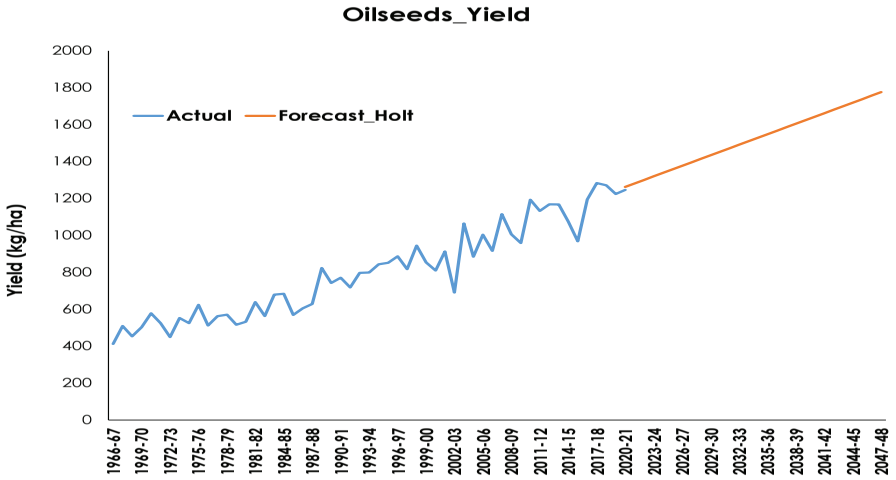

Cereals_Yield
Yield (kg/ha)
Actual
Forecast

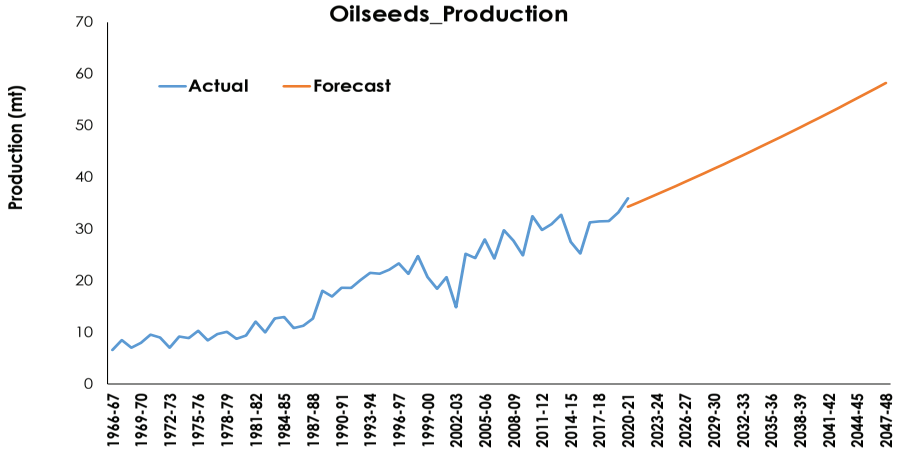

Pulses_area
Area (000 ha)
Actual
Forecast_Holt

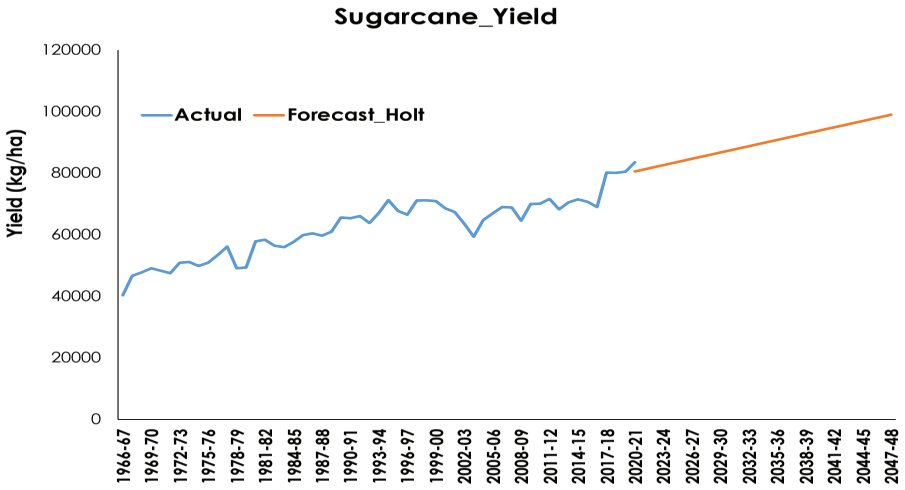

Pulses_Yield
Yield (kg/ha)
Actual
Forecast_ExpGR


Oilseeds_area
Area (000 ha)
Actual
Forecast_Holt


Pulses_Production
Production (mt)
Actual
Forecast


Oilseeds_Yield
Yield (kg/ha)
Actual
Forecast_Holt


Oilseeds_Production
Production (mt)
Actual
Forecast
0
10
20
30
40
50
60
70
1966-67
1969-70
1972-73
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
2014-15
2017-18
2020-21
2023-24
2026-27
2029-30
2032-33
2035-36
2038-39
2041-42
2044-45
2047-48


Sugarcane_Yield
Yield (kg/ha)
Actual
Forecast_Holt
0
20000
40000
60000
80000
100000
120000
1966-67
1969-70
1972-73
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
2014-15
2017-18
2020-21
2023-24
2026-27
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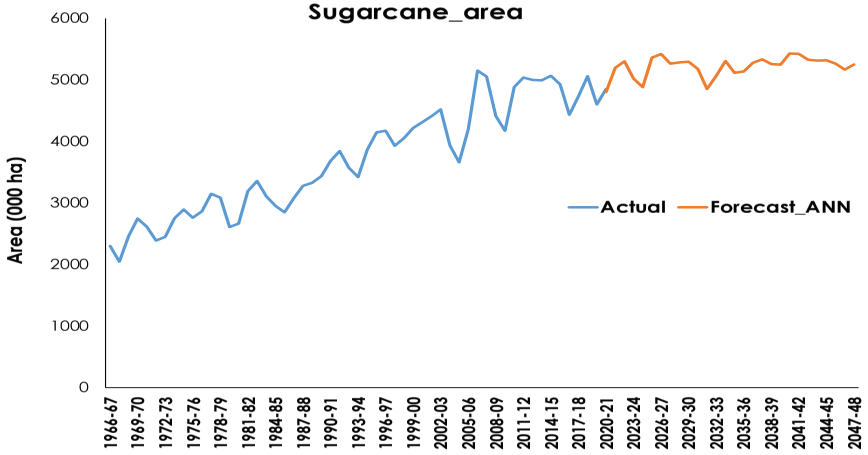
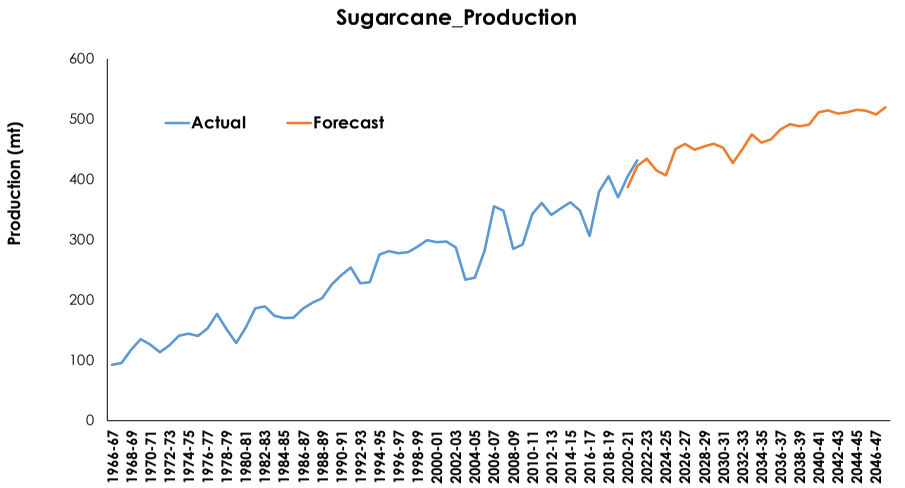
2032-33
2035-36
2038-39
2041-42
2044-45
2047-48


Sugarcane_area
Area (000 ha)
Actual
Forecast_ANN
0
1000
2000
3000
4000
5000
6000
1966-67
1969-70
1972-73
1975-76
1978-79
1981-82
1984-85
1987-88
1990-91
1993-94
1996-97
1999-00
2002-03
2005-06
2008-09
2011-12
2014-15
2017-18
2020-21
2023-24
2026-27
2029-30
2032-33
2035-36
2038-39
2041-42
2044-45
2047-48


