

Drivers of Agrifood System Transformation in Odisha



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Sarba Narayan Mishra, Subhrajyoti Mishra, Manmeet Ajmani,
K.R. Ashok, Debdudd Behura and Manoj Kumar Das

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Acronyms

AFS	agrifood system
FPOs	farmer producer organizations
GVA	gross value added
ORMAS	Odisha Rural Development and Marketing Society
OUAT	Odisha University of Agriculture and Technology
SHG	self-help group
TE	Triennium Ending

Preface

The agrifood system (AFS) encompasses all processes and actors involved in food production, processing, distribution, and consumption. Such systems are dynamic, adapting to urbanization and growing demands. This report is a part of the consultative assignment on the “Drivers of agrifood system transformation in Odisha” given in 2023 to the Agriculture Consultancy Support Service Cell (ACSSC) at Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, by the International Food Policy Research Institute. The objectives of the assignment were to identify and analyze various internal and external drivers of AFS transformation in Odisha, along with various policy options for its future growth in the state.

For this purpose, a stakeholder’s consultation meeting, entitled “Agrifood Value Chain in Odisha—Challenges and Opportunities,” was organized by ACSSC at Krushi Bhawan, Bhubaneswar, Odisha, on 29 November 2023. The proceedings of the meeting were compiled and published on both the OUAT and the CGIAR websites. Further, a dissemination seminar was organized by ACSSC on 3 September 2024 to obtain expert opinion, feedback and suggested policy recommendations based on the contents of the penultimate draft of this report. Participants at the seminar include stakeholders representing national and international organizations, government officials, members of faculties and scientists of universities and the Indian Council of Agricultural Research (ICAR) institutions, representatives from civil societies, agriculture and marketing experts, and private companies involved in agrifood value chains in Odisha.

There have been several challenges in completing the assignment in time owing to the unavailability of validated state-level secondary data (published and unpublished), keeping in view the extensive scope of the topic, which covers the entire agrifood system of the state. A vibrant tapestry of activities of diverse stakeholders characterizes Odisha’s agrifood system. Nonetheless, smallholder farmers face significant challenges, particularly from climate-related shocks, which are reflected in fluctuations in the agricultural gross value added for the state. Interestingly, many farmers are now earning more from wage work than from their traditional farming. This shift in livelihood patterns of smallholder households is driven by factors like population growth, urbanization, and rising incomes, all of which have led to a surge in demand for higher-value food products.

Innovative technologies, such as Bt cotton, high-yielding hybrid maize varieties, and climate-resilient crop varieties, have played a crucial role in boosting productivity and encouraging crop diversification in Odisha’s agricultural sector. Government initiatives, including increased funding for irrigation, subsidized credit, and farmer welfare programs, have been vital in shaping this landscape, although the fisheries sector is lagging and needs more attention.

Improved rural infrastructure, like better roads and improved market access, has greatly supported this transformation in Odisha’s AFS. Community organizations, including agricultural producer organizations and self-help groups, are making strides with initiatives like Shree Anna Abhiyan (the special programme for promotion of millets in tribal areas of Odisha).

To revitalize rural communities and their economies across Odisha, efforts are required to strengthen rural non-farm sectors, enhance farm productivity, and improve logistics along with cold chain facilities. Supporting small farmers through better access to resources including land, labor, technologies and farm inputs, encouraging crop diversification, and investing in agrifood processing and digital marketing are essential steps toward ensuring sustainable growth and economic vitality across agrifood value chains in Odisha.

Dr. Sarba N. Mishra

Director
Agriculture Consultancy Support Service Cell
Odisha University of Agriculture and Technology
Bhubaneswar, Odisha
India

Abstract

Globally, agrifood systems (AFS) are experiencing rapid transformation driven by a range of factors. This transformation process is also observed across several states of India, including Odisha. This study develops a conceptual framework to examine the key drivers of AFS transformation in Odisha. Analytical tools, including trend analysis, the Simpson Index, and the Just-Pope Yield function, were used to assess the impact of various determinants of changes in the state's AFS. The report presents an analysis and breakdown of growth trends in the agrifood system over the last two decades, identifies constraints and opportunities for future growth, and evaluates the coherence of government agricultural policies, offering direction for future policies to manage and motivate AFS transformation in Odisha.

Odisha's AFS is characterized by diverse stakeholders, with smallholder farmers facing significant challenges, particularly from climate-induced shocks and the volatility in agricultural gross value added (GVA). Among farming households, wage income now surpasses earnings from traditional agricultural activities, such as crop cultivation and livestock production. Several demographic and economic factors, including population growth, urbanization, and rising incomes, have profoundly influenced the structure and operations of the AFS, as evidenced by increasing demand for higher-value food products, including processed foods. The adoption of innovative technologies, such as Bt cotton and climate-resilient crop varieties, has enhanced farm productivity and profitability, driving crop diversification. Increased use of purchased farm inputs, such as high-yielding variety seeds, inorganic fertilizers, pesticides, and agricultural machinery, has further shaped Odisha's agrifood landscape.

Government policies, including higher annual budget allocations for irrigation infrastructure, climate-resilient technologies, subsidized credit and insurance, and farmer welfare programs, have been instrumental in shaping Odisha's AFS. However, despite strong growth, the fisheries sector remains underfunded compared to other subsectors. Improved rural infrastructure—such as expanded road and irrigation networks, grain and cold storage facilities, mobile connectivity, and improved market access—has contributed positively to AFS transformation in the state. Additionally, rural organizations, including farmer producer organizations (FPO), self-help groups (SHG), Krishi Vigyan Kendra (KVK) and agricultural extension centers, have played a crucial role in advancing the state agricultural initiatives, such as Shree Anna Abhiyan, the special programme for promotion of millets in tribal areas of Odisha. The increasing number of hotels and restaurants, coupled with rising investments in the agrifood industry, underscores the expanding role of the agro-processing sector in Odisha's economy.

To revitalize rural economies, efforts should focus on boosting rural non-farm sectors, enhancing farm productivity, and strengthening infrastructure, particularly logistics and cold chain facilities. Investments in agrifood processing, promoting digital marketing, and fostering climate-resilient technologies are also important. Small farmers need support through strengthened FPOs, better access to quality seeds and mechanization, especially women farmers. Policies should be modified to promote increased crop and enterprise diversification, fishery sector growth, and organic farming. Agrifood parks and research in processing technologies can increase value addition and promote entrepreneurship within the AFS. Finally, solar energy integration will ensure sustainability and economic growth across agrifood value chains.

Keywords: Agrifood system transformation, drivers, climate change, resilience, natural disasters, food and nutritional security.

1 Introduction

The concept of 'food system' is evolving rapidly (Béné et al.2019). A more holistic concept of a food system has gained traction among both scholars and policy-makers (Ericksen 2008; Global Panel on Agriculture and Food Systems for Nutrition 2016) with a perspective that integrates all the elements, which includes environment, people, inputs, processes, infrastructures, and institutions, among others; activities that relate to the production, processing, distribution, preparation, and consumption of food; and the output of these activities, including socioeconomic and environmental outcomes (HLPE 2017). Agrifood systems (AFS) remain a major employer, particularly in poorer countries and for the poorer segments of society (Abdelaziz et al. 2020).

The sustainability and resilience of AFS are under serious threat unless current trends in the drivers affecting AFSs change (FAO 2022). These systems around the world presently face multiple challenges, such as insufficient food access, nutritional insecurity, and climate change-induced agricultural productivity disruptions (Piñeiro et al.2020). Many of these challenges arise from the difficulties in adopting food innovations and technology (Lusk et al. 2018), the impact of the environmental changes on agriculture (Libby 2004), concerns about food safety and regulatory barriers (Hooker and Caswell 1996), and issues related to workers' health, safety, and wages, which lead to supply chain disruptions (Gereffi and Fernandez-Stark 2016).

The agrifood systems in India, including Odisha (Figure 1.1), are also transforming rapidly, reflecting similar global challenges. Odisha has an agrarian economy with more than 75 percent of the population residing in rural areas. The manufacturing sector contributed 37 percent of the state economy followed by the services sector (36 percent), agriculture (16 percent), and mining (11 percent) over TE 2022-23, the three-year period ending 2022-23. Within the agriculture sector, the contribution of crops was 58 percent followed by forestry (16 percent), livestock (14 percent) and fishery (12 percent). The share of crops in total agricultural gross value added (GVA) has declined by 8 percent during the last decade, while the fishery sector has registered an impressive increase of 6 percent. Further, Odisha's agriculture is subject to the vagaries of the monsoon and natural calamities, which are reflected in the highly volatile GVA growth seen in Odisha's agriculture compared to that of the nation.

Figure 1.1 Location of Odisha within India



Marginal and small farmers constitute around 93 percent of the operational holdings in Odisha (Agriculture Census Division 2020). The 2019 Situation Assessment of Agricultural Households report showed that between 2012-13 and 2018-19, while the percentage of marginal farmers as a share of all farmers declined from 76.5 to

70.4 percent in India, their share remained almost static at 77 percent in Odisha. Landless agricultural households, which constituted 12.8 percent of the total farming households in the state in 2012-13, declined to 8.4 percent by 2018-19. The average size of farm landholdings was 0.40 hectares (ha) in Odisha compared to 0.55 ha in India (MSPI 2021).

The gross value added from the agrifood industry experienced a decline in recent years, dropping from Rs 20 billion in 2011-12 to Rs 9 billion in 2016-17.¹ However, this trend reversed in 2021-22, reaching Rs 25 billion. In contrast, the GVA from manufacturing industries increased more than four times between 2011-12 and 2021-22, from Rs 222 billion to Rs 976 billion.

In Odisha, rising urbanization, population growth, and increasing incomes have led to a shift in consumption patterns, with reduced reliance on cereals and increased demand for processed foods and animal products. These changes are transforming the agrifood system in ways that reflect broader global trends.

The transformation of agrifood systems must address the interconnected challenges of feeding a growing population, protecting the environment, combating climate change, improving nutrition and health, reducing inequality, and ensuring global stability. Without significant changes, current systems may not be sustainable, equitable, or sufficiently resilient in the long term. Studying the drivers of AFS transformation in Odisha is crucial to understanding the factors that influence food security, sustainability, and economic growth in the state. This knowledge will help inform policy decisions to improve resilience, enhance productivity, and ensure equitable outcomes for all stakeholders involved in the AFS. By identifying key drivers of change, we can address emerging challenges such as climate change, inequality, and technology adoption, creating a more robust and sustainable AFS for Odisha.

With this perspective, our study evaluates the factors affecting the transformation of AFS in Odisha with the following objectives:

- To understand the concept of AFS transformation and identify the drivers of change.
- To analyze trends in the drivers of the AFS transformation in Odisha.
- To suggest suitable policies for improving the AFS in the State.

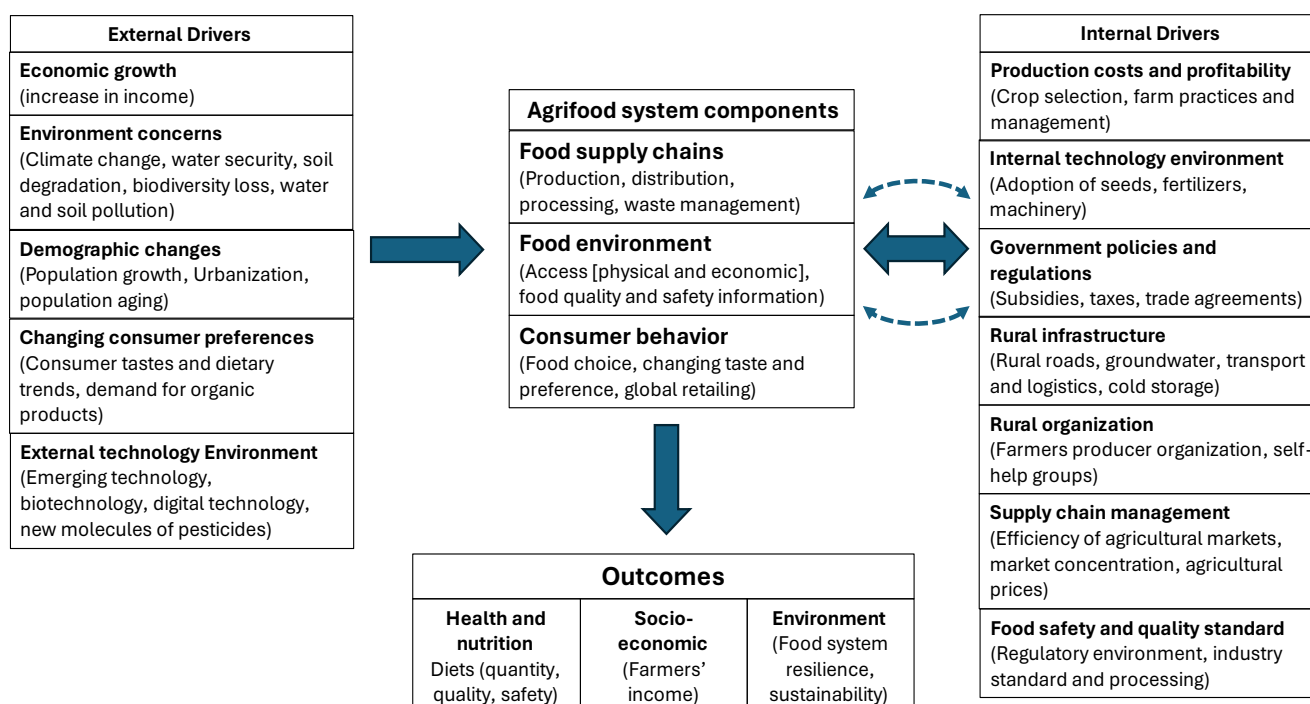
¹In this report, the Indian rupee is denoted as Rs.

2 Methodology

2.1 Conceptual model for agrifood transformation

An agrifood system (AFS) refers to the broad network of activities required to produce, process, distribute, and consume food. It involves everything from agricultural inputs, like seeds, water, and fertilizers, to farming techniques, supply chain logistics, and market operations that move food from farms to consumers. AFSs are shaped by various factors, including environmental conditions, economic policies, societal norms, and technological innovations. These factors are critical for ensuring food security, supporting economic livelihoods, and influencing environmental health, making AFSs essential for achieving sustainable global development. Thus, the AFS is a complex network influenced by many external and internal drivers. Several key components of the system interact to shape overall AFS outcomes related to health and nutrition, socioeconomic measures, and the environment (Figure 2.1).

Figure 2.1 Conceptual framework of an agrifood system—its components and drivers of change



Source: Conceptualized by the authors.

2.2 Analytical Tools

2.2.1 Trend analysis

As with all AFSs globally, the AFS in Odisha has been influenced by several internal and external drivers. These drivers were analyzed by collecting secondary data from published sources and government offices, such as the Department of Agriculture and Farmers' Empowerment of the Government of Odisha. The data was subjected to tabular, percentage, and trend analysis to understand patterns and changes over time, providing a comprehensive view of the factors transforming the AFS in Odisha.

2.2.2 Simpson Index

Crop diversification is one of the important internal drivers influencing the transformation of AFSs. To quantify crop diversification in Odisha's agriculture, the Simpson index was calculated. It is the most suitable index for measuring the diversification of crops in a particular geographical region and is calculated as follows:

$$\text{Simpson Index} = 1 - \sum P_i^2$$

where $P_i = A_i / \sum A_i$ is the proportion of the area devoted to the i^{th} crop activity in the total crop acreage.

If the Simpson Index for a zone or region is near zero, it indicates that the zone is relatively specialized in growing a particular crop. In contrast, if the index is close to one, then the zone is diversified in terms of the area allocated to different crops.

2.2.3 Just and Pope production function

Climate variables, like temperature and rainfall, are major determinants of the structure and performance of AFSs. The Just-Pope production function (1978) is widely used to analyze the relationship in agricultural production between input use and outputs, incorporating risk and uncertainty. Unlike traditional production functions, which assume a deterministic relationship between inputs and outputs, the Just-Pope model distinguishes between the effects of inputs on the mean (average) level of output and the variance (risk) of output. This distinction allows for a better understanding of how input use affects not only expected yields but also the associated risks. The Just-Pope function allows for a more nuanced understanding of how inputs and climate factors jointly affect agricultural production. The mean production function captures how the independent variables affect the average level of crop yields, while the variance function models how the same variables affect the variability or risk associated with crop production. Higher volatility due to climatic conditions generally leads to greater uncertainty in production outcomes, as reflected in increased yield variance.