Sugarcane_Production
Production (mt)
Actual
Forecast
0
100
200
300
400
500
600
1966-67
1968-69
1970-71
1972-73
1974-75
1976-77
1978-79
1980-81
1982-83
1984-85
1986-87
1988-89
1990-91
1992-93
1994-95
1996-97
1998-99
2000-01
2002-03
2004-05
2006-07
2008-09
2010-11
2012-13
2014-15
2016-17
2018-19
2020-21
2022-23
2024-25
2026-27
2028-29
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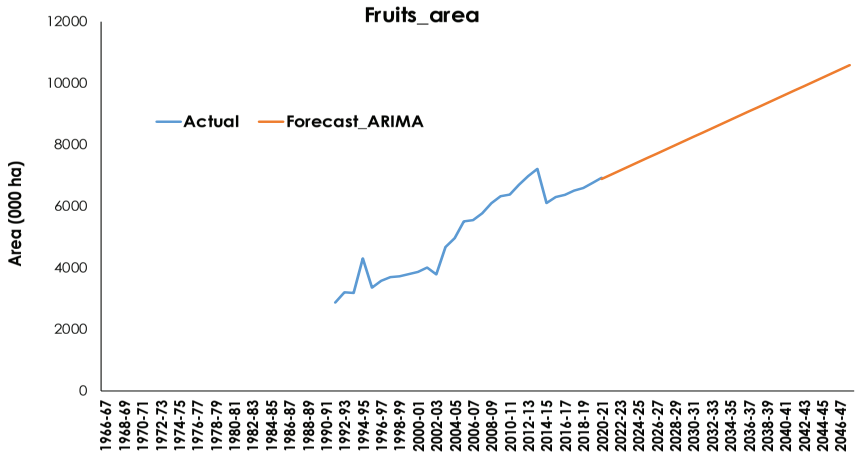
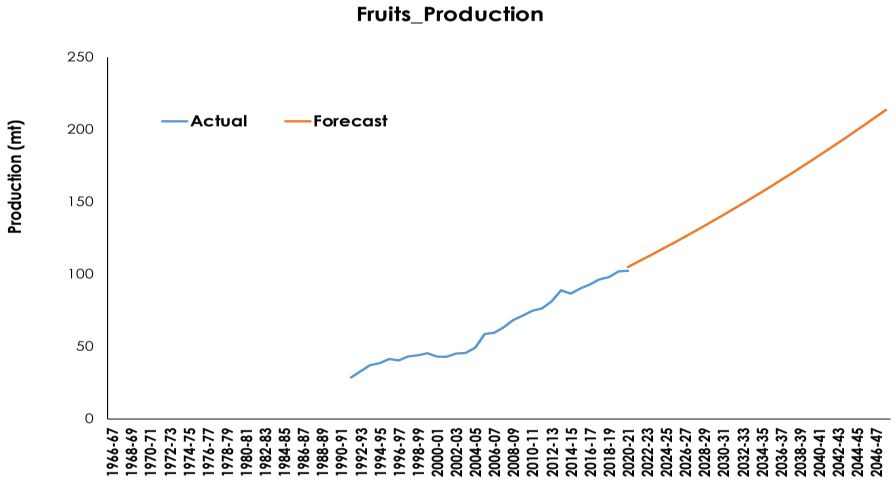
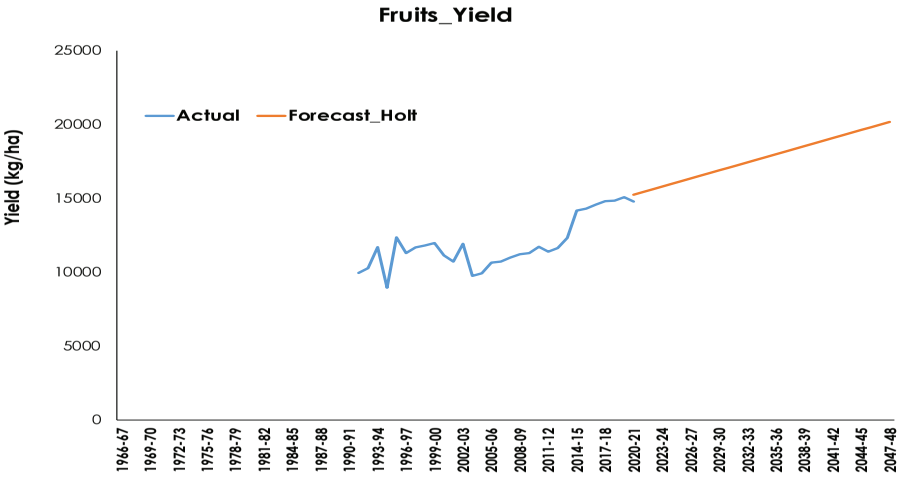
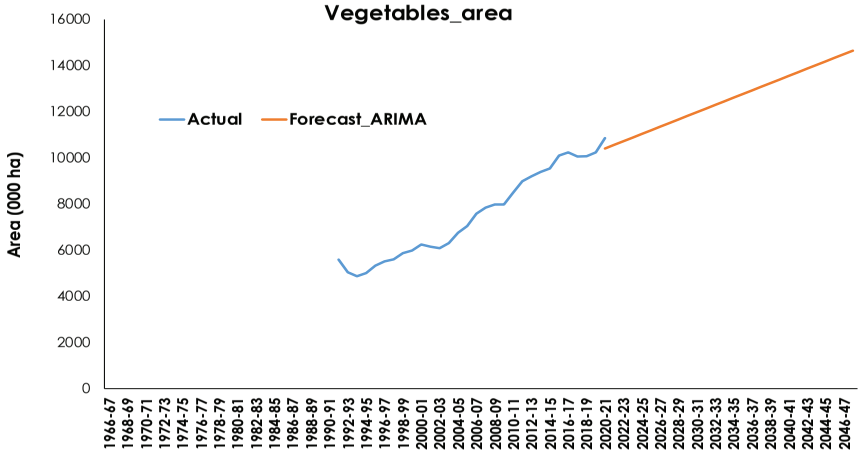
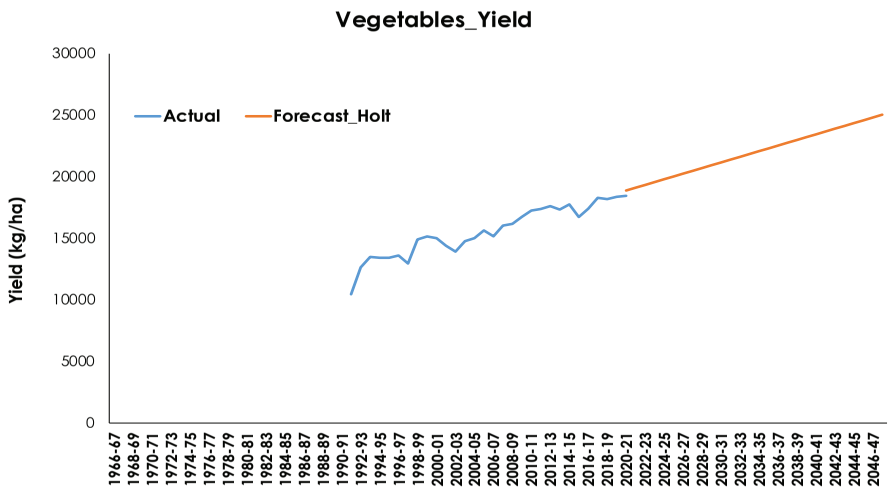
2038-39
2040-41
2042-43
2044-45
2046-47

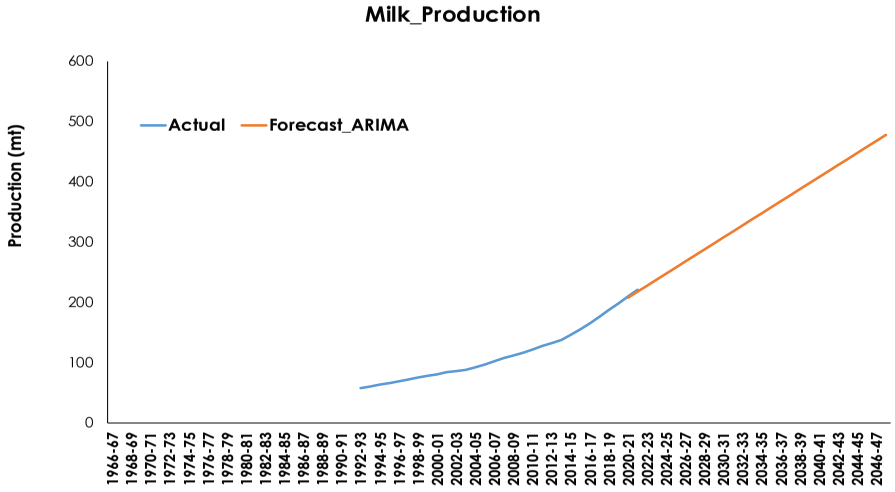

Fruits_area
Area (000 ha)
Actual
Forecast_ARIMA

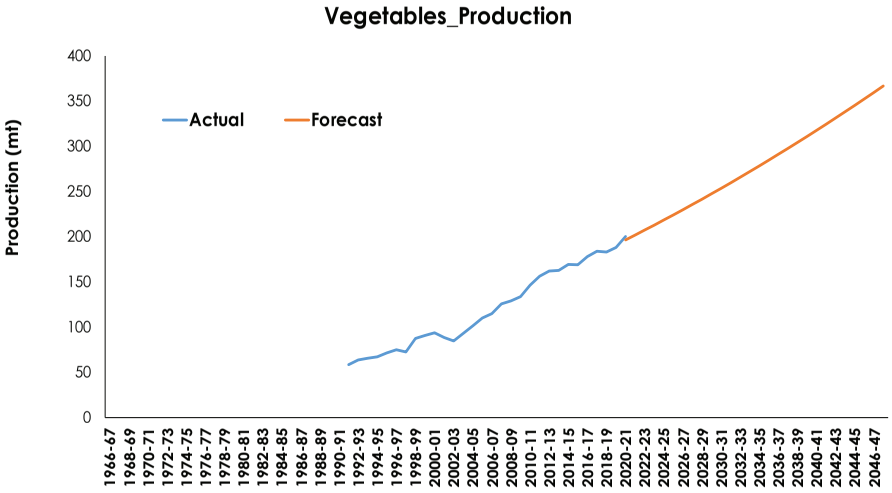

Fruits_Production
Production (mt)
Actual
Forecast

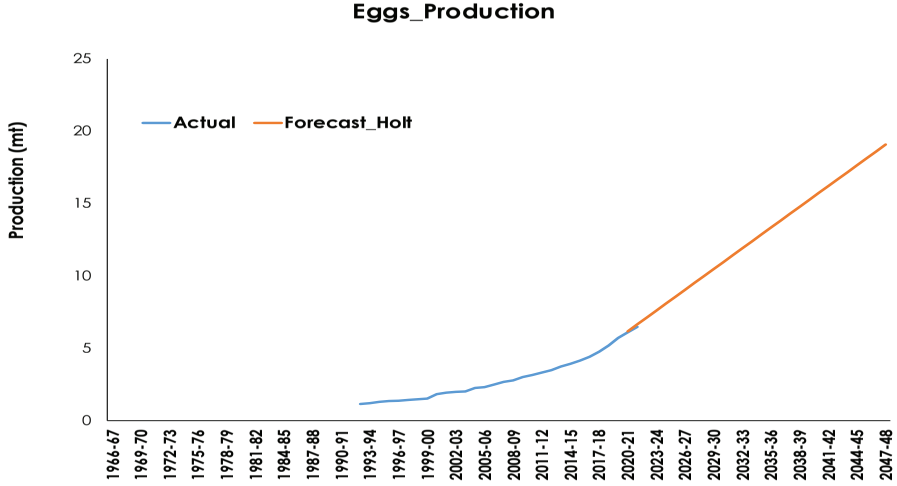

Fruits_Yield
Yield (kg/ha)
Actual
Forecast_Holt

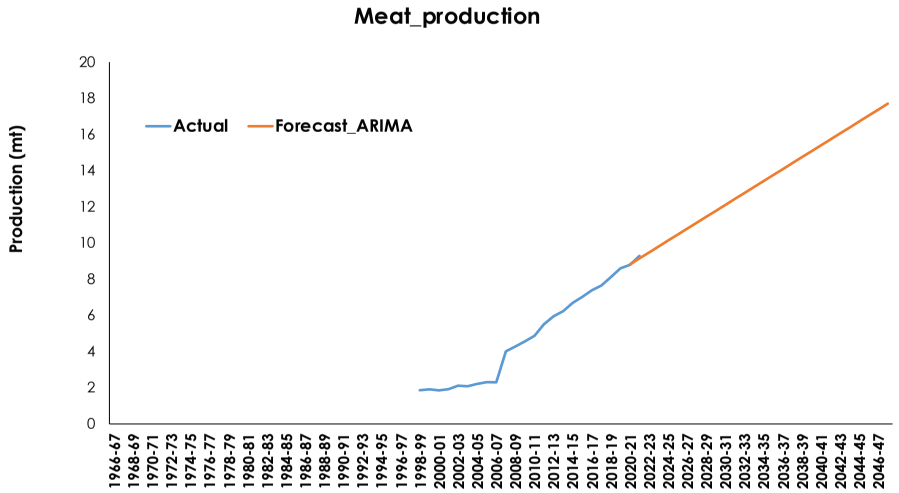

Vegetables_area
Area (000 ha)
Actual
Forecast_ARIMA

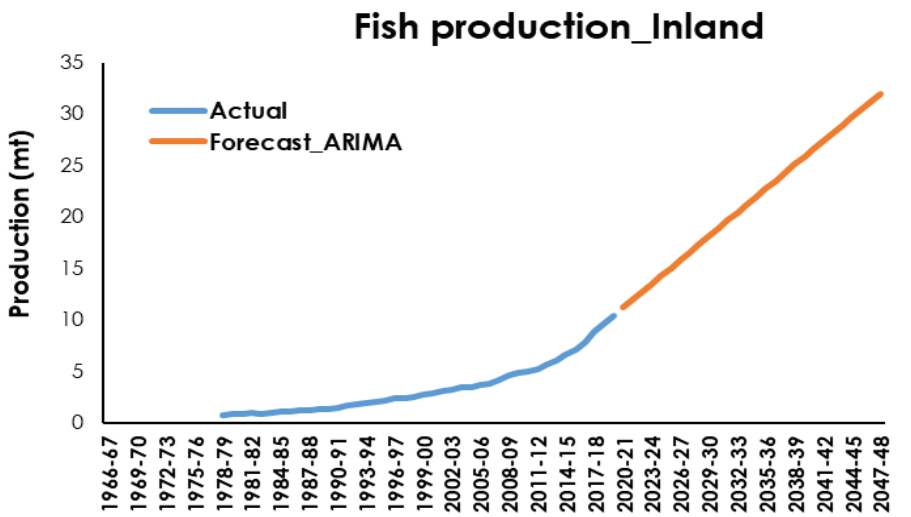

Vegetables_Yield
Yield (kg/ha)
Actual
Forecast_Holt

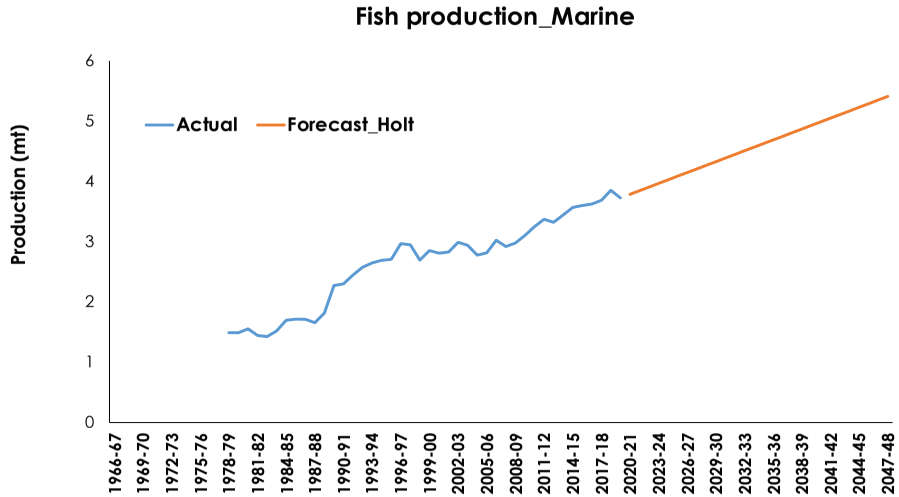

Milk_Production
Production (mt)
Actual
Forecast_ARIMA

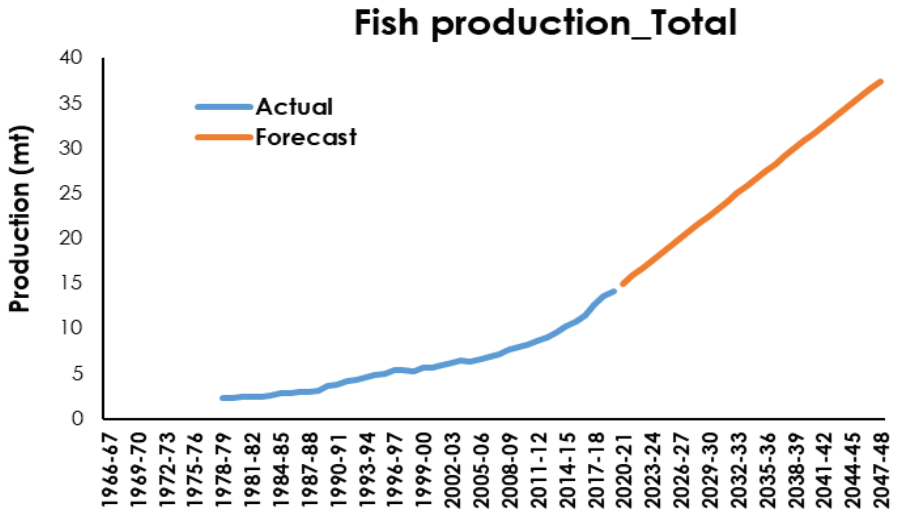

Vegetables_Production
Production (mt)
Actual
Forecast


Eggs_Production
Production (mt)
Actual
Forecast_Holt


Meat_production
Production (mt)
Actual
Forecast_ARIMA


Fish production_Inland
Production (mt)
Actual
Forecast_ARIMA


Fish production_Marine
Production (mt)
Actual
Forecast_Holt


Fish production_Total
Production (mt)
Actual
Forecast

Appendix 6.1 Export surplus assessment (food demand (6.34%) & production: yield potential realization)