To study the impact of climatic variables on Odisha's AFS, agroclimatic zone-specific data on the yields of paddy, maize, and green gram, along with temperature and rainfall for those zones, were considered. The Just and Pope production function is specified as:

$$y_{it} = f(X_{it}\beta) + h(X_{it}\delta)\omega_{it}$$

Where, y_{it} is the yield of the i^{th} crop; $f(X_{it}\beta)$ represents the average production function, and X is a set of independent variables, that includes climate, location, and time period variables. The function $h(X_{it}\delta)$ explicitly models heteroskedastic errors to estimate variance effects. The parameters of $f(X_{it}\beta)$ provide the average effect of climate variables on yield, while $h(X_{it}\delta)$ offers the impact on yield variance. A positive marginal effect on yield variance indicates that an increase in that variable raises the standard deviation of yields, and vice versa.

To estimate the Just-Pope function, the feasible generalized least squares method was used as follows:

1. Ordinary Least Squares (OLS): Estimate the model and obtain the residuals.
2. Logarithm of Squared Residuals: Regress these residuals against X as the independent variables.
3. Predicted Residuals: Calculate the antilogarithm of the predictions from step (2) to obtain consistent variance estimates.
4. Weighted Least Squares: Estimate the original model using the square root of the variance predictions as weights.

This study adopted a fixed effects model, allowing for unit-specific effects for each zone, which does not require the restrictive assumption of zone-specific effects being independent of the covariates (as would be the case in a random effects model). Zone dummies were included in the regression equation to capture invariant zone-specific effects over time.

The analysis included linear climate variables and interactions of regions with temperature and rainfall, accounting for non-uniform effects across regions. The Just-Pope yield function was estimated with alternative specifications by incorporating additional variables such as acreage, annual rainfall (in mm), temperature (mean and standard deviation), and rainfall intensity. Rainfall intensity ranges from 1/12 (uniformly intense) to 1 (a single month receiving the entire annual rainfall). Linear and quadratic time trends were included to capture technological change effects.

The linear mean function $f(X; \beta d)$ is:

$$f(X; \beta d) = \beta_0 + \beta_1 \text{Acreage} + \beta_2 \text{Rainfall} + \beta_3 \text{Temperature} + \beta_4 \text{SD-Temperature} + \beta_5 \text{Rainfall intensity} + \beta_6 \text{trend} + \beta_7 \text{SQ-trend} + \sum_{i=1}^{i=R-1} T_i D_i + \sum_{i=1}^{i=R-1} P_i D_i + \sum_{i=1}^{i=R-1} d_i D_i$$

Where $T_i D_i$ are temperature interaction dummies, $P_i D_i$ are rainfall interaction dummies, and $d_i D_i$ ($i=1,2,\dots$) are the zone-specific dummies taking the values 1 and 0.

The variance function is assumed to have a semi-log linear form:

$$\ln h^2(X; \beta, \eta) = (\delta X + \eta D) = \delta_0 + \delta_1 \text{Acreage} + \delta_2 \text{Rainfall} + \delta_3 \text{Temperature} + \delta_4 \text{SD-Temperature} + \delta_5 \text{Rainfall Intensity} + \delta_6 \text{trend} + \delta_7 \text{SQ-trend} + \sum_{i=1}^{i=R-1} T_i \eta_i + \sum_{i=1}^{i=R-1} P_i \eta_i + \sum_{i=1}^{i=R-1} d_i \eta_i$$

Where, $[\ln h^2(X; \beta, \eta)]$, the logarithm of squared residuals from the first stage OLS, is the dependent variable, and the independent variables are the same as those used in the first stage OLS. η_i is the coefficient of the dummy variables.

The stationarity of the variables was tested before estimating the Just-Pope yield function using a panel unit root test.

3 Drivers of Agrifood System Transformation in Odisha: A Critical Analysis

As discussed, the transformation of the agrifood system (AFS) is determined by several internal and external drivers. In this chapter, a critical analysis is done to understand the drivers that influence Odisha’s AFS.

By way of description, Odisha’s AFS is vital to the state’s economy (Pal et al. 2023). It contributes to the economy through both on-farm activities, such as primary agriculture, and off-farm activities, like processing, trade, input supply and food services. In 2017/18, on-farm activities made up 78 percent of the GVA of the Odisha AFS, while off-farm activities accounted for 22 percent. Fruits and vegetables, livestock, and fisheries play a significant role in Odisha’s AFS compared to other agrifood value chains. However, Odisha’s AFS faces challenges in processing and food services, as their contribution is relatively low. Therefore, there are significant opportunities to enhance the role of off-farm activities to drive growth in the state’s AFS.

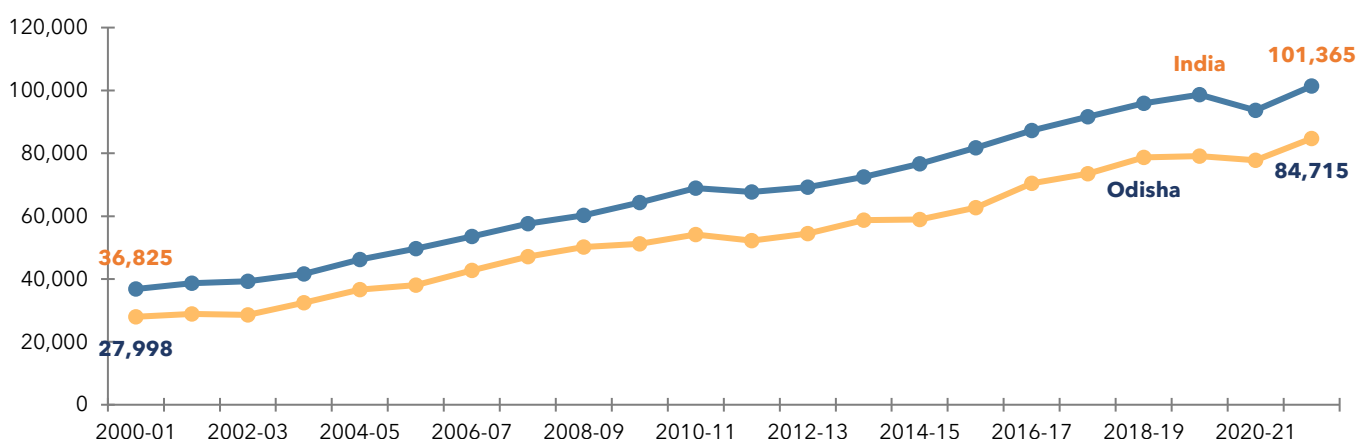
3.1 External drivers of change in the agrifood system of Odisha

3.1.1 Economic growth

Economic growth plays a vital role in transforming AFSs. When economies grow, more resources are available to invest in better infrastructure, tools and technology for farming, making agriculture more efficient and productive. For farmers, this means easier access to good-quality seeds, fertilizers, and equipment, all of which help them produce more food. As economies expand, new markets open up, giving farmers opportunities to sell their produce locally and globally. With rising incomes, people seek a wider variety of nutritious foods, driving improvements in food supply chains. Economic growth also uplifts rural communities by creating jobs, reducing poverty, and enhancing food security.

Per capita income growth. Rising income has a positive impact on the demand for higher-value foods. Odisha witnessed more than a threefold increase in average per capita income between 2000-01 and 2021-22, whereas, in the case of India as a whole, this increase was about 2.75 times (Figure 3.1).

Figure 3.1 Per capita income of Odisha and India, 2000-01 to 2020-21, Rs



Source: Ministry of Statistics and Programme Implementation

Note: Gross value added at constant prices 2011-12 divided by total population.

Changing composition of farm household income. The per capita income of farming households in Odisha in 2018-19 was Rs 59,712 (MSPI 2019). The share of income from farm production in Odisha is comparatively lower

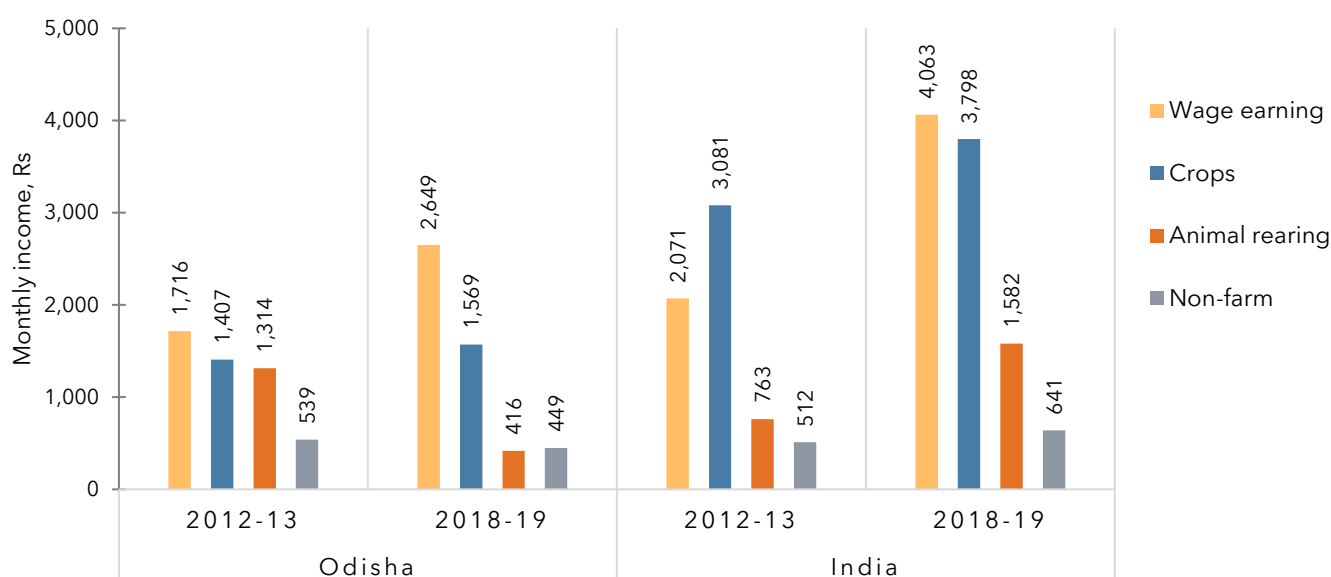
than the national average, with wage-earning being the major source of income in the state, contributing over 50 percent of total income (Table 3.1 and Figure 3.2). Between 2012-13 and 2018-19, incomes from animal rearing and non-farm activities declined significantly in Odisha—earnings from animal rearing declined by 68 percent, whereas earnings from non-farm activities fell by 17 percent. In the case of crops, earnings increased by around 12 percent. Somewhat surprisingly, for agricultural households in Odisha, total monthly income increased only by Rs 107 per month between 2012-13 and 2018-19. In contrast, for agricultural households in India as a whole, average incomes increased by Rs 3,657 over the same period.

Table 3.1 Percent composition of income of agricultural households in Odisha, 2012-13 and 2018-19

	Year	Wage earning	Crops	Animal rearing	Non-farm
Odisha	2012-13	34.5	28.3	26.4	10.8
	2018-19	51.8	30.7	8.1	8.8
India	2012-13	32.2	48.0	11.9	8.0
	2018-19	39.8	37.2	15.5	6.3

Source: Situation Assessment Survey 2012-13 and 2018-19

Figure 3.2 Composition of monthly income of agricultural households, Rs

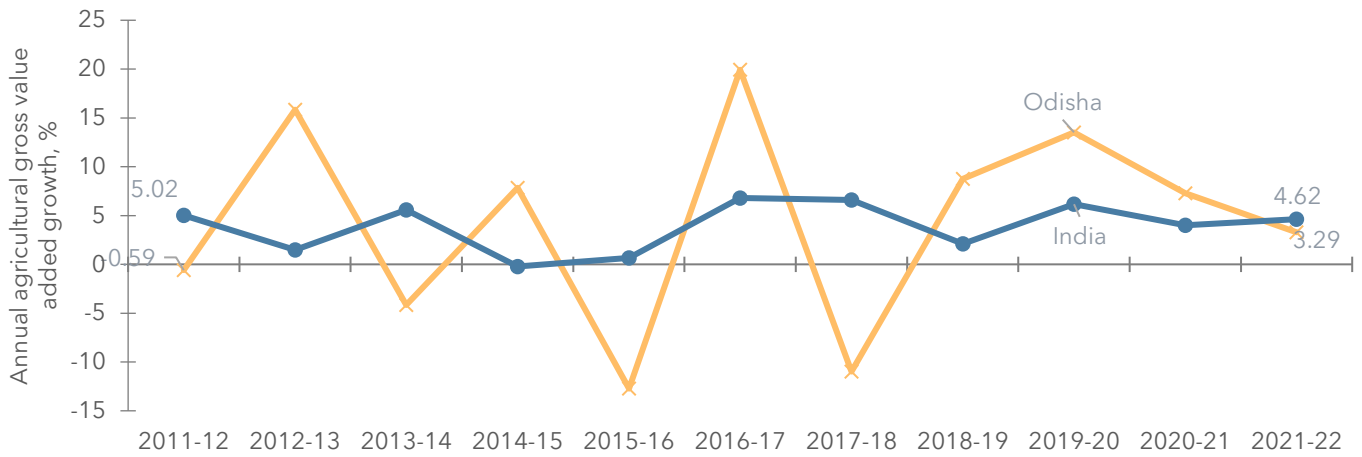


Source: Situation Assessment Survey 2012-13 and 2018-19

Overall, this trend suggests that increasing reliance on wage income may have contributed to rising migration rates in Odisha and across India, which in turn may affect the AFS. If more farm households seek wage income, their reduced involvement in traditional farming and animal rearing could have broader consequences on the sustainability of AFSs.

Performance of the agriculture sector in Odisha. Agricultural GVA growth across years since 2011 in both Odisha and India remained broadly stable with little apparent rise or decline overall (Figure 3.3). However, GVA added by agriculture in Odisha’s economy exhibits considerable instability with high volatility across the years mainly due to climate-induced natural disasters. This volatility may lead to uncertainty in food production and supply, which can impact food security and potentially discourage long-term investments in AFSs.

Figure 3.3 Annual agricultural gross value-added growth for Odisha and India between 2011-12 and 2021-22



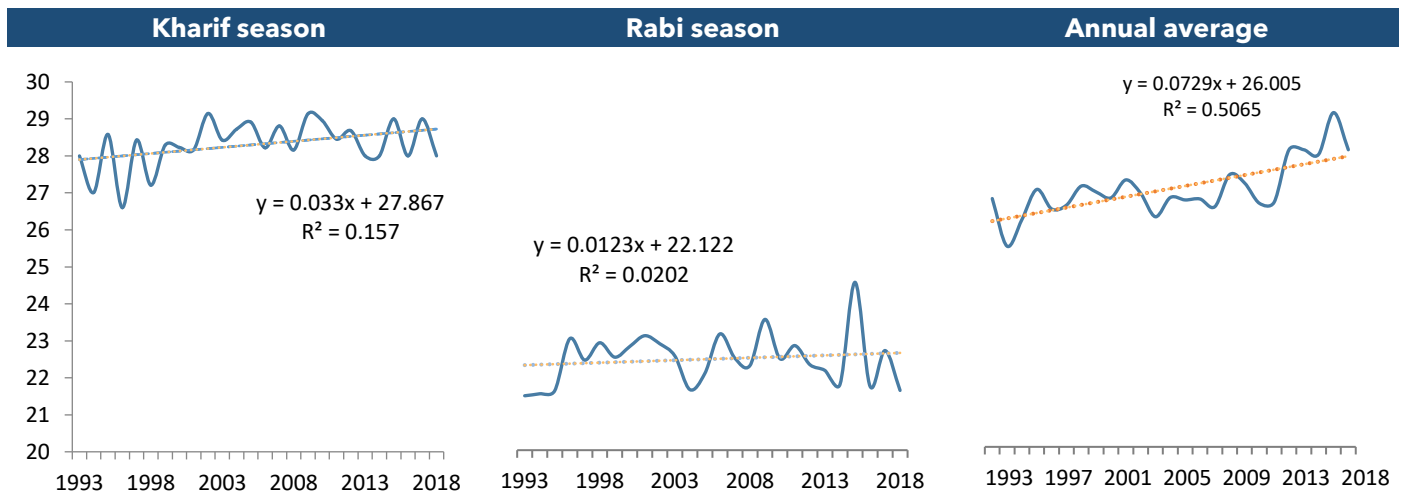
Source: Ministry of Statistics and Programme Implementation

3.1.2 Environmental concerns and impact of climate variability

Changes in climate patterns can affect crop yields and livestock production due to extreme weather conditions, shifting growing seasons, and increased incidence of pests and diseases (FAO 2016).