Million Tonnes

	2011-12 (base year)	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	Hypothesis
Foodgrains	17	21	39	65	89	127	189	Exportable
Cereals & Millets	18	24	42	68	90	125	182	Exportable
Rice	9	16	30	43	59	78	109	Exportable
Wheat	5	8	14	26	38	49	68	Exportable
Nutri-cereals	0	0	-1	-3	-4	-7	-10	Importable
Maize	4	1	1	2	-1	7	18	Transitioning
Pulses	-3	-3	-3	-2	-1	1	7	Transitioning
Vegetables	2	-11	0	17	45	84	166	Transitioning
Fruits	0	-6	-6	-2	7	23	54	Transitioning
Sugar & products	3	-2	7	5	6	-11	13	Transitioning
Edible oil (incl. vanaspati)	-9	-11	-11	-10	-9	-5	0	Importable

Appendix 6.2 Export surplus assessment (food demand (7%) & production: business as usual)

Million Tonnes

	2011-12 (base year)	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	Hypothesis
Foodgrains	17	21	26	37	35	36	38	Exportable
Cereals & Millets	18	24	30	43	41	42	43	Exportable
Rice	9	16	26	35	40	40	40	Exportable
Wheat	5	8	10	20	26	29	41	Exportable
Nutri-cereals	0	0	-3	-5	-8	-12	-17	Importable
Maize	4	1	-2	-6	-15	-13	-17	Importable
Pulses	-3	-3	-5	-5	-6	-6	-5	Importable
Animal Food	2	5	5	5	3	-1	-8	Transitioning
Eggs	0	1	2	2	2	2	2	Transitioning
Meat	1	2	1	0	-1	-3	-6	Transitioning
Fish	1	2	3	3	2	0	-3	Transitioning
Milk	0	12	9	0	-13	-28	-49	Transitioning
Vegetables	2	-11	-18	-24	-27	-27	-18	Importable
Fruits	0	-6	-16	-25	-32	-38	-38	Importable
Sugar & products	3	0	6	5	6	10	12	Exportable
Edible oil (incl. vanaspati)	-9	-11	-12	-12	-12	-11	-8	Importable

Appendix 6.3 Export surplus assessment (food demand (7%) & production: yield potential realization)

Million Tonnes

	2011-12 (base year)	2019-20	2025-26	2030-31	2035-36	2040-41	2047-48	Hypothesis
Foodgrains	17	21	37	62	83	118	176	Exportable
Cereals & Millets	18	24	41	65	85	119	172	Exportable
Rice	9	16	30	44	60	78	109	Exportable
Wheat	5	8	13	26	37	48	68	Exportable
Nutri-cereals	0	0	-1	-3	-5	-8	-12	Importable
Maize	4	1	0	0	-6	2	10	Transitioning
Pulses	-3	-3	-4	-3	-2	-1	4	Importable
Vegetables	2	-11	-4	10	34	70	146	Transitioning
Fruits	0	-6	-9	-8	-2	10	36	Transitioning
Sugar & products	3	-2	6	5	6	-11	12	Transitioning

Appendix 6.4 Export surplus assessment (food demand (8%) & production: business as usual)

Million Tonnes

	2011-12 (base year)	2019-20	2022-23	2025-26	2030-31	2035-36	2040-41	2047-48	Hypothesis
Foodgrains	17	21	25	23	32	24	22	16	Exportable
Cereals & Millets	18	24	29	29	39	33	32	26	Exportable
Rice	9	16	20	27	36	40	41	41	Exportable
Wheat	5	8	14	10	19	25	28	40	Exportable
Nutri-cereals	0	0	-2	-3	-6	-9	-13	-20	Importable
Maize	4	1	-1	-4	-9	-22	-22	-32	Importable
Pulses	-3	-3	-4	-5	-7	-8	-9	-10	Importable
Animal Food	2	5	4	4	1	-3	-10	-23	Transitioning
Eggs	0	1	1	1	1	1	0	-2	Transitioning
Meat	1	2	1	1	-1	-3	-6	-11	Transitioning
Fish	1	2	2	2	1	-1	-5	-11	Transitioning
Milk	0	12	7	0	-21	-48	-81	-128	Importable
Vegetables	2	-11	-16	-23	-35	-44	-51	-50	Importable
Fruits	0	-6	-13	-21	-35	-48	-60	-69	Importable
Sugar & products	3	0	6	6	5	5	9	11	Exportable
Edible oil (incl. vanaspati)	-9	-11	-11	-12	-13	-13	-12	-9	Importable

Appendix 6.5 Export surplus assessment (food demand (8%) & production: yield potential realization)

Million Tonnes

	2011-12 (base year)	2019-20	2022-23	2025-26	2030-31	2035-36	2040-41	2047-48	Hypothesis
Foodgrains	17	21	33	35	57	72	105	153	Exportable
Cereals & Millets	18	24	37	39	62	77	109	155	Exportable
Rice	9	16	23	30	44	61	79	110	Exportable
Wheat	5	8	16	13	25	37	47	67	Exportable
Nutri-cereals	0	0	-1	-1	-3	-6	-9	-14	Importable
Maize	4	1	0	-2	-4	-13	-7	-5	Importable
Pulses	-3	-3	-4	-4	-5	-5	-4	-1	Importable
Vegetables	2	-11	-11	-9	-1	17	46	114	Transitioning
Fruits	0	-6	-10	-13	-17	-18	-12	5	Importable
Sugar & products	3	-2	6	6	5	5	-12	12	Transitioning
Edible oil (incl. vanaspati)	-9	-11	-11	-12	-11	-10	-7	-2	Importable

Appendix 7.1 Methodological approach for projection of fertilizer and pesticide

Fertilizer consumption

L_FER_CON_TOT = -0.23 + 0.69*L_FER_CON_TOT(-1) + 0.95*L_GIA - 0.77*L_WPI_FER + 0.25*L_WPI_FA ...(1)

Pesticide consumption

L_PES_CON = 4.06 + 0.53*L_PES_CON(-1) + 0.42*L_AREA_COT + 0.18*COTDUM2010 - 0.18*COTDUM2012 ... (2)

Notations: L denotes natural logarithms

FER_CON_TOT	= Total fertilizer consumption (N+P+K) in lakh tons
WPI_FER	= Wholesale price index (2011-12=100) of fertilizers
WPI_FA	= Wholesale price index (2011-12=100) of food articles
PES_CON	= Total pesticide consumption in tons
AREA_COT	= Area under cotton (million ha)
COTDUM2010, COTDUM2012	= Cotton dummy in 2010 and 2012

Diagnostics

S.No	Equation	Adjusted R2	D-W statistic	ADF test of the residuals
1	Fertilizer	0.97	1.75	-4.57***
2	Pesticide	0.74	2.14	-4.89***

Appendix 7.2 Government initiatives for reducing the usage of pesticides and fertilizers

In order to encourage the use and production of biofertilizers/biopesticides/traditional indigenous practices over chemical fertilizers/pesticides and ensure transition from agrochemicals to sustainable farming practices, the Government of India had launched various schemes over the years.[7,8] Sustainable farming practices include non-chemical system of farming such as organic and natural farming systems. While organic systems use off-farm purchased organic and biological inputs, natural farming systems are based on biomass mulching, indigenous cow-based inputs but excludes all purchased organic and biological inputs.[9] The Government is promoting the adoption of both organic farming and natural farming through the following schemes.

Paramparagat Krishi Vikas Yojana (PKVY)[10] : PKVY was launched in 2015.It is an extended component of Soil Health Management (SHM) under the Centrally Sponsored Scheme (CSS), National Mission for Sustainable Agriculture (NMSA). It encourages cluster-based organic farming with Participatory Guarantee System (PGS) certification which is a decentralized organic farming certification system. The program supports mobilization of farmers for cluster formation, training, certification and marketing and post-harvest management. The scheme aimed to form 10000 clusters of 20 ha each and convert nearly two lakh hectares of agricultural land to organic farming by 2017-18.

[7] https://pib.gov.in/newsite/PrintRelease.aspx?relid=194633. (accessed on 19th September, 2023)
[8] https://pib.gov.in/Pressreleaseshare.aspx?PRID=1656146 (accessed on 19th September, 2023)
[9] http://agriculture.up.gov.in/nmnf/natural_farming/guid/NMNFGuidelines.pdf (accessed on 21st September, 2023)
[10] https://darpg.gov.in/sites/default/files/Paramparagat%20Krishi%20Vikas%20Yojana.pdf (accessed on 19th September, 2023)

A total financial assistance of Rs 14.95 lakhs spread over three years is provided per cluster of 20 ha. Around Rs 50000 per hectare/3 years is given, of which Rs 31000 (62%) goes directly to the farmers through direct benefit transfer (DBT) for on-farm/off-farm organic inputs, production/procurement, post-harvest management etc. The pattern of funding is in the ratio of 60:40 by the Central and State governments respectively. It is in the ratio of 90:10 (Centre: State) for North Eastern and Himalayan States while assistance is 100% for Union Territories.

Mission Organic Value Chain Development for North Eastern Region (MOVCDNER): MOVCDNER is a centrally sponsored scheme initiated in 2015, a sub-mission under the National Mission for Sustainable Agriculture. Its objective is to develop end to end organic value chains in North Eastern States starting from inputs, seeds, certification, and creation of facilities for collection, aggregation, processing, marketing and brand building initiative.[11]

The scheme supports third party certified organic farming of traditional crops in the north eastern region through cluster development and formation of Farmer Interest Groups (FIGs)/Farmers Producer Organizations/Companies (FPOs/FPCs). Through the FPCs, farmers are provided infrastructural, technical and financial support to achieve economies of scale, engage bulk buyers, and have direct market linkages to national and international markets with least dependence on traders/middlemen.[12]

The scheme was initiated with an average annual allocation of Rs 134 crore and as of February 2021, it had covered 74880 ha area.[13] The allocation was increased to Rs 200 crore per year with an aim to bring additional one lakh ha area under 200 new FPOs over a period of three years. As of July 2023, around 1.73 lakh ha area has been brought under organic farming benefitting 1.89 lakh farmers. It led to the formation of 379 FPOs/FPCs and establishment of 205 collection, aggregation and grading units; 190 custom hiring centres; 123 processing unit and pack houses; and development of 7 brands.[14] Financial assistance of Rs 46575/ha for three years is provided for creation of FPO, support to farmers for organic inputs, quality seeds/planting material and training and certification.[15] Out of this, around Rs. 32500/ ha for 3 years is provided to farmers for off-farm /on-farm organic inputs wherein Rs. 15,000 is provided as DBT to the farmers and Rs. 17,500 for the planting material is given to the farmers by State Lead Agency in kind.

National Mission on Oilseeds and Oil Palm (NMOOP)[16]: Under NMOOP, financial assistance of up to Rs 300 per ha is provided for use of biofertilizers including supply of Rhizobium culture/Phosphate Solubilising Bacteria (PSB)/Sinc Solubilising Bacteria (ZSB)/ Azatobacter/Mycorrhiza and vermi compost.

National Food Security Mission (NFSM)[17]: Under NFSM, financial assistance @ Rs 300 per ha or 50% of the cost whichever is less, is granted for the use of various biofertilizers including Rhizobium/Azotobactor/ Azospirilieum, Phosphate solubilising bacteria (PSB) etc in pulses.

[11] https://asfac.assam.gov.in/sites/default/files/swf_utility_folder/departments/asfac_medhassu_in_oid_6/portlet/level_2/9.3.pdf (accessed on 20th September, 2023)
[12] https://pib.gov.in/PressReleseDetailm.aspx?PRID=1697160 (accessed on 20th September, 2023)
[13] https://pib.gov.in/PressReleseDetailm.aspx?PRID=1697160 (accessed on 20th September, 2023)
[14] https://pib.gov.in/PressReleasePage.aspx?PRID=1939604 (accessed on 20th September, 2023)
[15] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1946809 (accessed on 20th September)
[16] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1592263 (accessed on 20th September)
[17] https://www.nfsm.gov.in/Guidelines/NFSM12102018.pdf (accessed on 21st September, 2023)

Integrated Nutrient Management (INM) & Integrated Pest Management (IPM)[18]: To promote soil health and maintain higher agricultural productivity, fertilizers are necessary while pesticides play a significant role in sustaining agricultural production by protecting crops from pests. For promoting a balanced and cautious use of fertilizers, the Government of India has been advocating soil test based Integrated Nutrient Management. Under INM, Soil Heath Card Scheme has been implemented since 2015-16 to help farmers identify their soil health condition.[19] Soil health card provides crop-specific recommendations on appropriate dosage of fertilizers to be applied based on soil samples analyzed by the soil testing labs (STL).

The Government of India has also implemented the "Sub-Mission on Plant-protection and Plant Quarantine" Scheme, which promotes Integrated Pest Management to educate farmers on the judicious use of chemical pesticides. Additionally, biocontrol methods and biopesticides are advocated under IPM.

One acre Integrated Organic Farming System (IOFS) models[20]: The Indian Council of Agricultural Research (ICAR)-Indian Institute of Farming Systems Research developed IOFS models under the scheme All India Network Programme on Organic Farming (AL-NPOF). IOFS is a model that consists of providing crop, cropping systems and one acre of land.[21]Need based trainings are provided to farmers to develop IOFS models.[22] In Kerala, Sikkim, Meghalaya, and Tamil Nadu, IoFS models have been built which are suitable for marginal farmers. They offer the opportunity to produce more than 80% of the inputs needed for organic farming within the farm, thereby lowering the cost of production.

PM-PRANAM (PM Programme for Restoration, Awareness, Generation, Nourishment and Amelioration of Mother Earth)[23]: PM-PRANAM which was approved in June 2023 aims to support the wide-spread movement initiated by States/Uts to preserve Mother Earth's health through promotion of sustainable and balanced use of fertilizers, adoption of alternate fertilizers, and promotion of organic farming and implementation of resource conservation technologies. Under PM-PRANAM, a State/UT would get a grant equal to 50% of the fertilizer subsidies that were saved by that State/UT in a given fiscal year by reducing its consumption of chemical fertilizers (Urea, DAP, NPK, and MOP) compared to the average consumption over the previous three years.

Capital Investment Subsidy Scheme (CISS): CISS for commercial production units for organic/biological inputs was introduced in 2004-05 under National Project on Organic Farming. It aims to promote organic farming by increasing the availability and quality of biopesticides, biofertilizers and composts.[24] Individuals, groups of farmers, proprietary/partnership firms, cooperatives, fertilizer industry, companies, corporations, and NGOs are among the beneficiaries eligible for the subsidy for the establishment of a biofertilizer and biopesticides production unit, while APMCs, Municipalities, NGOs,

[18] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1602828 (accessed on 21st September, 2023)
[19] https://cdn.s3waas.gov.in/s388ae6372cfdc5df69a976e893f4d554b/uploads/2018/07/2018072691.pdf (accessed on21st September, 2023)
[20] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1592263 (accessed on 20th September, 2023)
[21] https://www.indiafilings.com/learn/integrated-organic-farming-system/ (accessed on 21st September, 2023)
[22] https://pib.gov.in/newsite/PrintRelease.aspx?relid=194883 (accessed on 20th September, 2023)
[23] https://pib.gov.in/PressReleasePage.aspx?PRID=1945750#:~:text=The%20Cabinet%20Committee%20on%20Economic,(PM%2DPRANAM)%E2%80%9D. (accessed on 21st September, 2023)
[24] https://www.nabard.org/content1.aspx?id=592&catid=23&mid=23 (accessed on 20th September)

and private entrepreneurs are eligible for the subsidy for the establishment of fruit and vegetable waste compost unit. While most of the aforementioned schemes were aimed at promoting the use of organic inputs, Capital Investment Subsidy Scheme (CISS) was solely aimed at encouraging the production of these inputs.

The scheme provides credit linked and back-ended capital investment subsidy at 25% of total financial outlay subject to the maximum of Rs 40 lakh per unit for the establishment of biofertilizers/biopesticides unit.[25] For fruit & vegetable market waste compost unit, the scheme provides 33% of total financial outlay subject to a maximum of Rs 63 lakh per unit.

In 2009-10, it was estimated that the production of biofertilizers and biopesticides was about 28000 and 40000 tonnes per annum (TPA) respectively against the installed production capacity of around 80000 TPA (for biofertilizers and biopesticides).[26] This was much lower than the potential requirement of 7.6 lakh TPA of biofertilizers and 15 lakh tonnes of biopesticides in the country.

Bharatiya Prakritik Krishi Padhati (BPKP)[27]: BPKP was included in Paramparagat Krishi Vikas Yojana (PKVY) as a sub-scheme in 2020-21. BPKP is based on the principles of natural farming. The scheme encourages traditional indigenous practices to enable farmers to avoid the use of externally purchased inputs. It promotes on-farm biomass recycling and focuses on biomass mulching, use of cow dung-urine formulations and exclusion of synthetic chemical inputs. BPKY emphasizes on improving farmers' profitability, availability of quality food and restoration of soil fertility and farmland ecosystem along with generation of employment and contribution to rural development.

The program is implemented on a demand-driven basis in accordance with Centrally Sponsored Scheme (CSS) guidelines and has a total outlay of Rs. 4645.69 crore for the six-year period (2019-20 to 2024-25). With a goal of covering 12 lakh ha in 600 major blocks of 2000 hectare in various states, BPKP provides financial assistance of Rs 12200/ ha for three years for cluster creation, capacity building and handholding by trained personnel, certification, and residue analysis. The scheme complies with Participatory Guarantee System (PGS) certification. Only eight states have chosen to participate in the program: Andhra Pradesh, Chattisgarh, Kerala, Himachal Pradesh, Madhya Pradesh, Odisha, Tamil Nadu, and Jharkhand.

National Mission on Natural Farming (NMNF)[28]: By up scaling the Bhartiya Prakritik Krishi Paddati (BPKP), in 2023-24, the Government has formulated National Mission on Natural Farming (NMNF) as a separate and independent scheme for implementation all across the country. NMNF aims to motivate farmers to adopt chemical free farming and enhance the reach of natural farming.