Temperature. Rising temperatures can reduce crop yields by affecting plant growth, reducing water availability, and increasing the likelihood of heat stress. This can lead to lower agricultural productivity, threatening food security. Figure 3.4 presents the average annual temperatures for the kharif (monsoon) and rabi (post-monsoon winter) seasons, along with the overall average temperature in Odisha between 1993 and 2018. These plots demonstrate considerable variability in temperature over the 25 years.

Figure 3.4 Temperature variability in Odisha, 1993-2018, Celsius



Source: ENVIS (2024), Odisha Agricultural Statistics 2013-14, 2014-15.

Note: As data for 2000 is not available, the average of preceding and succeeding years taken into consideration.

There has been a rising trend in average temperature during both the kharif and rabi seasons, as well as an overall increase in the annual temperature, signaling rising temperature in Odisha. Rising temperatures over time are more apparent in *kharif* than in the rabi season. The results are significant in the context of Odisha, where about 50 percent of the cropped area is under rice cultivation, and more than 90 percent of rice is cultivated in the kharif season.

Rainfall. Rainfall plays a crucial role in AFSs, as it impacts water supply, soil conditions, and plant development. Variability in rainfall through droughts or submergence due to flooding can lead to reduced crop yields, change in cropping patterns, disrupt supply chains, and threaten food security and sustainability of the system. Thus, rainfall

is a crucial factor affecting the AFS. Though the average annual rainfall in Odisha is 1,451 mm, the distribution of the rains can be highly erratic, often causing drought in some regions and flooding in others within the same cropping season (Figure 3.5).

Figure 3.5 Average annual precipitation in Odisha, 1990/91-2020/21, mm



Source: Special Relief Commissioner, Odisha

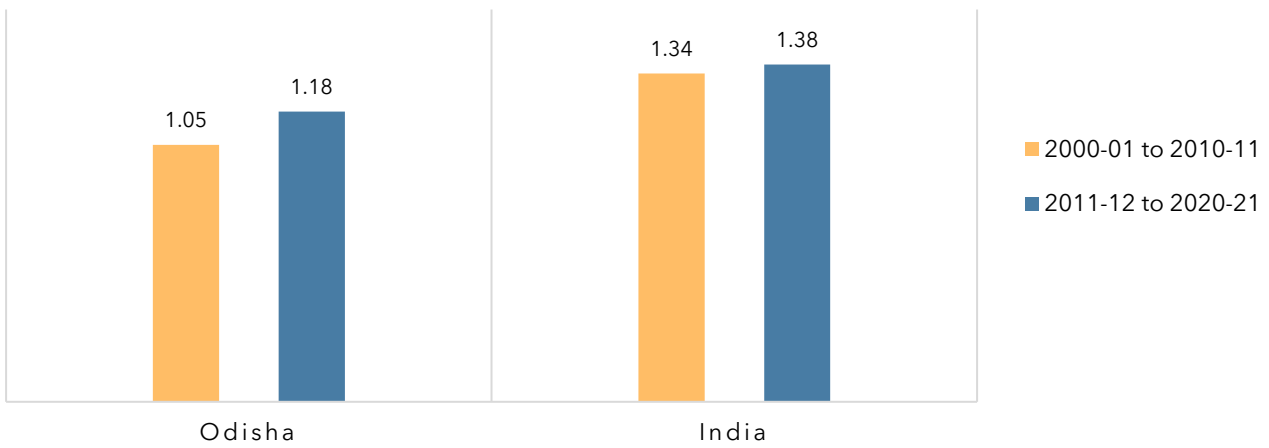
Impact of climate variability on crop yields. To study the impact of climatic variables, such as temperature and rainfall, on crop yields, the Just and Pope production function was estimated using climatic data for ten agroclimatic zones (ACZ) in Odisha over the 25 years from 1993 to 2018. Climate variables can significantly influence both the mean and variance of crop yields in the Just-Pope framework. The analysis included linear climate variables and interactions of regions with temperature and rainfall, accounting for non-uniform effects across regions. Given the data availability and computation issues, only 3 ACZ are considered in the analysis, namely, East and Southeastern Coastal Plain zone, North Central Plateau zone, and Western Undulating zone.

The agroclimatic zone-specific study reveals that rainfall had a significant positive effect on paddy yields in the Western Undulating agroclimatic zone but no significant effect in the other zones (Annex Table 1). Similarly, higher rainfall intensity decreased green gram yields mainly due to excessive or erratic rainfall but had no significant impact on the yields of other crops. On the other hand, variability in rainfall intensity significantly reduced paddy yields. Also, this variability negatively impacted green gram yields in the North Central zone.

3.1.3 Demographic changes

Population growth. The rise in population has a profound impact on the AFS in any given economy. A growing population increases the demand for food and puts pressure on natural resources, such as land and water, which can affect agricultural sustainability (FAO 2017). With a sizeable youth population, India has witnessed growing demand for ready-to-cook, ready-to-eat, and ready-to-serve products. Also, India has witnessed tremendous growth in food delivery platforms, such as ZOMATO, Swiggy, and UBER Eats, which cater to the changing tastes and preferences of a diversified culture and population. In Odisha and India, the population over the last two decades has risen at similar rates, as shown in Figure 3.6.

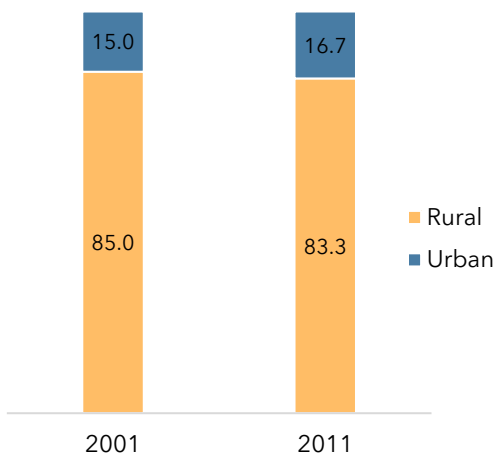
Figure 3.6 Decadal population growth of Odisha and India, percent



Source: Ministry of Statistics and Programme Implementation

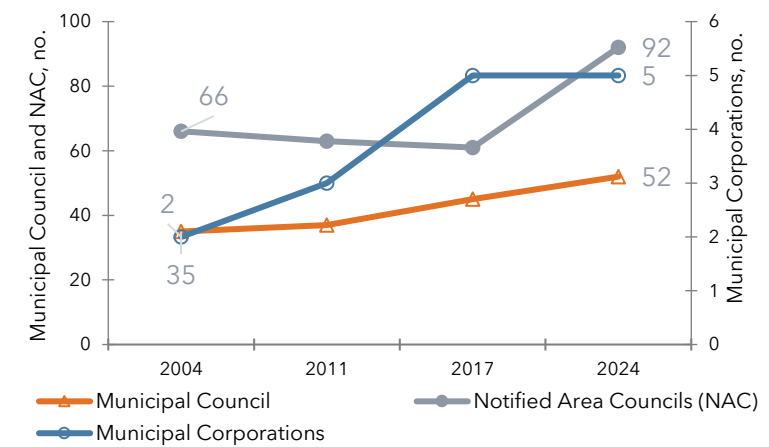
Expanding urbanization. Urbanization is changing the food system globally, particularly in Sub-Saharan Africa and South Asia (de Bruin et al 2021). In the case of Odisha, there has been a rise in the share of the total population that lives in urban areas (Figure 3.7). A reflection of this is that, over the last two decades, there has been a rapid rise in urban local government bodies—Municipal Corporations, Municipal Councils, and Notified Area Councils—in the state (Figure 3.8). This rapid expansion of urban areas reflects migration from rural areas and has potentially significant impacts on Odisha’s AFS. Eating out has now become common among the urban populace, which will have a bearing on food processing, packaging, and food retailing activities, as reflected in the rise of restaurants and food stalls across urban areas in Odisha.

Figure 3.7 Urban population share in Odisha, 2001 and 2011



Source: Ministry of Statistics and Programme Implementation

Figure 3.8 Trends in number of urban local government bodies in Odisha, 2004-2024



Source: IPRD 2004, 2011, 2017; HT news

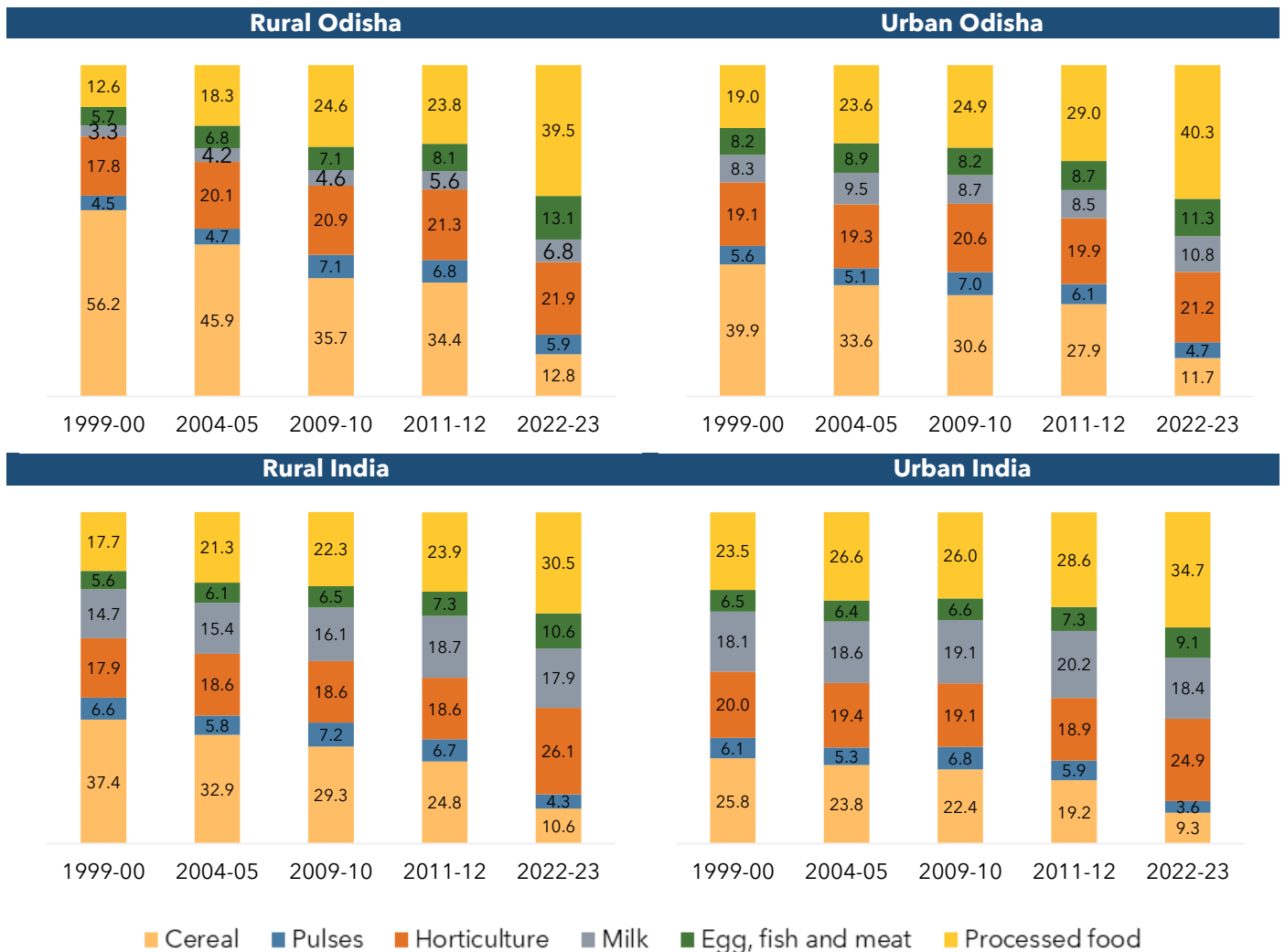
3.1.4 Changing consumer preferences

Consumers reallocate expenditure to products that better align with their evolving preferences. As consumers increasingly prioritize factors such as health and nutrition, affordability, accessibility, sustainability, and convenience, food systems must adapt to meet these evolving demands. This can lead to shifts in agricultural production patterns and supply chains. Ultimately, changing preferences push food systems toward greater innovation and sustainability.

In rural Odisha, the share of consumption expenditure reveals that cereal consumption declined significantly by 43 percent between 1999-2000 and 2022-23. The same trend was observed in urban Odisha (Figure 3.9). Over the same period, a considerable increase was seen in the share of consumption expenditure on processed food in

both rural and urban Odisha, signaling changing consumption preferences towards processed and convenient foods. Similarly, consumption of nutrient-rich, high-value products like meat, milk, and horticultural products has either increased or remained the same during this period. Analysis of the changing share in per capita consumption expenditure in India between 1999-2000 and 2022-23 shows a similar pattern. In the decade between 2011-12 to 2022-23, expenditure on cereal consumption declined by nearly 14 percent to reach 10.6 percent in rural India and by nearly 10 percent to reach 9.3 percent in urban India. In the case of processed food, there has been an increase of around 7 percent in rural India and 6 percent in urban India.

Figure 3.9 Per capita food consumption expenditure by food group, rural and urban Odisha and India, percent of total



Source: Ministry of Statistics and Programme Implementation (2014; 2024)

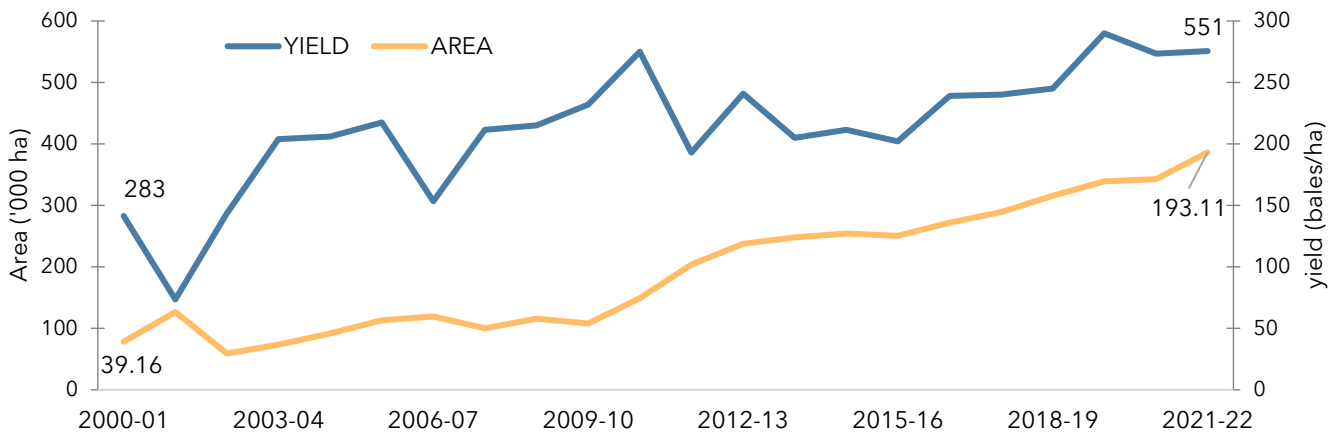
Note: Cereal = Cereal and cereal substitutes, Pulses = Grams, pulses and products, Milk = Milk and dairy products, Processed food = Beverages, processed food, sugar, salt, and edible oil, Horticulture = vegetables, fruits (dry and fresh), and spices

3.1.5 External technology environment

The external technology environment refers to technological factors and innovations originating outside the state or country and not under its control. These include new tools, machinery, techniques in biotechnology, precision farming, and digital solutions developed by research institutions, tech companies, or other sectors outside the state, which farmers can adopt to improve productivity, sustainability, and efficiency.