[25] https://ncof.dacnet.nic.in/uploads/SchemaGuidelines/Capital_Investment_Subsidy_Scheme_CISS_Guidelines.pdf (accessed on 20th September, 2023)

[26] https://www.nabard.org/auth/writereaddata/File/NPOF_English.pdf (accessed on 20th September, 2023)

[27] https://naturalfarming.niti.gov.in/bharatiya-prakritik-krishi-paddhati-bpkp/ (accessed on 20th September, 2023)

[28] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1911558#:~:text=To%20motivate%20farmers%20to%20adopt,Prakritik%20Krishi%20Paddati%20(BPKP). (accessed on 20th September, 2023)

The success of NMNF will necessitate behavioral change in farmers to switch from chemical inputs to cow based locally produced inputs. This would further involve continuous creation of awareness, training, handholding and capacity building of farmers in the initial years.

With a total outlay of Rs 1584 crore, NMNF aims to cover 7.5 lakh hectares of land, developed into 15,000 natural farming clusters in the next 4 years and each cluster would comprise 50 or more farmers with 50 ha of land.[29] Alongside 15000 model natural farming clusters, Bharitya Prakritik Kheti Bio-inputs Resources Centres (BRCs) would be set up to prepare and supply bio-inputs like Jeevaamrit, Ghana Jeevamrit, neemastra etc. wherein cow dung and urine, neem and bio culture play an important role.

Under this scheme, farmers would be provided a financial assistance of Rs 15000 per ha @ Rs 5000 per ha/year for three years as DBT for the creation of on-farm input production infrastructure. The incentives would be provided to the farmers on the condition that they commit to undertake natural farming on long term basis. Through NMNF, the government proposes to cover 1 crore farmers along the Ganga belt and in other rainfed regions of the country.

However, despite two decades of efforts by the government to promote non-chemical farming practices, only 2.7 % (3.8 million ha) of the India's net-sown area is under organic and natural farming.[30] Further, it is stated that the overall funds spent on the schemes and programmes for promoting the use and production of biofertilizers and organic fertilizers is significantly less than the annual subsidy given for chemical fertilizers[31] (which was Rs 175099 crore in 2023-24[32]).

[29] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1906884 (accessed on 21st September, 2023)

[30] https://www.downtoearth.org.in/news/agriculture/natural-option-organic-natural-farming-not-only-profitable-sustainable-but-also-productive-81684 (accessed on 21st September, 2023)

[31] https://www.cseindia.org/content/downloadreports/11235 (accessed on 20th September, 2023)

[32] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1911558#:~:text=To%20motivate%20farmers%20to%20adopt,Prakritik%20Krishi%20Paddati%20(BPKP). (accessed on 20th September, 2023)

Appendix 7.3a Crop-wise seed demand in 2025-26

crops	Area projected (2025-26) (m. ha)	New SMR	Revised Seed Rate (kg/ha)*	SRR Projected (2025-26)	Seed requirement at 100% SRR			Seed requirement at projected SRR		
					Certified seed (000' q)	Foundation seed (000'q)	Breeder seed (q)	Certified seed (000' q)	Foundation seed (000'q)	Breeder seed (q)
WHEAT	31.37	32	100	47.97	31370	980	30635	15049	470	14696
PADDY	46.32	80	30	35.84	13895	174	2171	4981	62	778
MAIZE	10.36	150	20	67.09	2071	14	92	1390	9	62
JOWAR	3.66	180	10	29.59	366	2	11	108	1	3
BAJRA	7.40	300	5	46.72	370	1	4	173	1	2
RAGI	1.09	200	10	92.14	109	1	3	100	1	3
BARLEY	0.55	30	87.5	38.81	485	16	539	188	6	209
URD	5.21	53	15	37.34	782	15	278	292	6	104
MOONG	6.57	53	15	26.64	986	19	351	263	5	94
ARHAR	5.21	120	12.5	62.57	651	5	45	407	3	28
PEAS	0.67	14	88	43.01	587	42	2995	252	18	1288
GRAM	10.82	26	58	28.20	6275	241	9282	1770	68	2618
LENTIL	1.44	40	30	64.35	432	11	270	278	7	174
GROU-NDNUT	6.14	18	120	25.09	7363	409	22724	1847	103	5701
RAPE/ MUST	6.93	240	5	65.18	347	1	6	226	1	4
TIL	1.62	250	5	68.66	81	0	1	56	0	1
SUNFLOWER	0.12	50	6	30.60	7.08	0	3	2	0	1
SOYABEAN	13.75	2000	68.5	34.96	9418	471	23546	3292	165	8231
CASTOR	0.72	120	7.5	65.08	54	0	4	35	0	2
SAFFLOWER	0.03	67	12	37.33	3.2	0	1	1	0	0
TOTAL	**158.59**				**75652**	**2403**	**92961**	**30710**	**925**	**33998**

Appendix 7.3b Crop-wise seed demand in 2030-31

crops	Projected area (2030-31) (m. ha)	New SMR	Revised seed rate (kg/ ha)*	Projected SRR (2030-31)	Seed requirement at 100% SRR			Seed requirement at projected SRR		
					Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)	Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)
WHEAT	31.68	32	100	55.10	31679	990	30937	17455	545	17046
PADDY	47.01	80	30	33.46	14103	176	2204	4719	59	737
MAIZE	10.97	150	20	73.06	2193	15	97	1602	11	71
JOWAR	2.92	180	10	29.81	292	2	9	87	0	3
BAJRA	7.10	300	5	42.32	355	1	4	150	1	2
RAGI	1.01	200	10	100.00	101	1	3	101	1	3
BARLEY	0.51	30	87.5	42.61	446	15	495	190	6	211
URD	6.94	53	15	36.38	1041	20	371	379	7	135
MOONG	8.96	53	15	24.70	1345	25	479	332	6	118
ARHAR	5.89	120	12.5	87.30	736	6	51	642	5	45
PEAS	0.82	14	88	46.83	719	51	3669	337	24	1718
GRAM	11.94	26	58	30.46	6926	266	10246	2109	81	3120
LENTIL	1.41	40	30	89.52	422	11	263	377	9	236
GROUN-DNUT	6.29	18	120	25.17	7548	419	23295	1900	106	5864
RAPE/ MUST	7.24	240	5	68.07	362	2	6	246	1	4
TIL	1.50	250	5	100.00	75	0	1	75	0	1
SUN-FLOWER	0.05	50	6	22.30	3.15	0	1	1	0	0
SOYABEAN	14.86	2000	68.5	32.74	10182	509	25454	3333	167	8333
CASTOR	0.56	120	7.5	73.05	42	0	3	31	0	2
SAF-FLOWER	0.01	67	12	44.17	1.2	0	0	1	0	0
TOTAL	**163.02**				**78571**	**2509**	**97589**	**34068**	**1030**	**37649**

Appendix 7.3c Crop-wise seed demand in 2035-36

crops	Area projected (2035-36) (m. ha)	New SMR	Revised Seed Rate (kg/ ha)*	SRR Projected (2035-36)	Seed requirement at 100% SRR			Seed requirement at projected SRR		
					Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)	Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)
WHEAT	31.99	32	100	63.28	31991	1000	31241	20245	633	19771
PADDY	47.72	80	30	31.24	14315	179	2237	4472	56	699
MAIZE	11.61	150	20	79.55	2323	15	103	1848	12	82
JOWAR	2.34	180	10	30.03	234	1	7	70	0	2
BAJRA	6.82	300	5	38.34	341	1	4	131	0	1
RAGI	0.93	200	10	100.00	93	0	2	93	0	2
BARLEY	0.47	30	87.5	46.77	410	14	455	192	6	213
URD	9.24	53	15	35.45	1386	26	494	491	9	175
MOONG	12.22	53	15	22.90	1834	35	653	420	8	149
ARHAR	6.65	120	12.5	100.00	831	7	58	831	7	58
PEAS	1.00	14	88	50.98	881	63	4495	449	32	2292
GRAM	13.18	26	58	32.89	7646	294	11310	2515	97	3720
LENTIL	1.37	40	30	100.00	411	10	257	411	10	257
GROUN-DNUT	6.45	18	120	25.25	7737	430	23881	1954	109	6031
RAPE/ MUST	7.55	240	5	71.08	378	2	7	268	1	5
TIL	1.39	250	5	100.00	69	0	1	69	0	1
SUN-FLOWER	0.02	50	6	16.24	1.4	0	1	0.2	0	0
SOYABEAN	16.07	20	68.5	30.66	11007	550	27518	3375	169	8437
CASTOR	0.43	120	7.5	82.00	32	0	2	26	0	2
SAF-FLOWER	0.00	67	12	52.26	0.5	0	0	0.2	0	0
TOTAL	**167.59**				**81922**	**2628**	**102726**	**37863**	**1151**	**41897**

Appendix 7.3d Crop-wise seed demand in 2040-41

crops	Area projected (2040-41) (m. ha)	New SMR	Revised Seed Rate (kg/ ha)*	SRR Projected (2040-41)	Seed requirement at 100% SRR			Seed requirement at projected SRR		
					Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)	Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)
WHEAT	32.31	32	100	72.69	32306	1010	31549	23482	734	22932
PADDY	48.43	80	30	29.17	14530	182	2270	4238	53	662
MAIZE	12.30	150	20	86.63	2460	16	109	2131	14	95
JOWAR	1.87	180	10	30.26	187	1	6	57	0	2
BAJRA	6.54	300	5	34.73	327	1	4	114	0	1
RAGI	0.86	200	10	100.00	86	0	2	86	0	2
BARLEY	0.43	30	87.5	51.35	377	13	418	193	6	215
URD	12.31	53	15	34.54	1846	35	657	638	12	227
MOONG	16.67	53	15	21.23	2500	47	890	531	10	189
ARHAR	7.52	120	12.5	100.00	940	8	65	940	8	65
PEAS	1.23	14	88	55.51	1079	77	5507	599	43	3057
GRAM	14.55	26	58	35.52	8440	325	12485	2998	115	4434
LENTIL	1.34	40	30	100.00	402	10	251	402	10	251
GROUND-NUT	6.61	18	120	25.34	7932	441	24481	2010	112	6203
RAPE/ MUST	7.88	240	5	74.23	394	2	7	293	1	5
TIL	1.29	250	5	100.00	64	0	1	64	0	1
SUN-FLOWER	0.01	50	6	11.83	0.6	0	0	0.1	0	0
SOYABEAN	17.37	20	68.5	28.71	11899	595	29748	3417	171	8542
CASTOR	0.33	120	7.5	92.05	25	0	2	23	0	2
SAF-FLOWER	0.00	67	12	61.83	0.2	0	0	0.1	0	0
TOTAL	**172.28**				**85795**	**2762**	**108454**	**42213**	**1291**	**46885**

Appendix 7.3e. Crop-wise seed demand in 2047-48

crops	Area projected (2047-48) (m. ha)	New SMR	Revised Seed Rate (kg/ ha)*	SRR Projected (2047-48)	Seed requirement at 100% SRR			Seed requirement at projected SRR		
					Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)	Certified seed (000' q)	Foundation seed (000' q)	Breeder seed (q)
WHEAT	32.75	32	100	88.24	32753	1024	31985	28901	903	28223
PADDY	49.45	80	30	26.49	14836	185	2318	3930	49	614
MAIZE	13.33	150	20	97.60	2665	18	118	2601	17	116
JOWAR	1.36	180	10	30.58	136	1	4	42	0	1
BAJRA	6.17	300	5	30.24	309	1	3	93	0	1
RAGI	0.77	200	10	100.00	77	0	2	77	0	2
BARLEY	0.38	30	87.5	58.51	335	11	372	196	7	218
URD	18.39	53	15	33.30	2758	52	982	919	17	327
MOONG	25.73	53	15	19.09	3859	73	1374	737	14	262
ARHAR	8.92	120	12.5	100.00	1115	9	77	1115	9	77
PEAS	1.63	14	88	62.53	1434	102	7318	897	64	4576
GRAM	16.71	26	58	39.55	9692	373	14338	3834	147	5671
LENTIL	1.29	40	30	100.00	388	10	243	388	10	243
GROUND-NUT	6.84	18	120	25.46	8212	456	25346	2091	116	6453
RAPE/ MUST	8.37	240	5	78.87	419	2	7	330	1	6
TIL	1.16	250	5	100.00	58	0	1	58	0	1
SUN-FLOWER	0.00	50	6	7.60	0.2	0	0	0.0	0	0
SOYABEAN	19.37	20	68.5	26.20	13271	664	33178	3476	174	8691
CASTOR	0.23	120	7.5	100.00	17	0	1	17	0	1
SAF-FLOWER	0.00	67	12	78.25	0.0	0	0	0.0	0	0
TOTAL	**179.07**				**92335**	**2981**	**117669**	**49701**	**1531**	**55483**

File No. Q-11018/02/2016-Agri
Government of India
National Institution for Transforming India
(Agriculture Vertical)

Sansad Marg, New Delhi
29th August, 2022

Office Memorandum

Sub: Constitution of working group on Crop Husbandry, Agriculture Inputs, Demand and Supply-reg

To assess the projection on Crop Husbandry, Agriculture Inputs , Demand and Supply for 2025-26, 2020-31 and 2035-36, a working group has been constituted under the chairpersonship of Prof. P. S. Birthal, Director, ICAR - NIAP, New Delhi.

II. The composition of the working group is as follows:

S.No.	Name & Organisation	Role
1.	Prof. P. S. Birthal, Director, ICAR - NIAP, New Delhi	Chairman
2.	Dr. C.S.C. Sekhar , Professor IEG	Member
3.	Dr. N. Sivaramne. Principal Scientist, ICAR-NAARM, Hyderabad	Member
4.	Dr. Vijay Laxmi Pandey, IGIDR, Mumbai, CESS	Member
5.	Dr. Shivendra Kr. Srivastava, ICAR-NIAP	Member
6.	Joint Secretary (Crops), Ministry of Agriculture & FW, Krishi Bhavan, ND	Member
7.	Joint Secretary (MIDH), Ministry of Agriculture & FW, Krishi Bhavan, ND	Member
8.	ADG (Seeds), ICAR	Member
9.	Animal Husbandry Commissioner, Ministry of AHDF, Krishi Bhavan, ND	Member
10.	Joint Secretary, Department of Fertilizers, Shastri Bhavan, ND	Member
11.	Additional Chief Secretary(Agri) /Pr. Secretary (Agri), Govt. of MP	Member
12.	Additional Chief Secretary(Agri) /Pr. Secretary (Agri), Govt. of Haryana	Member
13.	Additional Chief Secretary(Agri) /Pr. Secretary (Agri), Govt. of Andhra Pradesh	Member
14.	Additional Chief Secretary(Agri) /Pr. Secretary (Agri), Govt. of Rajasthan	Member
15.	DG, Fertilizer Association of India	Member
16.	Sr. ESA, DACFW, Krishi Bhavan	Member
17.	Representative of DG, CSO, SP Bhavan, ND	Member
18.	Sr. Adviser (Agriculture), NITI Aayog	Member Secretary

III. The Terms of Reference (ToR) for the working group will be as follows:

1. To study and analyse the tends in demand and supply of major food commodities and examine changing preference and habit of consumers for food and related items;

2. To assess the demand and supply of various food commodities and farm inputs namely fertilizers, seeds, credit, feed and fodder for 2025-26, 2030-31 and 2035-36;

iii) To estimate the normative requirements of rice, wheat, maize, nutri-cereals, pulses, foodgrains, oilseeds, sugarcane, fruits, vegetables and animal products viz., milk, meat, egg and fish;

iv) To estimate feasible level of export of the above-mentioned commodities for the years 2025-26, 2030-31 and 2035-36.

IV. The Chairman of the Working Group may co-opt any other official/non-official expert/representative of any organization as member(s), if required.

V. The Working Group may examine and address any other issues which are important though not specifically spelt out in ToR. The Working group may devise its own procedure for conducting its business/meetings/field visits/constitution of sub-group, etc.

VI. The expenditure of the members on TA/DA in connection with the meetings of the Working Group or any work incidental to functions of the Working Group/sub-group will be borne by the parent Department/Ministry/Organisation/State Government for official members. For non-official members-NITI Aayog may bear the TA/DA as admissible to Class-I officers of the Government of India.

VII. The Working Group will submit its Report within 9 months to NITI Aayog.

(Dr. Neelam Patel)
Sr. Adviser (Agriculture and Allied Sectors)
Email: neelam.patel@gov.in
Tel. No. : 23096613

Distribution:

Chairman and all Members of the Working Group

Copy to:

(i) Sh Manoj Ahuja, Secretary, Ministry of Agriculture and Farmers Welfare, Krishi Bhavan-110001for kind information
(ii) Shri Jatindra Nath Swain, Secretary, Ministry of Animal Husbandry, Dairying and Fisheries Krishi Bhavan-110001 for kind information
(iii) Ms Arti Ahuja, Secretary, Ministry of Chemicals and Fertilizers, Shastri Bhavan-110001

Copy for information to

(i) PS to Vice Chairman
(ii) Sr. PPS to Member RC
(iii) Sr. PPS to CEO

File No. Q-11018/02/2016-Agri
Government of India
National Institution for Transforming India
(Agriculture Vertical)

Subject: Minutes of the 1st Meeting of Working Group on Demand and Supply projections of Crops, Livestock, Fisheries and Agriculture Inputs –reg.