Spread of GM technology. Genetically modified crops, such as Bt cotton, developed by multinational corporations and approved through the regulatory process, have significantly influenced cropping systems in Odisha. Following the introduction of Bt cotton, the area under cotton in Odisha increased from 39,160 to 193,110 hectares (ha) between 2000-01 and 2022-23, and the yield increased from 283 to 551 bales/ha during the same period, significantly altering cropping patterns (Figure 3.10).

Figure 3.10 Trend in area and yield of cotton in Odisha, 2000/01-2021/22

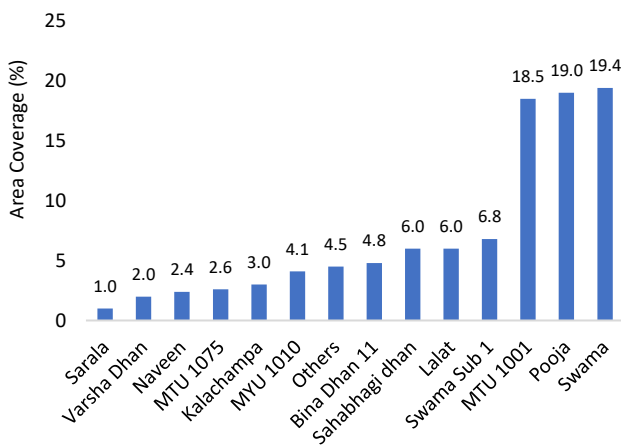


Source: Department of Agriculture and Farmers' Empowerment, Govt. of Odisha and Odisha Agricultural Statistics

Crop varieties from external research systems. Crop varieties from external research systems may markedly influence AFSs in a region or state. Farmers adopt varieties suited to different climates, soils, and disease resistance, which boosts resilience in agriculture. These varieties can increase productivity and contribute to food security by improving both the quantity and quality of crop outputs. External varieties developed for drought or pest resistance can help farmers adapt to changing climate conditions, ensuring the long-term sustainability of the AFS.

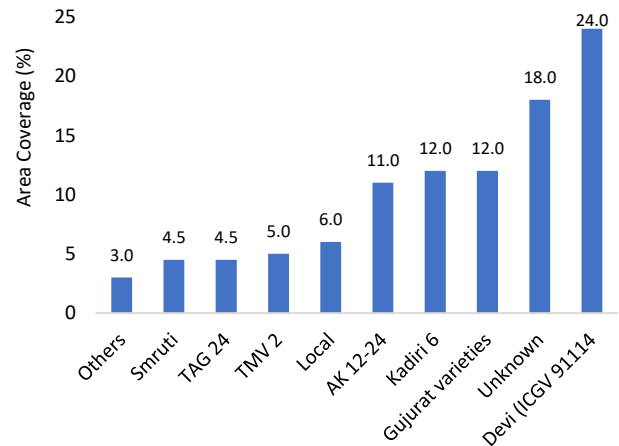
In Odisha, more than 90 percent of the area allocated to rice is planted with high-yielding variety (HYV) seeds. According to the latest study (Nayak et al. 2022), 44.6 percent of the rice area is planted with varieties released by the Regional Agricultural Research Station, Maruteru, Andhra Pradesh, followed by varieties from National Rice Research Institute (22 percent) and the International Rice Research Institute (17.6 percent) (Figure 3.11). These varieties have contributed immensely to enhancing rice production and yields in Odisha, helping improve food supply and security in the state (Raghu, Veetil and Das 2022; Pathak et al. 2018).

Figure 3.11 Rice—predominance of external varieties



Source: Behura et.al. 2020

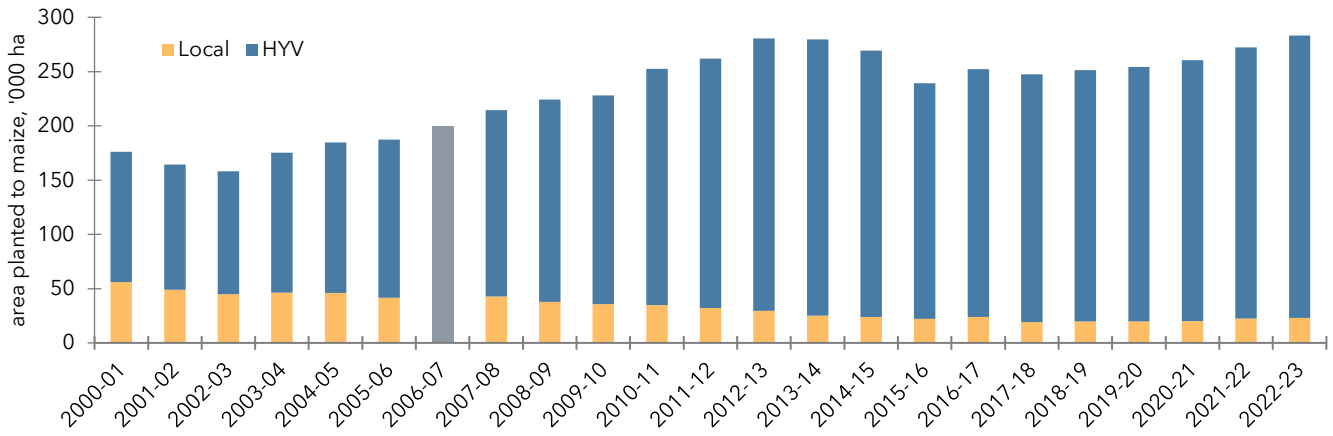
Figure 3.12 Groundnut—predominance of external varieties



Source: Nayak et al. 2022

Note: External varieties refer to those released by the private sector, the Indian Council of Agricultural Research, and other State Agricultural Universities in the country.

Figure 3.13 Maize area allocated to private sector high-yielding varieties, 2000-01 to 2022-23



Source: Department of Agriculture and Farmers' Empowerment, Govt. of Odisha; Odisha Agricultural Statistics
 Note: HYV = "high-yielding variety." No disaggregated data for 2006-07.

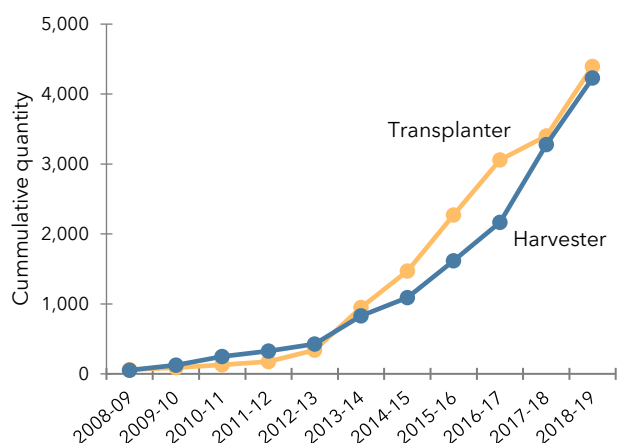
The area under maize has increased from 176,000 ha in 2000-01 to 283,000 ha in 2022-23 (Figure 3.13). The area allocation to maize HYVs significantly increased from 119,960 ha to 260,000 ha during the same period (Figure 3.13). All maize HYV seeds used by farmers in Odisha are for varieties that were released outside the state. These HYV seeds have significantly contributed towards yield enhancement in Odisha, with yields increasing from 1,235 kg/ha to 3,039 kg/ha.

Although the area under groundnut declined from 215,790 to 196,070 ha between 2000-01 and 2022-23, yields have increased from 1,058 kg/ha to 1,823 kg/ha, primarily due to the use of HYV seeds, such as Devi, Kadri 6, AK12-24, and TAG 24 (Figure 3.12). These varieties were contributed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and by research stations outside Odisha.

Mechanization and agrochemical. Mechanization and agrochemicals act as key external drivers of AFSs by enhancing productivity, efficiency, and scalability. Mechanized farming reduces labor, accelerates operations, and boosts yields, while agrochemicals improve pest control and soil health, thus changing the relative profitability of crops produced in AFSs. In Odisha, machinery and agrochemicals are imported from other Indian states and even from outside India. Transplanters and harvesters have significantly altered the cost-price relationships of crops cultivated in Odisha in the last decade. The use of harvesters has cumulatively increased from 53 to 4,228 between 2008-09 and 2018-19, while the number of transplanters increased from 60 to 4,396 over this period (Figure 3.14).

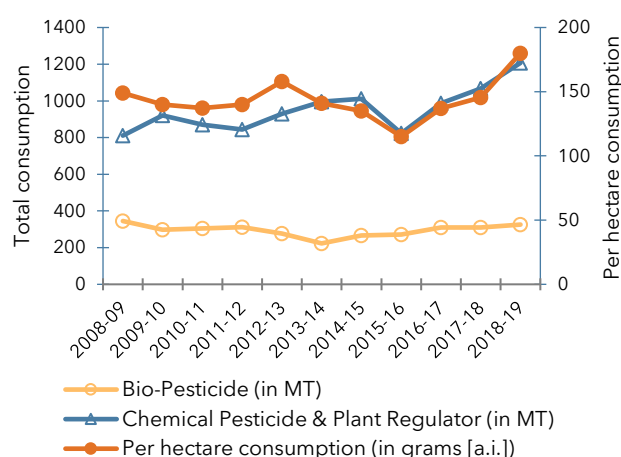
The use of chemical pesticides increased from 811 to 1,207 mt between 2008-09 and 2018-19, while the consumption of bio-pesticides declined from 345 to 325 mt. During the same period, to mitigate the impact of consumption of pesticides also increased from 149 grams of active ingredient (ai)/ha to 180 grams ai/ha (Figure 3.15). These pesticides are mainly technical-grade products of agrochemical industries based outside Odisha.

Figure 3.14 Distribution of transplanters and combine harvesters in Odisha, 2008-09 to 2018-19



Source: Odisha Agricultural Statistics

Figure 3.15 Consumption of pesticides and plant growth regulators in Odisha, 2008-09 to 2018-19



3.2 Internal drivers of change in the agrifood system of Odisha

In shaping the AFS, internal drivers play a crucial role. These drivers include the relative profitability of crops, adoption of modern inputs and machinery, policies and governance, market access, rural infrastructure, and rural organizations. In Odisha, these internal drivers are collectively driving the evolution of the AFS.

3.2.1 Cost and profitability of crops

Farmers make production decisions based on the economic viability of the different crops that they might produce, which influences what crops are grown and how resources are allocated. High profitability encourages investment in new technologies, better practices, and diversification, leading to increased yields and improved food supply and security. Conversely, low profitability can deter farmers from adopting innovative methods, potentially stalling progress. Overall, cost and profitability serve as essential drivers for transforming AFS toward greater efficiency and sustainability.

The cost of cultivation, yields, and profitability per hectare for paddy and green gram are presented in Figure 3.16 and Figure 3.17, respectively.² It is evident that, though the productivity of paddy has been volatile due to climate shocks, it shows an increasing trend. Rice cultivation has proved profitable in recent years, except in 2015-16, which was a drought year. The enhanced minimum support price and bonus of Rs 800 per quintal declared by the Government of Odisha for the year 2024-25 will seriously disrupt the state's rice economy, making area expansion under rice inevitable. In the case of green gram, there has been an increasing trend towards profitability.

²Paddy and green gram are among the top crops cultivated in Odisha.

Figure 3.16 Trends in per hectare cost of cultivation, yield, and profitability of paddy in Odisha

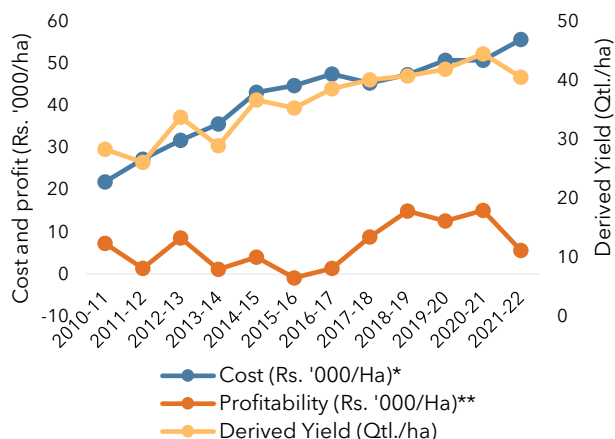
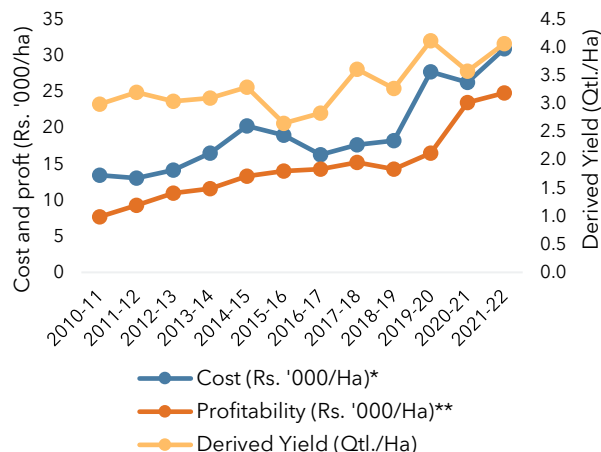


Figure 3.17 Per hectare cost of cultivation, yield, and profitability of green gram in Odisha



Source: Directorate of Economics and Statistics (2023)

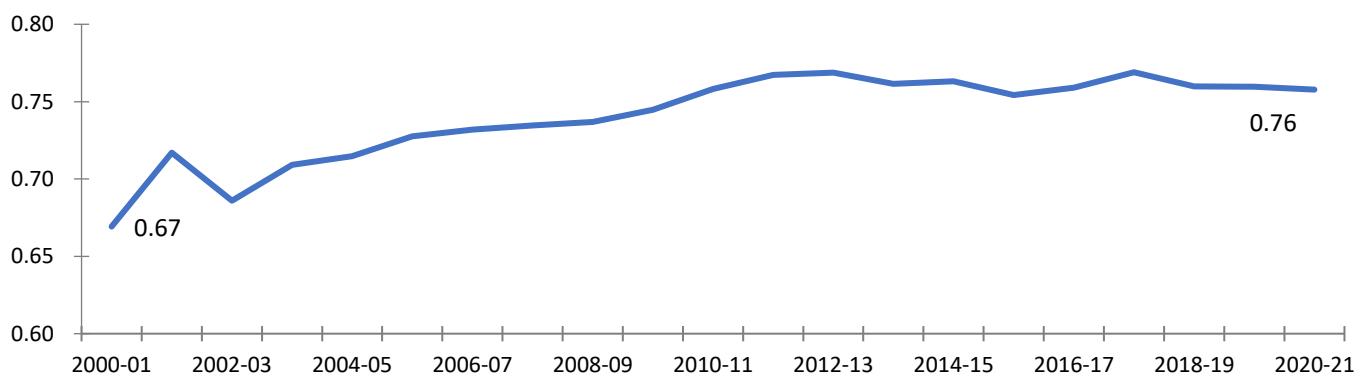
Note: *1) The sum of all costs incurred by the farmer and the value of family labour (A2 and FI, respectively, in the statistical database) have been considered as the cost of cultivation. **2) Cost has been deducted from the total value of the main product and by-product to find profitability. 3) Qtl. = Quintal, 4) ha = hectare.

Crop diversification. Profitability also influences crop diversification, which is very important for a resilient AFS. Crop diversification also plays a vital role in sustaining AFSs by boosting productivity and environmental sustainability. By cultivating a variety of crops, farmers can lessen reliance on a single harvest, thereby reducing risks from pests, diseases, and climatic aberrations. This approach enhances soil health, as diverse plants contribute different nutrients to following crops and lower the chances of soil degradation.

Moreover, crop diversification expands market opportunities by offering a broader range of agricultural products, meeting diverse consumer demands, and increasing farm income. It also promotes biodiversity, which supports essential ecosystem services like pollination and pest management. Ultimately, diverse cropping systems foster sustainable agricultural practices, ensuring long-term food security and ecosystem resilience.

Simpson’s crop diversification index has been estimated for Odisha from 2000-01 to 2020-21 and is presented in Figure 3.18. The index shows a progressive rise from 0.67 to 0.76 between 2000-01 and 2011-12, indicating increased crop diversification. However, since 2011-12, the index has remained almost stable, reflecting the need for renewed efforts to promote crop diversification in Odisha.

Figure 3.18 Trends in Simpson’s Index of crop diversification for Odisha, 2000-01 to 2020-21



Source: Authors’ own calculation.

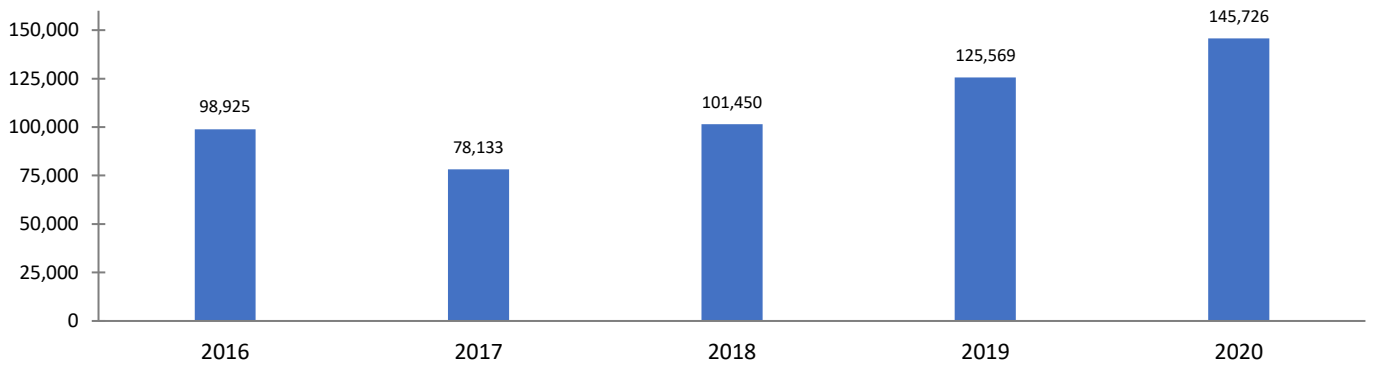
3.2.2 Internal technology environment

The internal technology environment of AFSs refers to the specific technological resources, tools, and innovations integrated into current agricultural practices and operations in Odisha. These technologies differ from the external technology environment, which was discussed earlier, where technologies are diffused from outside Odisha. The

internal technology environment focuses on the adoption of technology generated within and outside the state's research system.

Adoption of climate-resilient varieties. Climate-resilient varieties are essential for AFSs as they enhance food security and sustainability in the face of climate change. The introduction of high-yielding and climate-resilient rice seed varieties, such as Swarna Sub-1, Pooja, Sambha Sub-1, Ciherang Sub-1, CR 1009 Sub-1, and Pradhan Dhan, has helped farmers in drought and flood-prone areas to sustain productivity despite a sometimes adverse biophysical environment. Figure 3.19 depicts the recent trend in the distribution of seeds of climate-resilient rice varieties in Odisha.

Figure 3.19 Uptake of seed for climate resilient rice varieties in Odisha, 2016-2020, quintals

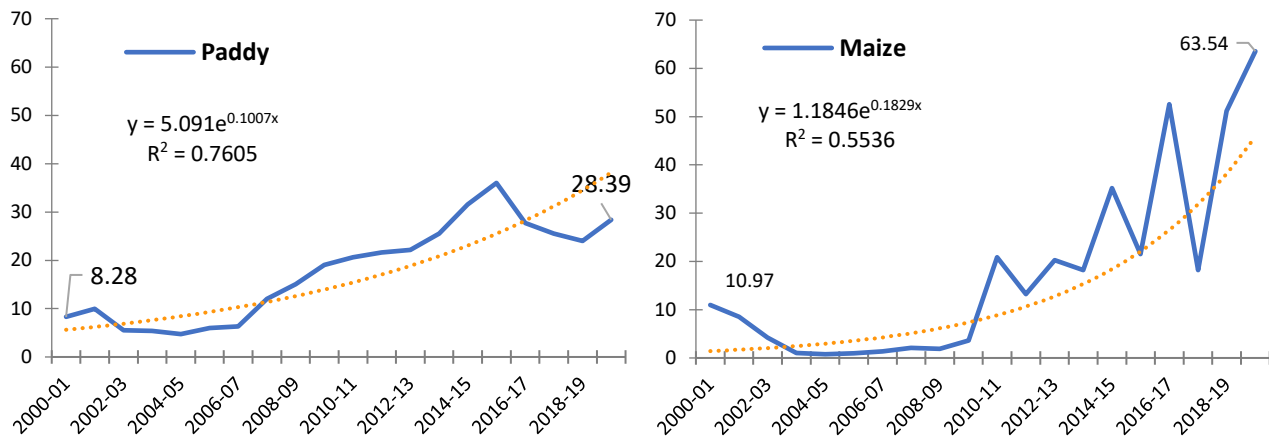


Source: Department of Agriculture and Farmers' Empowerment, Government of Odisha

Timely availability of good quality seeds at affordable prices helps ensure high crop productivity. Odisha State Seeds Corporation Ltd., through its 5,000 registered seed growers, facilitates the production of seed of major crops in the state. Further, it is the key agency involved in different stages of the seed chain, including the acquisition and supply of breeder seeds, the production and supply of foundation seeds, and the production and supply of certified seeds (Pandey, Behura, and Velasco 2017). The Odisha State Seed and Organic Product Certification Agency ensures the quality of seeds by certifying them through its network of offices. The adoption of climate-resilient seed varieties represents a critical aspect of AFS transformation in Odisha, as it enables farmers to maintain productivity and food security amidst increasing climate variability.

Seed replacement rate in Odisha. Maintaining an optimal seed replacement rate (SRR) is vital for enhancing productivity, resilience, and sustainability in AFSs. Over the years, there has been a significant improvement in the seed replacement of rice. In 2000-01, it was only 8.3 percent, but by 2019-20, it had increased to 28.4 percent (Figure 3.20). This growth represents a compound annual growth rate (CAGR) of around 7 percent, although it still falls slightly short of the recommended SRR of 33 percent for self-pollinated crops such as rice. An earlier study by Pandey, Behura, and Velasco (2017) indicates that SRR of rice is comparatively low in coastal flood-prone districts, such as Bhadrak, Cuttack, Jajpur, and Jagatsinghpur, and comparatively higher in inland districts, like Bolangir, Sonepur, Kalahandi, Nuapada, Rayagada, Boudh, Bargarh, and Jharsuguda. Further, there has been a significant 10 percent compounded annual growth in the SRR of maize, which increased from 11.0 percent in 2000-01 to 63.5 percent in 2019-20. The high SRR for maize is mainly due to the increasing use of hybrid maize varieties in the state.

Figure 3.20 Trend in annual seed replacement rates for paddy rice and maize in Odisha, 2000-01 to 2018-19, percent



Source: Odisha Agriculture Statistics 2020

Fertilizers. Fertilizer consumption is vital in AFSs as its use boosts crop yields and improves soil fertility, economic viability, and resource efficiency. Balanced and adequate fertilizer use on crops is essential for a sustainable and resilient AFS.

The use of fertilizer has witnessed an increase in both Odisha and India over the years (Figure 3.21). Fertilizer use in Odisha was only 72 kg/ha in 2018-19, which is about 1.8 times less than the average use rate for India as a whole. However, significant variability exists in fertilizer consumption across Odisha, with districts like Baragarh, Balasore, and Nabarangpur consuming more than the national average (Figure 3.22). The increased use of fertilizers in low-consuming districts of Odisha can play a crucial role in transforming AFSs by enhancing crop productivity, thereby contributing to food security.

Figure 3.21 Trends in consumption of fertilizer in Odisha and India, 1990-91 to 2018-19

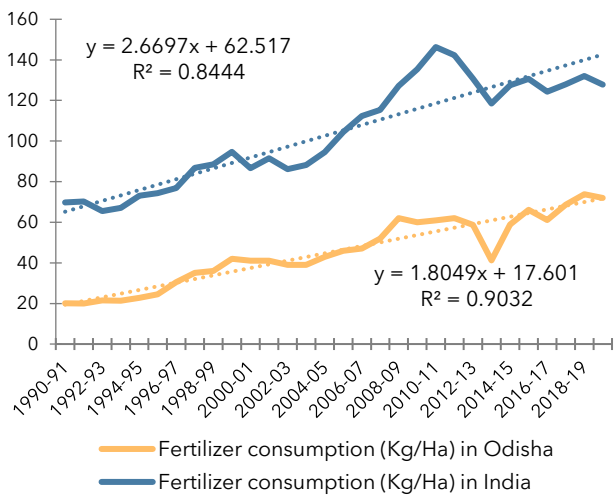
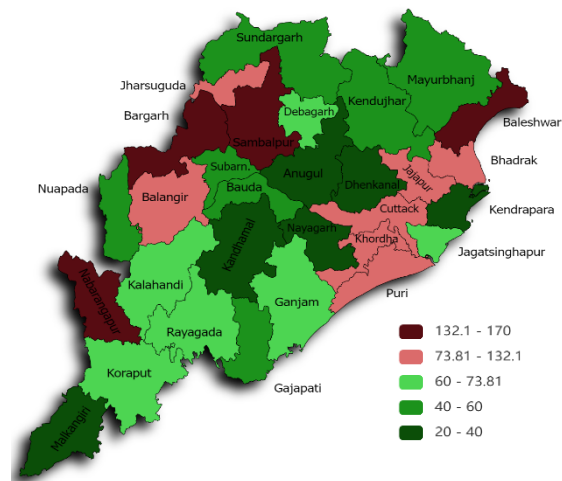


Figure 3.22 Map of consumption of fertilizer in Odisha by district, 2018-19, kg fertilizer/ha



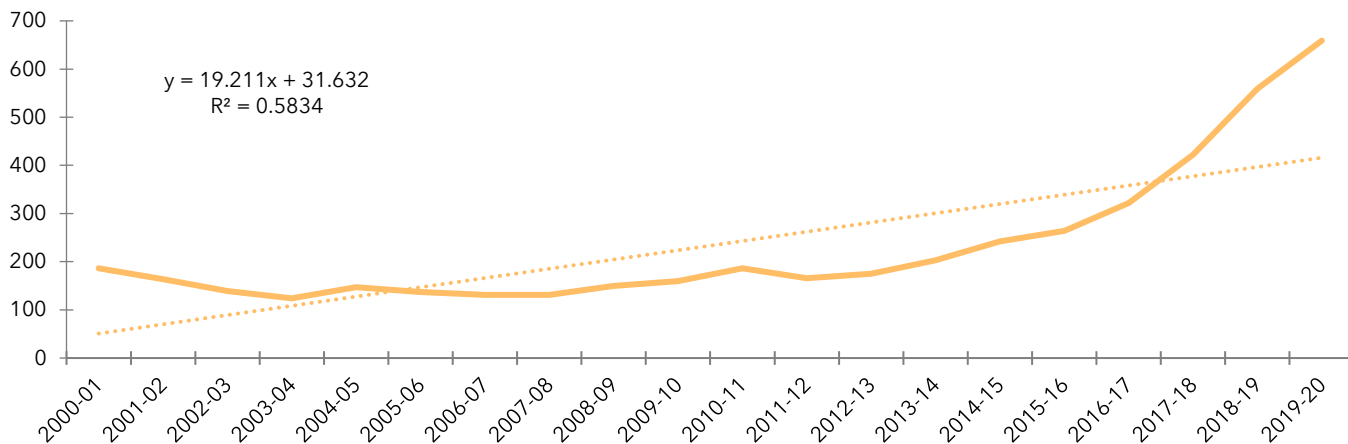
Source: DA&FE, Govt. of Odisha; Odisha Agricultural Statistics

Farm power and machinery. Farm power serves as a key proxy for farm mechanization, reflecting the extent to which agricultural operations rely on mechanical means rather than manual labor. It encompasses various sources of power, including tractors, motorized equipment, and irrigation systems, which enhance productivity and efficiency in farming practices. Mechanization enables farmers to implement agricultural production practices that improve resilience, such as efficient irrigation and timely crop management, helping them adapt to changing environmental conditions.

Electricity consumption in the farm sector has increased significantly over the years. With increased reliance on groundwater extraction by the farming community through borewells and electricity supplied at a subsidized rate,

electricity consumption in the farm sector has been rising in Odisha. Under Jalanidhi I and II irrigation investment schemes, a large number of captive irrigation programs have been implemented in the state, including shallow tube wells, bore wells, dug wells, cluster micro river lifts, and cluster shallow tube wells. The majority of these programs utilize electricity, often from solar panels, for pumping (Figure 3.23).

Figure 3.23 Trends in farm electricity consumption for agriculture purpose in Odisha, 2000-01 to 2019-20, in millions of units

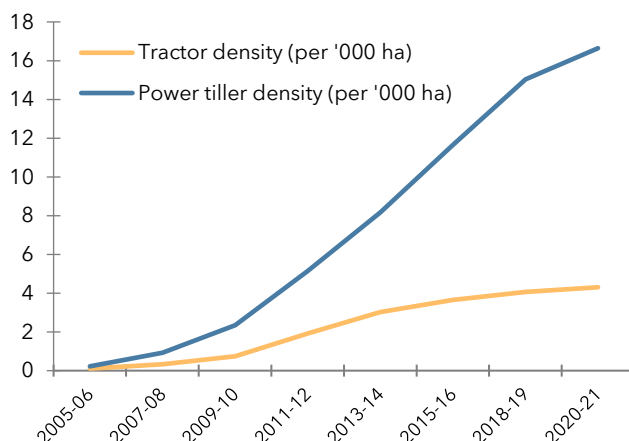
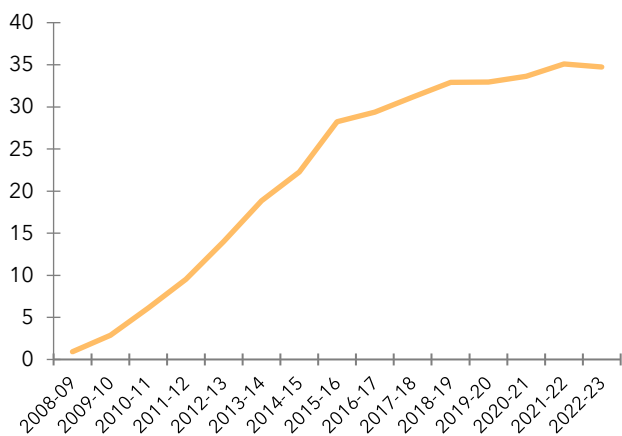


Source: Odisha Agriculture Statistics (2008-2020) and Department of Agriculture and Farmers’ Empowerment, Government of Odisha

Pump sets and tractors are crucial in the AFSs of developing countries as they enhance productivity and efficiency. Pump sets improve irrigation access, ensuring consistent water supply. At the same time, tractors facilitate timely land preparation and harvesting, reducing labor intensity and boosting crop yields, ultimately supporting food security and rural livelihoods. Both pump sets and tractors considerably influence crop choices and, ultimately, AFSs, especially in low and middle-income countries. In Odisha, the availability of labor has been a major challenge to carrying out farm operations in a timely manner. Farming communities have been increasingly relying on farm machinery, particularly for irrigation and land preparation, as illustrated in Figure 3.24 and Figure 3.25. Higher pump set density over the years illustrates that farmers are increasingly using pump sets to draw both ground and surface water resources for assured irrigation, thereby enhancing crop yields and profitability. Power tiller and tractor density per thousand hectares have also increased from 0.2 to 16.6 and 0.1 to 4.5, respectively, between 2005-06 and 2020-21.

Figure 3.24 Pump set density in Odisha 2008-09 to 2022-23, per '000 ha

Figure 3.25 Tractor and power tiller density in Odisha 2005-06 to 2020-21, per '000 ha



Source: Odisha Agriculture Statistics (2008-2019) and Department of Agriculture and Farmers’ Empowerment, Government of Odisha

3.2.3 Government policies and regulatory frameworks

Government policy directions and public investments are essential for transforming AFSs by creating frameworks that encourage sustainability, innovation, and food security. Financial incentives, like subsidies for sustainable farming and investments in rural infrastructure, motivate farmers to implement strategies that boost productivity and resilience. Moreover, regulations on food safety and quality protect consumers and build trust in AFSs. By fostering an enabling environment, effective government policies propel the evolution of sustainable AFSs, improving their economic viability and tackling associated environmental issues.