1. The first Working Group (WG) Meeting on Demand and Supply projections of Crops, Livestock, Fisheries and Agriculture Inputs, constituted vide O.M dated 17th August, 2022 was held under the chairpersonship ofMember (Agri), NITI Aayog on 6th October 2022 at 1000 hrs in Room No. 500 (Bengal Tiger), NITI Aayog. The Meeting was held in hybrid mode (in-person and virtual mode). The list of participants is enclosed as Annexure–I.
2. At the outset, Dr Neelam Patel, Sr. Adviser (Agri) welcomed the Hon'ble Member (Agriculture), NITI Aayog and members of the Working Group. It was shared that the Working Group has been constituted as per the directions of Hon'ble Member (Agri), NITI Aayog and it's a time-bound task. The timely release of the desired projections will enable Indian policy-makers in taking decisions based on empirical datasets.
3. Hon'ble Member (Agri), NITI Aayog acknowledged that the Agriculture Vertical has undertaken this task second time after constitution of NITI Aayog and this exercise is immensely useful. It was mentioned that the long-term sectoral growth projections used to be published by the Planning Commission of India. Since, NITI Aayog was constituted in 2014, development agenda for 3 and 5 years for various sectors have been published by the think-tank. It was shared that Demand and Supply projections for agrifood commodities are often referred in many high-level meetings chaired and extensively used in food management policy of India. In 2016, a Working Group on Demand and Supply projections was constituted by NITI Aayog under the chairmanship of Dr Pramod Kumar, Professor, Institute of Social and Economic Change, Bangalore. The projections were given till 2032-33. These estimations are helpful in addressing many issues related to agri-business, farmers' welfare, inflation control, buffer stocking, state agri-ecosytem, food management etc. and support in devising planning measures for sustainable agricultural practices- production & value chain. The Terms of Reference (ToR) had been identified for the Working Group that will be chaired by Prof Birthal. The chairman can decide on co-opting a few members or constitutesub-groups to drive the task. However, the number of experts in the WG should not be very large.Also, it was shared that an independent short term study can be proposed by the Group to fill any data gap needed by the WG.NITI Aayog can consider funding of such short term study.
4. Prof P.S. Birthal, Chairman of the Working Group shared that a small group meeting was convened to discuss the study approach, methodology to steer this task. The methodological approaches and data requirements were presented by Dr S.K. Shivendra.

5. Hon'ble Member mentioned that WG may see historical trend in agri-food sector after 1970. It emerged that in some cases like supply, it would be a better approach to prepare state level estimates and aggregate them to arrive at National level estimates. The NABARD or CSO databases can be explored for estimating credit demand.
6. The WG noted the episodes of sharp price rise in the case of dry fodder and underlined the need to prepare estimate of demand for dry fodder in the country.
7. All the members acknowledged that there is a need of empirically drawn demand-supply projection for policy-makers - both Central and State Government to address issues like availability of agri-inputs esp. bio-fertilizers/organic fertilizers, Nano-fertilizers, feed and fodder for livestock in states etc. The WG members assured full support in timely completion of the report.
8. The meeting ended with a vote of thanks to the chair.
   The Action Points from the meeting are as follows:

    1. To share the list of co-opted Members/Members if considered essential or sub-groups (Action: Chairman)
    2. To share the list of datasets required for the study and source (Action: Chairman)
    3. To prepare a list of interactions with Industry/associations/Institute/others. (Action: Chairman and Member Secretary)

Annexure-1

List of Participants

S.No.	Name & Organization
1.	Prof. P. S. Birthal, Director, ICAR - NIAP, New Delhi
2.	Smt Neeraja Adidam, Joint Secretary, Department of Fertilizers, Shastri Bhavan, ND
3.	Sh. Shankar L., Joint Commissioner, DoF, MoFAH&D
4.	Dr Vijay Laxmi Pandey, IGIDR, Mumbai, CESS
5.	Dr Shivendra Kr. Srivastava, ICAR-NIAP
6.	Sh. Kedar Nath Verma, Director (MIDH), Ministry of Agriculture & FW, Krishi Bhavan, ND
7.	Dr O.P Chaudhary, Joint Secretary, DAHD, Krishi Bhavan, ND
8.	Sh. B.M Sahare, Additional Director (Agriculture), Bhopal, MP
9.	Sh. Jag Raj Dandi, Joint Director, Dept. of Agriculture, Haryana
10.	Dr Subhra Sarkar, Deputy Director General, National Accounts Division (NAD), MoSPI
11.	Sh. Kana Ram, Commissioner (Agriculture), Rajasthan (joined via virtual mode)
12.	Dr. R.K Tewatia, Director (Agriculture Science), Fertilizer Association of India
13.	Sh. Arputhaswamy (IES), DES, Ministry of Agriculture and Farmers Welfare
14.	Ms Shraddha Pal, Asst. Director, Animal Husbandry Statistics Division, DADH
15.	Sh. Dipankar Mishra, Asst. Director, DAH&D
16.	Dr Neelam Patel, Sr. Adviser (Agriculture), NITI Aayog
17.	Dr Tanu Sethi, Sr Associate (Agri), NITI Aayog

File No. Q-11018/02/2016-Agri Government of India
National Institution for Transforming India (Agriculture Vertical)

Minutes of the consultation of the Working Group on Demand and Supply projections of Crops, Livestock, Fisheries and Agriculture Inputs –reg.

1. A consultation was organised under the chairmanship of Hon'ble Member (Agri), NITI Aayog to discuss changing food consumption and production patterns (Terms of References no. 1 of the working group constituted on Demand and Supply projections) on 27th February 2023 (Monday), 3:00- 5:30 PM at Room No. 122, NITI Aayog. In absentia of Hon'ble Member, NITI Aayog, the consultation was chaired by Prof Dr. Pratap Singh Birthal, Chairman of the Working Group and Director, ICAR- National Institute of Agricultural Economics and Policy Research. The list of participants is enclosed as annexure.
2. At the outset, Dr. Neelam Patel, Sr. Adviser (Agri), NITI Aayog and Member Secretary of the working group welcomed members of the Working Group, Sr. Government Officers and representatives from various Associations.
3. Dr. Birthal welcomed the participants and briefed about the working group task and highlighted the importance of projections on demand and supply of agri-commodities for food security along with imports and exports. For calculation of Demand projections, data is inevitable and it was requested that respective Ministry/Departments may share the requested data sets on priority.
4. A Presentation on food consumption and demand was made by Dr S. K Srivastava, Senior Scientist, ICAR-NIAP. The presentation covered changing consumption patterns and food demand of Indian households till 2011-12, preliminary estimates on normative food demand and models adopted in the study.
5. Detailed discussion was held on coefficient of estimates and future scenarios, changing food preferences towards value added food products, future model for the study etc. It was iterated that latest data sets are required for making projections.

The agreed Action Points are as follows:

1. To send reminder to respective Ministries/Departments to share state-wise time series data on Area, production, productivity of horticultural crops, milk, non-veg items, crops, etc. on priority. (**Action:** Member Secretary and Respective Ministry/ Departments).
2. To convene following meeting of Stakeholders:
   i. With MoSPI officials to discuss the use of supply use tables (SUTs) and food balance sheet;
   ii. With the food processing Industry and Hotel Association to discuss third processing – market share, food utilization and waste etc.
   iii. With Animal Feed Industry Association

(Action: Member Secretary)

3. To share unit-level household survey data, updated balanced diet recommendations for children (age group wise) as recent report (2020) does not has values for children. This data will help in studies related to projections on recent trend in consumption pattern and estimation of population weighted - all India average balance diet recommendations for moderate and sedentary activity (**Action:** ICMR-NIN).
4. To visit ICMR-NIN for collecting data (**Action:** Dr Sivaramane, N., Principal Scientist, ICAR-NAARM and other Members).
5. To provide estimates on diversion of raw produce (individual food items) to processing industry in quantity terms in India and extent of direct& indirect uses of food commodities (edible oils, cereals, pulses, milk, etc.) (**Action:** The Food Processing Industry association, Indian Oilseed and Produce Export Promotion Council, India Pulses and Grains Association, Indian Sugar Mills Association, and Indian Dairy Association).

Consultation on Demand and Supply projections of Crops, Livestock, Fisheries and Agriculture Inputs for 2025-26, 2030-31 and 2035-36

Monday, 27th February 2023 (3 :00 PM-5:30 PM)

Venue: Room no. 122, First Floor, NITI Aayog

Sr. No.	Name	Designation	Ministry/Department	Signature
1.	Jagtaj Dandi	Joint Director	Agriculture, Haryana State Govt.	
2.	Agrima Srivastava	Assistant Manager-Regulatory	FSII, Bayanash Seeds	
3.	C.R. Sehgal	Professor	Institute of Economic Growth, D.U.	
4.	Raka Saxena	Principal Scientist	ICAR-NIAP	Raka Saxena
5.	Malika Verma	Director-govt affairs	FSII	
6.	P S Birthal	Director,	NIAP	
7.	Neelam Patel	Sr. Adviser (NITI)	NITI Aayog	
8.	Shubha Thakur	JS Agri	D/o A+FW	
9.	Dr. D.K. Yadav	ADG, (Retd)	ICAR	
10.	Ritesh Sharma	Executive Food Regulatory Affairs	AIFPA	
11.	RAJEEV KUMAR	DIRECTOR	MoSPI	
12.	Arpit Saxena	Advisor	MoAFW-DES	
13.	MANOJ KUMAR	Deputy Secretary	D/o Fertilizers (M/o C&F)	27.02.2023
14.	Dr. Niyati Joshi	Director	D/o Fisheries	
15.	Lalit Kumar	Sr. Agronomist	FAI	Lalit Kumar
16.	R.K. Tewatia	Director (Agril. Sciences)	FAI	
17.	A.K. Dixit	Pr. Scientist (ICAR-CIRG)	ICAR-	
18.	Sivaraman N	ICAR-NAARM	ICAR	
19.	Ranjit Kr. Paul	ICAR-IASRI, New Delhi	ICAR	
20.	Dilip Mahajan	Dy. Md. (Tech. & Cons.)	ISMA	
21.	S.L. Srivastava	Sr. Scientist	ICAR-NIPB	
22.	Dr. Tanu Sethi	Sr. Associate	NITI Aayog	

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Designed by:

NITI Aayog