Central and state governments have implemented several schemes for the development of agricultural and allied sectors across India. To focus specifically on the development of these sectors, the Government of Odisha has presented a separate budget for agriculture since 2013-14. The budgetary allocation to agriculture and allied sectors has increased significantly from 2014-15 to 2023-24. Table 3.2 presents the budgetary allocation to the four departments facilitating agriculture in Odisha from the triennium ending average (TE) 2017-18 to TE 2023-24.³The Water Resources Department has consistently received more than 50 percent of the total agricultural budget, starting from Rs 6261.93 crores in TE 2017-18 and increasing to Rs 8195.62 crores in TE 2023-24. Though the fishery and animal husbandry sector has experienced remarkable growth during the last decade, the budgetary allocation remained low at Rs 351.79 crores in TE 2017-18. However, this allocation more than tripled by TE 2023-24, reaching Rs 1,141.7 crores, though its share in the total agricultural budget stayed at just 7 percent. Increasing the budgetary allocation to the Fisheries and Animal Resources Development Department could significantly contribute to sustaining the sector's growth. Overall, the share of the total state budgetary allocation that goes to the agriculture sector has fluctuated between 23.0 percent in TE 2017-18 and 16.4 percent in TE 2023-24.

Table 3.2 Budgetary allocation across different departments concerning agriculture and allied sector in Odisha from TE 2017-18 to 2023-24 (Rs in crores)

Department	TE 2017-18	TE 2020-21	TE 2023-24
Department of Agriculture and Farmers Empowerment	2,865.69 (27)	5,851.83 (36)	5,385.09 (33)
Cooperation Department	1,144.81 (11)	1,293.23 (8)	1,662.72 (10)
Water Resources Department	6,261.93 (59)	8,505.71 (52.5)	8,195.62 (50)
Fisheries and Animal Resources Development Department	351.79 (3)	557.72 (3.5)	1,141.70 (7)
Total budget for agriculture sector	10,624.22(100)	16,208.49(100)	16,385.13(100)
Total budget of the state	46,250.00	68,866.67	100,000.00
Share of agriculture in total budget of the state (percent)	23.0	23.5	16.4

Note: Figures in parentheses indicate the percentage of the total budget for the agricultural sector. Crore = 10,000,000.

Over the years, government policy towards agricultural development has largely focused on increasing irrigation density in Odisha, as evidenced by the budgetary allocations within the sector. The budgetary allocation under major departments in 2023-24 is presented in Annex Table 2. Rs 5788.23 crores (31.4 percent) was dedicated to the development of irrigation infrastructure, which includes schemes such as the Accelerated Irrigation Benefit Program, the Mega Lift Irrigation projects, the Prime Minister's Krushi Sinchai Yojana, construction of in-stream storage structure, the Command Area Development Program, and minor and medium irrigation projects. The share of the budget dedicated to other major programs includes farmers' welfare under the Krushak Assistance for Livelihood and Income Augmentation scheme (10.7 percent), infrastructure development (8.3 percent), interest subventions for providing crop loans (4.1 percent), indemnity towards crop insurance (3.3 percent), Shree Anna Abhiyan (the Special Programme for Promotion of Millets in Tribal Areas of Odisha) (2.7 percent), fisheries development and fishermen welfare (2.2 percent), horticulture development (2.1 percent), climate resilient

³Triennium ending average (TE) means the average over the three years prior. For instance, TE 2017-18 refers to the average from 2015-16 to 2017-18.

agriculture (1.8 percent) and the Rashtriya Krushi Vikas Yojana program for risk mitigation and promoting agribusiness entrepreneurship (1.7 percent).

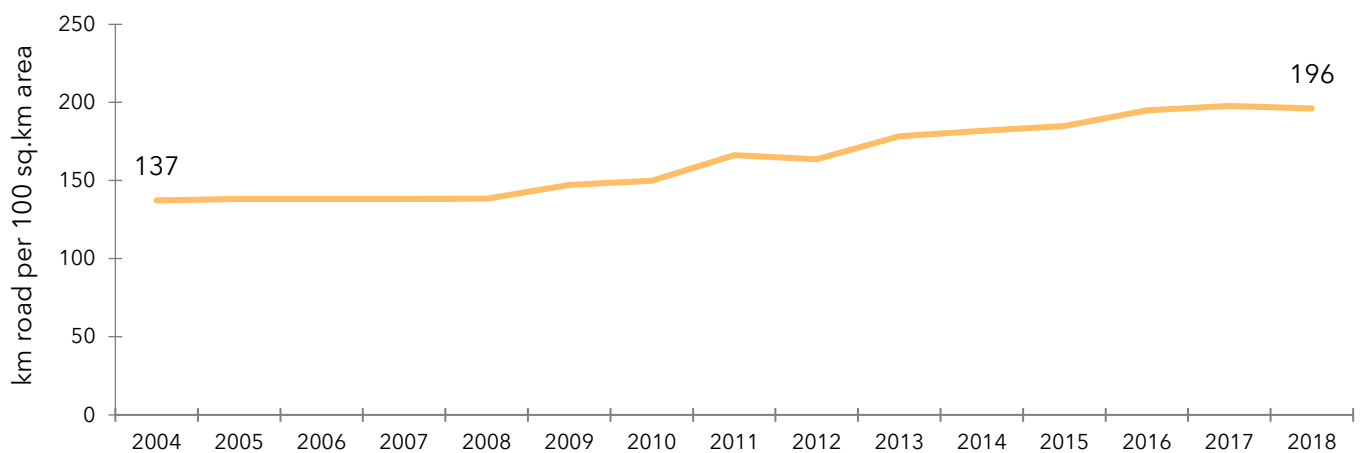
3.2.4 Rural Infrastructure

Rural infrastructure is essential for sustainable AFSs, as it enhances market access, improves supply chains, and supports efficient agricultural practices. Well-developed roads and transportation networks enable farmers to reach markets more effectively, maximizing profits and reducing post-harvest losses. Infrastructure, such as storage facilities and irrigation systems, boosts productivity and product quality. Investment in rural infrastructure stimulates local economies, creates jobs, and promotes the adoption of modern technologies. It also enhances resilience to climate change through better water management and disaster preparedness. Ultimately, a robust rural infrastructure determines the nature of AFSs.

Road density. In Odisha, increased road density has helped improve communication in previously inaccessible hinterlands, particularly tribal pockets. Under the Location Accessible Multi-modal Initiative Yojana, bus service connects each gram panchayat in Odisha to its district headquarters.

Logistics, particularly road infrastructure, play a vital role in meeting the consumption needs of the community. During the last decade, road density in Odisha has increased from 137 to 196 km per 100 sq.km (Figure 3.26). Both central and state governments have been facilitating the construction and maintenance of road infrastructure in Odisha.

Figure 3.26 Trends in road density in Odisha, 2004-2018

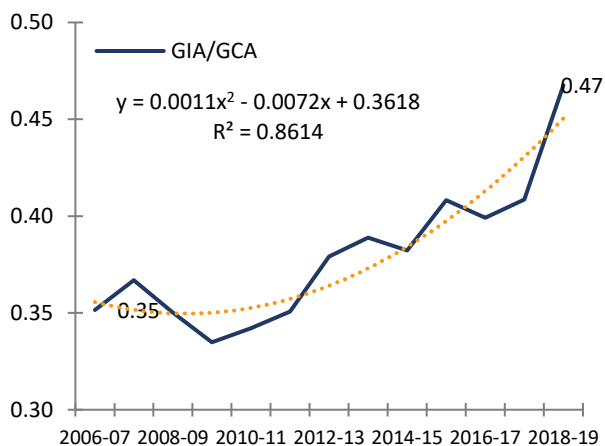


Source: Ministry of Road Transport and Highways (various), Authors' own calculations

Irrigation infrastructure. Irrigation infrastructure plays a crucial role in AFSs by significantly increasing crop yields, providing reliable water supply, enabling year-round cultivation, and strengthening resilience against droughts and climate variability. Access to irrigation allows farmers to diversify their crops, leading to higher profitability and market adaptability. A robust irrigation infrastructure is essential for fostering sustainable agricultural practices and crop diversification.

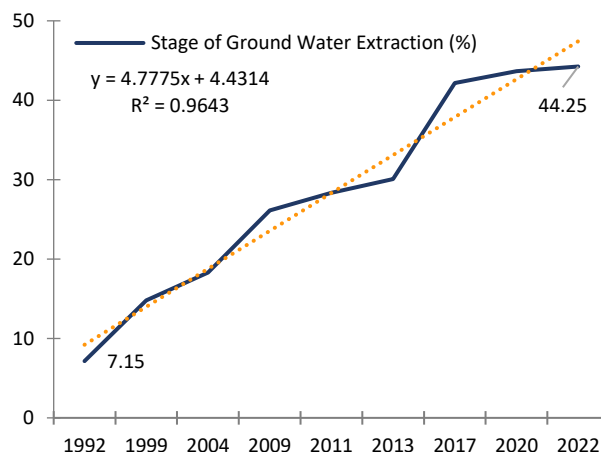
Over the years, considerable efforts have been made to increase the area under irrigation in Odisha. The ratio of gross irrigated area to gross cropped area has increased from 0.35 to 0.47 (Figure 3.27). Most of the irrigation infrastructure, such as dams and check dams, depends on annual monsoon rainfall for irrigation purposes. Thus, during drought years, the farming community becomes vulnerable due to insufficient water for irrigation.

Figure 3.27 Trend in gross irrigated area to gross cropped area, Odisha



Source: Odisha Agriculture Statistics (2006-2019)

Figure 3.28 Trends in ground water extraction in Odisha



Source: Dynamic Ground Water Resources of Odisha, 2022

Groundwater extraction has been increasing steadily in Odisha over the last three decades. Extraction constituted only 7.15 percent of groundwater supplies in 1992, but extraction levels had increased to 44.25 percent in 2022 (Figure 3.28). The rapid rise in groundwater extraction is due to the increasing use of pump sets by the farming community in Odisha. There now are concerns about excessive groundwater extraction in a few coastal blocks in Balasore, Bhadrak, Kendrapara, Jajpur, Cuttack, and Khordha districts, and some inland blocks of Nuapada and Angul districts, where extraction rates of more than 80 percent are reported (Figure 3.29 and Figure 3.30). Optimal groundwater extraction in low-extracting districts can help sustain productivity, resilience, and the overall efficiency of AFSs in Odisha.

Figure 3.29 Ground water extraction in Odisha by district, percent

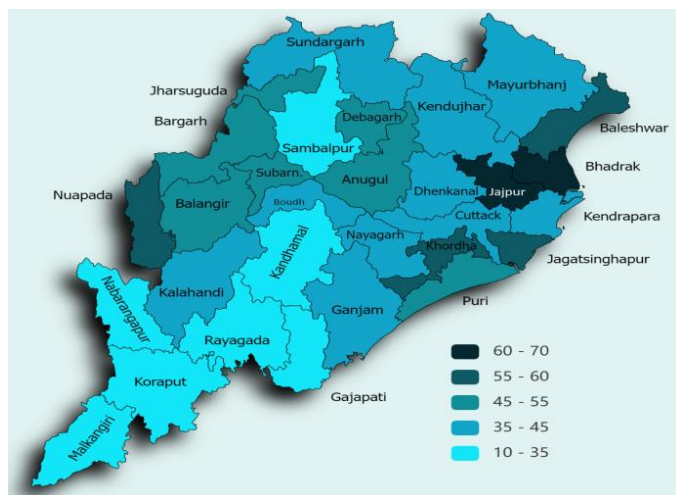
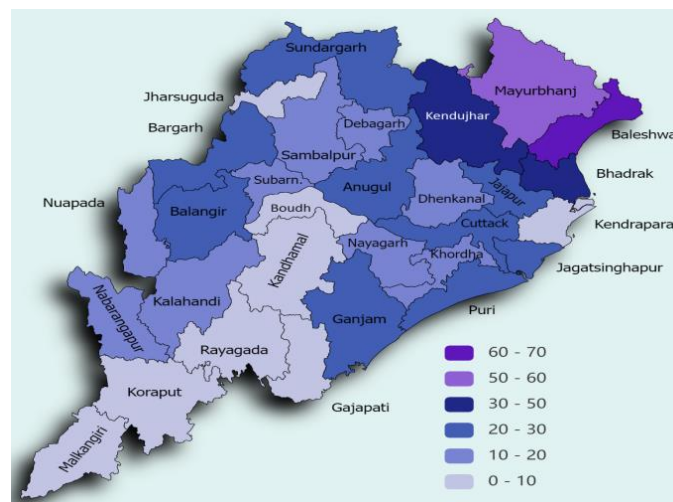


Figure 3.30 Quantity of ground water used for irrigation in Odisha by district ('000 hectare meter [Ham])

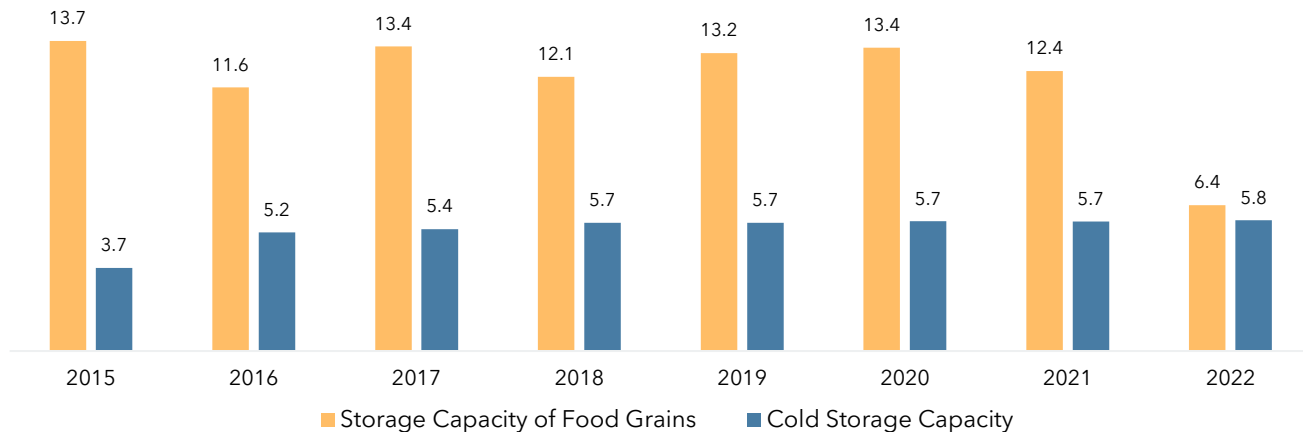


Source: Dynamic Ground Water Resources of Odisha, 2022

Storage infrastructure. Storage infrastructure is essential for minimizing post-harvest losses and maintaining food quality. Sufficient storage facilities enable farmers to keep their produce fresh and avoid spoilage, especially for perishable goods. This facility allows them to sell crops when prices are highest, thereby maximizing profits. Moreover, effective storage stabilizes market prices by alleviating supply fluctuations. It also strengthens food security by enabling communities to store excess produce for off-peak periods. Additionally, enhanced storage infrastructure supports value addition through processing, benefiting local economies and promoting sustainable agricultural practices in rural areas.

In Odisha, investments in cold storage infrastructure, such as those by the Odisha State Cooperative Marketing Federation, play a crucial role in reducing post-harvest losses and maintaining the quality of perishable goods (Figure 3.31). The State Cooperative Marketing Federation operates multi-commodity cold storage facilities at Bhubaneswar, Rayagada, and Jagatpur, with capacities from 4,000 to 5,000 mt. This cold storage infrastructure not only preserves crops but also facilitates crop diversification by empowering farmers to shift towards perishable commodities, thus contributing to the transformation of AFS.

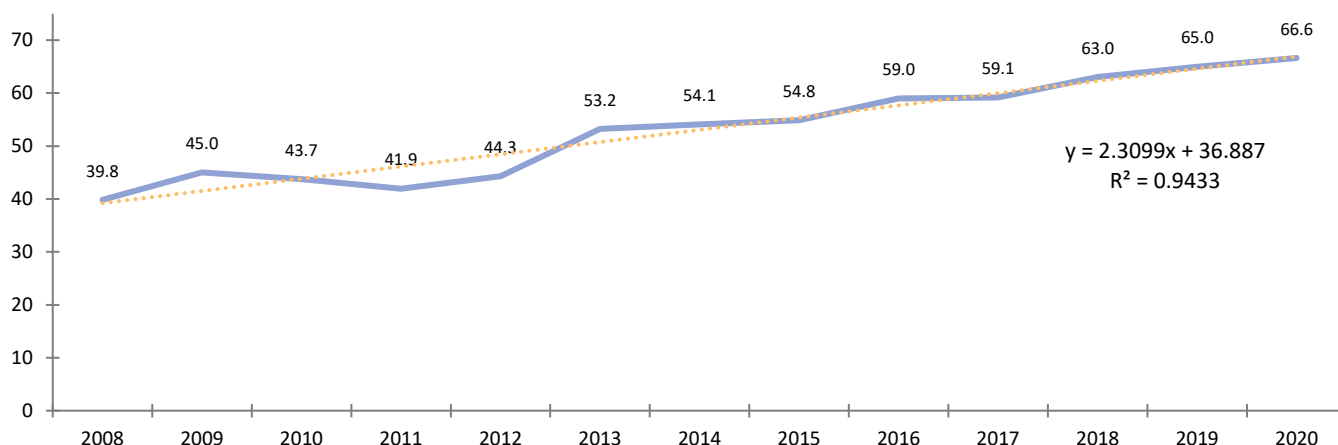
Figure 3.31 Trends in food grain storage and cold storage capacity in Odisha, 2015-2022, in lakh metric tons



Source: DAFW (various issues); Reserve Bank of India (2023).
 Note: Lakh = 100,000.

Cellular telephone use. Mobile phone use by farmers enables them to access information about market prices, agricultural input availability, and weather advisories, all of which help them to make informed decisions. There has been a rapid increase in mobile phone users in Odisha, particularly in rural areas. The rural share of all mobile subscribers in the state increased from 40 percent in 2008 to 67 percent in 2020 (Figure 3.32). With increased financial transactions through the Unified Payment Interface, farming communities now have better cellular connectivity. Most financial benefits through different government schemes are now channeled through bank accounts, especially the Jan Dhan Yojana financial inclusion scheme, which is directly linked to cellular service. Increased cellular connectivity in rural areas will improve access to crucial information, support financial inclusion, and promote modern technologies (Fu and Akter 2016). This has the potential to drive transformation in the AFS by improving decision-making, market access, and productivity.

Figure 3.32 Rural share of total cellular telephone subscribers in Odisha, percent



Source: Ministry of Communications, Government of India. (various issues).

3.2.5 Rural organizations

Rural organizations are vital in promoting sustainable AFSs by empowering smallholder farmers through capacity building, resource access, and market linkages. They train farmers in eco-friendly practices such as organic farming, crop diversification, and water conservation, enhancing resilience towards climate change. These organizations facilitate collective action, ensuring fair prices and reducing the influence of market intermediaries. Additionally, they advocate for pro-farmer policies and provide platforms for sharing traditional and modern agricultural knowledge. By fostering community resilience, promoting climate-adaptive strategies, and supporting diversified livelihoods, rural organizations play a key role in creating equitable and sustainable AFSs.

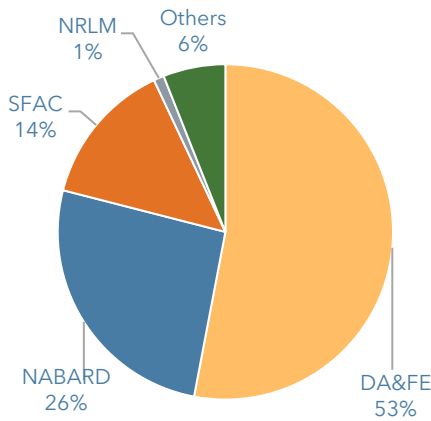
Krishi Vigyan Kendra. The Odisha University of Agriculture and Technology (OUAT), through its 31 Krishi Vigyan Kendra centers, provides training and support to farmers on best practices, new technologies, and sustainable farming methods. Since 2015-16, training on different farm technologies has been imparted to thousands of farmers, rural youths, and extension functionaries. Climate resilient and production-enhancing technologies were transferred to the farmers through thousands of frontline demonstrations (Annex Table 3). Farm advisories are regularly shared with farmers and extension functionaries by SMS messages through the Kissan Mobile Advisory Service.

Farmer producer organizations. Farmer producer organizations (FPO) empower smallholder farmers through collective action. They provide farmers with better access to resources such as seeds, fertilizers, and technology, enabling the adoption of sustainable farming practices like organic cultivation and crop diversification. FPOs improve market access by reducing the influence of intermediaries, ensuring fair prices, and enhancing bargaining power. They also offer training in climate-resilient agricultural methods, promoting eco-friendly practices that conserve natural resources. By supporting income diversification and resilience to climate change, FPOs contribute to a more sustainable and equitable AFS.

In Odisha, there are several types of farmer collectives. These include self-help groups (SHG), Farmer Interest Groups, Pani Panchayats, cooperatives, farmer producer organizations, and farmer producer companies, all of which are components of the state AFS. The Odisha Farmer Producer Organizations Policy 2018 underwent revisions to facilitate the integration and promotion of activities along the agrifood value chains, creating a more conducive environment for the effective operations of FPOs. Odisha experiences a low marketable surplus for major farm commodities, leading to poor disposal income for the farming community. Low input use, limited access to the market, and poor awareness about new farm technologies and innovations are major constraints for farmers. To mitigate these problems, FPOs are promoted in Odisha with the aim of bringing farmers together for collective production, value addition, and marketing efforts. By taking advantage of economies of scale and leveraging farmers' collective strength, FPOs create local-level commodity-specific agricultural value chains that connect farmers to consumers through markets.

Currently, 722 FPOs are registered in the state, with a membership of 218,780 farmers. Of these, 53 percent are promoted by the Department of Agriculture and Farmers Empowerment, Government of Odisha, followed by the National Bank for Agriculture and Rural Development (26 percent), the Small Farmers' Agri-Business Consortium (14 percent), the National Rural Livelihood Mission (1 percent) and other agencies (6 percent) (Figure 3.33). The distribution of FPOs in Odisha by the type of farm produce on which they are focused is presented in Figure 3.34.

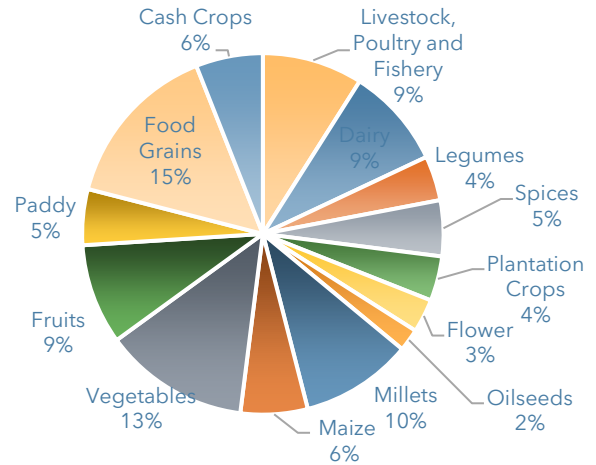
Figure 3.33 Promotion of farmer producer organizations in Odisha, by facilitating organizations



Source: FPO Odisha, NABARD Annual Report 2023, SFAC 2024

Note: DA&FE = Department of Agriculture and Farmers Empowerment, Govt. of Odisha; NABARD = National Bank for Agriculture and Rural Development; SFAC = Small Farmers' Agri-Business Consortium; NRLM = National Rural Livelihood Mission.

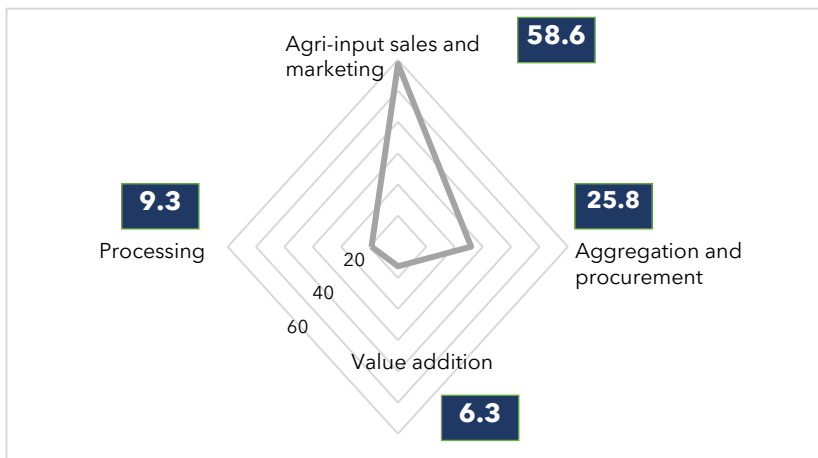
Figure 3.34 Distribution of farmer producer organizations by type of farm produce handled in Odisha, percent



Source: Compiled data from FPO Odisha, 2024; Farm sector development department, NABARD, 2023

About 59 percent of the FPOs in the state are involved in agro-input marketing, followed by 26 percent in aggregation and procurement of farm products, 9 percent in processing, and only 6 percent in value addition (Figure 3.35).

Figure 3.35 Distribution of farmer producer organizations by type of their business operations, percent



Source: ICRISAT (2024)

Self-Help Groups. Self-Help Groups (SHG) are community-based, voluntary associations of individuals, typically from low-income or marginalized communities, who come together to support each other in improving their financial and social well-being. The primary objectives of SHGs are to promote savings among members, provide access to microcredit, and encourage mutual assistance. SHGs typically consist of 10 to 20 members, usually women, who regularly save small amounts of money, which is pooled and used to provide loans to members for income-generating activities, healthcare, education, or emergencies. They also foster skills development, entrepreneurship, and social empowerment, especially in rural areas.

In Odisha, the empowerment of women through SHGs is a key development initiative taken up by the Government of Odisha under the aegis of Mission Shakti since 2001. Mission Shakti supports women SHGs in agriculture and agribusinesses by providing them training, credit access, and market linkages to enhance their economic

participation. There are more than 620,000 women SHGs in Odisha with a membership of more than 7.0 million women. Within these women SHGs, members have been motivated to establish 3,271 producers' groups and 45 producers' companies. Regular assistance and monitoring are provided to facilitate the activities of the women SHGs. The majority of the activities undertaken by the women SHGs are in convergence with the specific mandates of departments of the Government of Odisha. In Odisha, women SHGs are involved in paddy procurement, poultry farming, pisciculture, horticulture, and supply of pre-school uniforms to Anganwadi Centers, which provide basic healthcare, childcare, and preschool activities.

Through 2021-22, 562 women SHGs from 20 districts have facilitated paddy procurement. During 2021-22, over 1.85 million mt was procured by the women SHGs, thereby enabling them to receive service charges worth Rs 580.1 million.

Mission Shakti has also enabled the members of the women SHGs to read and collect electricity charges from households in collaboration with the Department of Energy, Government of Odisha. During 2021-22, 1,317 women SHGs in 21 districts were associated with this activity, which brought transparency and increased collection of bills. Women SHGs reach almost 950,000 consumers and can generate Rs 100.1 million in commission charges.

In association with the Fisheries and Animal Resources Development Department in 2021-22, women SHGs participated in pisciculture and poultry farming (Table 3.3). Similarly, members of women SHGs were involved in hybrid vegetable cultivation, mushroom farming, and floriculture activities in association with the Department of Horticulture (Table 3.4).

Table 3.3 Activities of women self-help groups under the Fisheries and Animal Resources Development Department in Odisha during 2021-22

Activities	Self-help groups	Members involved	Turnover, lakhs (Rs)
Fishing in gram panchayat tanks	7,419		15,896
Broiler farming (1,000 birds)	1,744		18,690
Layer farming in deep litter	1,002		2,855
Backyard poultry farming (50 birds)		1,000	2,850

Source: Department of Mission Shakti, Government of Odisha

Note: Lakh = 100,000.

Table 3.4 Activities of women self-help groups under the Horticulture Department in Odisha during 2021-22

Activities	Self-help groups	Turnover, lakhs (Rs)
Hybrid vegetable cultivation	3,350	2,240
Mushroom cultivation	500	897
Floriculture	150	66

Source: Department of Mission Shakti, Government of Odisha

Note: Lakh = 100,000.

Women SHGs are granted loans with subsidized interest rates, and the SHG-Bank Linkage program forms a significant part of Mission Shakti's efforts to promote financial inclusion. The interest subsidy program was initiated in 2013, allowing women SHGs to access loans of up to Rs 3 lakhs at an annual interest rate of 2 percent. This interest rate was further reduced to 1 percent from April 2015, and since 2019, women SHGs have been availing loans with no interest if the loans are repaid on time.

3.2.6 Supply chain management

Supply chain management is crucial for sustainable AFSs by optimizing efficiency and minimizing food waste from production to consumption. It promotes responsible resource use and enhances transparency, allowing

consumers to make informed choices. Supply chain management improves market access for smallholder farmers, ensuring fair prices and supporting local food systems. Additionally, it fosters collaboration among stakeholders and incorporates climate-resilient strategies, helping the agrifood sector adapt to environmental changes. Overall, effective supply chain management is essential for building resilient, equitable, and sustainable AFSs. In Odisha, key institutions and agents in the supply chain of agrifood commodities are the electronic National Agriculture Market (e-NAM), the Odisha Rural Development and Marketing Society (ORMAS), and the Odisha State Cooperative Marketing Federation.

Electronic National Agriculture Market (e-NAM). The establishment of the e-NAM platform facilitates better market access and fair pricing for farmers' produce, thus reducing their reliance on intermediaries. In Odisha, efforts have been made to promote digital marketing of farm commodities through Agricultural Produce Market Committees. In 2023-24, 66 such committees were integrated into the e-NAM platform (Table 3.5). Further, 399,075 farmers and 9,655 traders were onboarded during 2023-24. The trade volume on the e-NAM platform reached 163.67 lakh mt, with a total value of Rs 4208.12 crores. It is crucial to continue prioritizing efforts to raise awareness among farmers about the benefits of digital marketing in the state.

Table 3.5 Digital marketing through eNAM in Odisha

Particulars	2023-24
Agricultural Produce & Livestock Market Committees on eNAM Platform (number)	66
Volume of trade on eNAM (lakh tons).	163.67
Value of trade on eNAM (in crore Rs)	4208.12
Farmers on board (number)	399,075
Trade functionaries on board (number)	9,655

Source: Odisha State Agricultural Marketing Board.

Note: Lakh = 100,000. Crore = 10,000,000.

Marketing of rural farm and non-farm products through the Odisha Rural Development and Marketing Society. ORMAS facilitates the creation of marketing channels for farmers, micro-enterprises, and SHGs. It helps rural producers to develop sustainable livelihoods through adopting appropriate rural indigenous technologies, product development, and diversification with accepted designs, packaging, certification, and branding activities. Over the years, ORMAS has been organizing exhibitions across the districts to create a market for the products of SHGs. Since 2003-04, the marketing society has organized 389 exhibitions, where 62,873 SHGs and other institutions from Odisha have participated, creating a market worth Rs 53,149.38 lakhs (Annex Table 4).

Odisha State Cooperative Marketing Federation. Apart from the procurement and distribution of fertilizers in the state, Odisha State Cooperative Marketing Federation has undertaken procurement of green gram, red gram, sunflower, and groundnut directly from farmers under the price support scheme of the Government of India through the National Agricultural Cooperative Marketing Federation of India. Table 3.6 shows the procurement of oilseeds and pulses in Odisha by the state cooperative marketing federation from 2019-20 to 2022-23.

Table 3.6 Procurement of oilseeds and pulses by the Odisha State Cooperative Marketing Federation, 2019-20 to 2022-23

Year	Quantity (mt)	Farmer beneficiaries (persons)	Value in crore Rs
2019-20	7,593	8,849	50.84
2020-21	-	-	-
2021-22	9,238	7,492	60.90
2022-23	4,072	4,806	29.16

Source: Odisha State Cooperative Marketing Federation

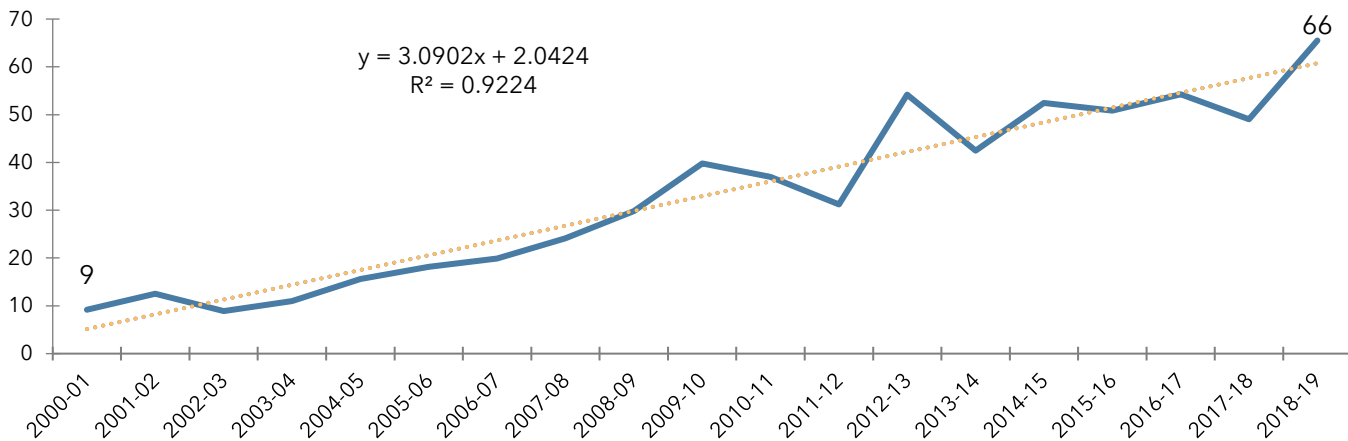
Note: '-' = data not available. Crore = 10,000,000.

Government intervention in paddy markets. Paddy procurement for the public distribution system (PDS) in Odisha involves the state government purchasing paddy from farmers at the minimum support price. This initiative

ensures food security, stabilizes farmers' incomes, and promotes local agriculture. The procurement process aims to provide essential cereals to vulnerable populations, enhancing their access to affordable food in rural areas.

In Odisha, the procurement of paddy under the public distribution system has seen a significant increase over the years. In 2000-01, procurement was only 0.92 million tons, but by 2018-19, it had risen to 6.55 million tons (Figure 3.36). The process also involves various organizations, such as primary agricultural credit societies, Large-Scale Adivasi Multi-Purpose Societies, women SHGs and Pani Panchayat water user associations. These organizations work together to procure paddy from farmers during both the kharif and rabi seasons. To streamline this process, an online platform, the Paddy Procurement Automation System, has been implemented.

Figure 3.36 Procurement of paddy in Odisha under the Public Distribution System, 2000-01 to 2018-19, in lakh metric tons



Source: Odisha Agriculture Statistics (2000 - 2019)
 Note: Lakh = 100,000.

Export markets. Although Odisha exports farm products such as rice, turmeric, millets, cashew kernel, and mango, it is challenging to provide detailed information on these exports because of a lack of data. The reason for the limited data may be that Odisha's farm commodity exports are not shipped through seaports in Odisha. India is the largest exporter of rice, contributing almost 40 percent to the global rice trade. Since 2010-11, India has witnessed tremendous growth in rice exports (Figure 3.37). Odisha produces between 7 and 8 percent of India's non-Basmati rice (Figure 3.38). However, rice exports from Odisha are not directly reflected in the export statistics, as its rice is exported through Vizag and Kakinada ports in Andhra Pradesh, which adjoins Odisha along the coast. During 2022-23, over two lakh tons of rice were exported from these ports, which included Odisha's rice. This is also true for maize.

Figure 3.37 Export of non-Basmati rice from India, in lakh metric tons

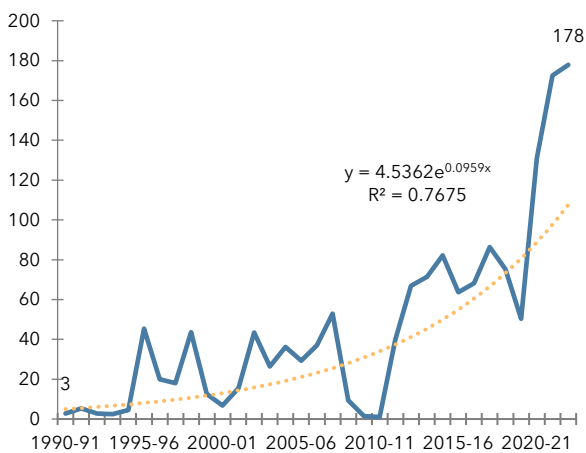
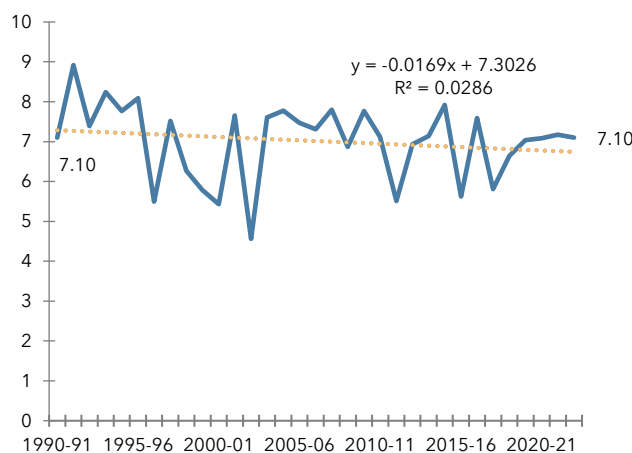


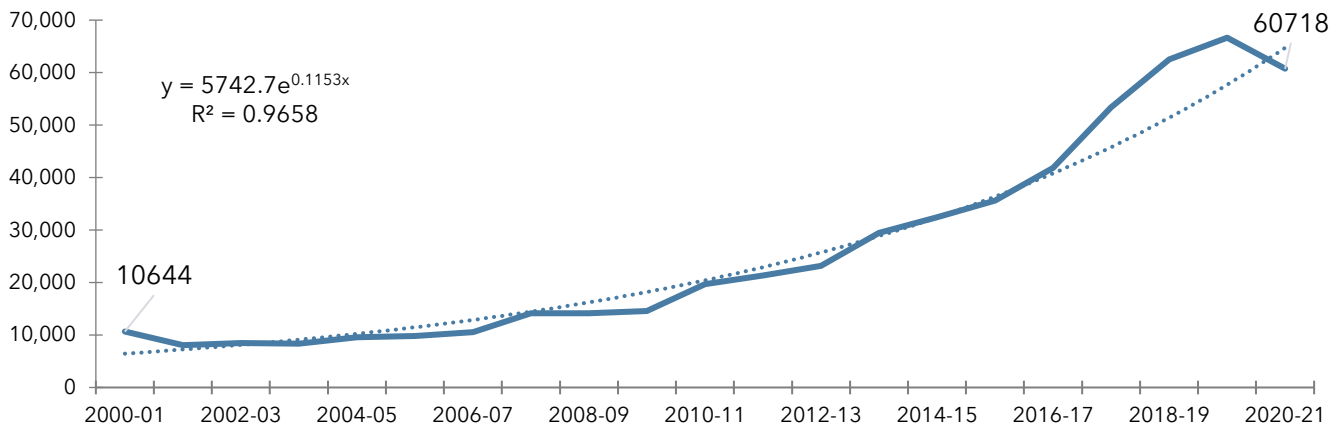
Figure 3.38 Odisha's share in India's non-Basmati rice production, percent



Source: https://agriexchange.apeda.gov.in/product_profile/exp_f_India.aspx?categorycode=0602
 Note: Lakh = 100,000.

Exports of farm commodities from Odisha face challenges due to a lack of logistics support at seaports, making their handling difficult. Also, there has been inconsistency in such exports, whether in terms of price, quality, or other factors. The only exception is fisheries exports, which have been streamlined and have experienced significant growth. Fisheries exports increased from 10,000 to 60,000 metric tons between 2000-01 and 2020-21 (Figure 3.39).

Figure 3.39 Trends in annual total market export of marine products from Odisha, metric tons



Source: Annual Activities Report 2019-20, Fisheries and Animal Resources Development Department, Government of Odisha

The lack of infrastructure for exporting farm products hinders the efficiency and sustainability of AFSs in Odisha. Enhancing export capabilities and streamlining the processes at seaports is crucial for better market access and improved profitability for farmers.

3.2.7 Food safety and quality standards

Food safety and quality standards are essential for AFSs as they ensure the safety and integrity of food products throughout the supply chain. They enhance consumer confidence and drive demand for safe and high-quality products. Implementing robust food safety and quality measures encourages sustainable agricultural practices, supports environmental stewardship, and fosters innovation in food processing and distribution, ultimately contributing to a resilient and efficient AFS.

Agrifood manufacturing. The transition from subsistence to commercial farming has been linked to the increase in the consumption of processed food. This is in line with the Government of India’s emphasis on the manufacturing sector through initiatives like ‘Make-in-India’ and ‘Start-up India.’ The importance of agrifood processing cannot be understated. Processing plays a crucial role in the production of ready-to-cook, ready-to-eat, and ready-to-serve products, thereby expanding and transforming AFSs. However, in Odisha, the share of agrifood manufacturing to total output has been declining—it decreased from 6.0 to 5.2 percent between 2011-12 and 2021-22 (Figure 3.40). This is mainly because most agrifood manufacturing units operate in the unorganized sector, which limits their scalability and overall contribution to AFS transformation.

While the share of investment in the agrifood industry to total investments in all types of industry has increased since the beginning of the last decade (Figure 3.41), greater efforts are required to bring these units into the domain of micro, small, and medium enterprises (MSME). Integration with such smaller-scale enterprises, supported by incentives and policies, could not only boost the contribution of agrifood manufacturing but could also play an important role in the transformation of AFSs by adding value to agricultural produce, enhancing food security and generating employment in rural areas.

Figure 3.40 Trend in share of agrifood manufacturing output in total manufacturing output in Odisha, 2011-12 to 2021-22, percent

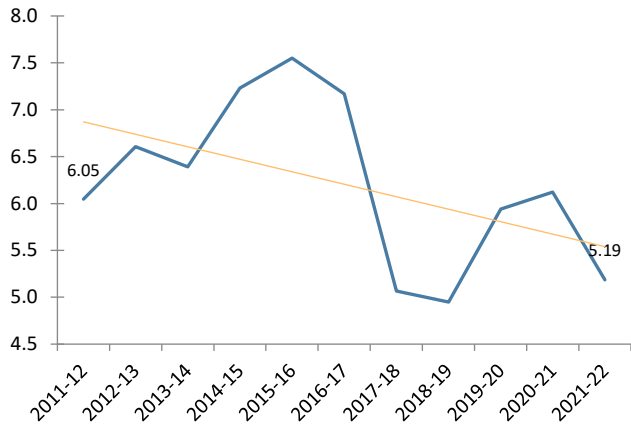
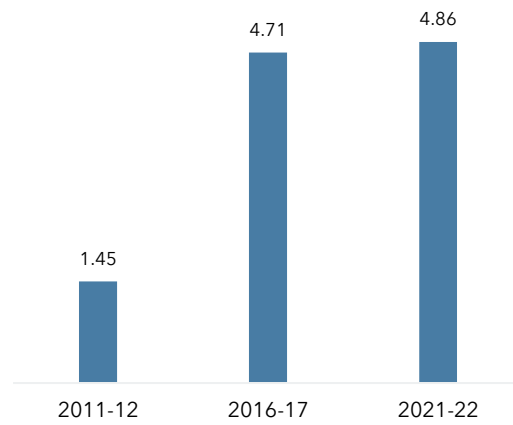


Figure 3.41 Share of total investment in agrifood industries in Odisha, 2011-12 to 2021-22, percent

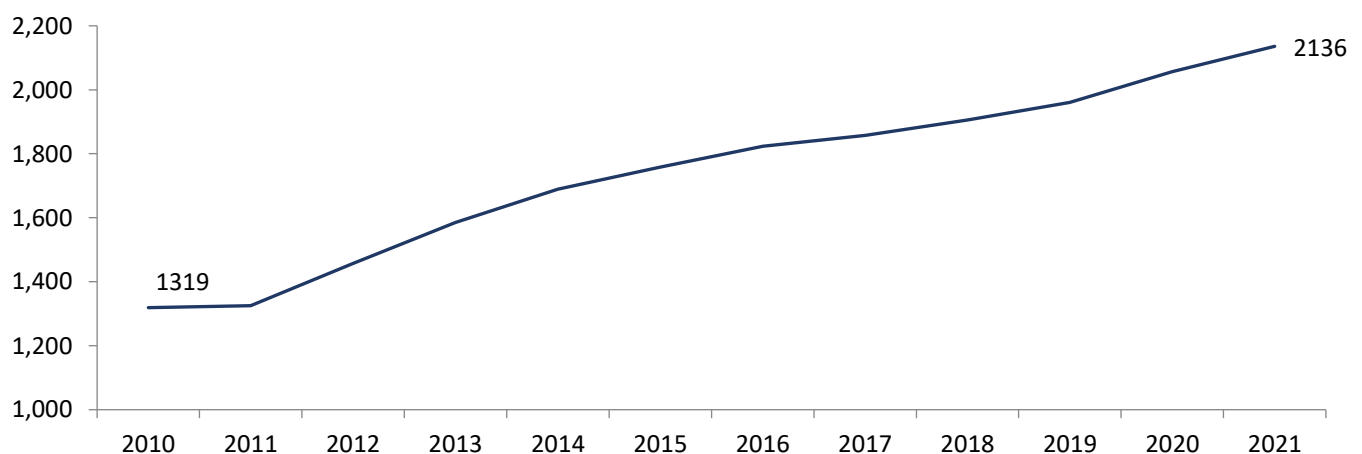


Source: Annual Survey of Industries

Hotels and restaurants. Hotels and restaurants are key players in creating sustainable AFSs. By sourcing ingredients locally, they not only support nearby farmers but also reduce the carbon footprint of the AFS associated with the transportation of food. They help minimize food waste through careful planning and designing creative menus, which inspires diners to appreciate seasonal and healthier options. Moreover, these establishments foster meaningful connections between producers and consumers, strengthening community ties and promoting a culture of sustainability. By prioritizing eco-friendly practices, hotels and restaurants can inspire guests to make more mindful choices, contributing to a more resilient and sustainable food system for everyone.

With a burgeoning youth population, along with the increasing income of middle-class households in Odisha and India, there has been a growing tendency to eat out among the population. This shift in consumption patterns is playing a significant role in transforming AFSs, as it drives demand for processed foods, ready-to-eat meals, and more diverse food options. Street food vendors are central to this transformation, providing affordable and accessible food options. However, since most of these vendors operate in the unorganized sector, this study focuses on registered hotels with restaurants. The number of hotels with restaurants has shown a steady increase from 2010 to 2021 (Figure 3.42), indicating a growing formal food service sector that contributes to AFS transformation by improving food safety, quality, and market reach.

Figure 3.42 Trend in numbers of hotels with restaurants in Odisha



Source: Department of Tourism, Government of Odisha.

4 Conclusions and Policy Implications

Globally, agrifood systems (AFS) are experiencing rapid change induced by various drivers. These changes can also be observed across AFSs in the states of India. For Odisha, a conceptual model for agrifood transformation has been framed based on both external and internal drivers impacting the AFS in the state. Among the external drivers, economic growth, the impact of climate variability, demographic change, consumer preferences, and the external technological environment have been identified. In contrast, the internal drivers include crop production, cost and profitability, internal technological environment, government policies for the farm sector, rural infrastructure, and rural organizations, along with supply chain management and food safety standards.

Over the last two decades, Odisha has experienced positive developments in its AFS, including increased household incomes, rapid urbanization, growth in fisheries exports, greater mechanization in farming, improved rural infrastructure (such as cold storage facilities), and the adoption of high-yielding and climate-resilient crop varieties. The government has also provided support to rural organizations and farmers. However, despite these developments, Odisha's AFS still faces challenges. These include climate variability, disparities in fertilizer usage, below-optimal groundwater extraction in many districts, limited crop diversification, inadequate rural infrastructure, and a lack of market integration for farmers. These positive developments and challenges together highlight the complex dynamics affecting AFS transformation in Odisha.

By examining both external and internal drivers, the following policy recommendations have been derived:

- To mitigate the effects of climate variability, climate-resilient technologies, including carbon farming, to counter biotic and abiotic stresses need to be assessed and implemented. Further, cultural practices to reduce soil acidity in Odisha should be promoted.
- In the case of inputs, the seed replacement rate of major non-rice crops is low. It is important to have a reliable and affordable supply of high-quality seeds for non-rice crops to support crop diversification. For this purpose, it is recommended that OUAT, the Indian Council of Agricultural Research (ICAR) institutions, and CGIAR centers located in Odisha be given support and responsibility for developing appropriate crop varieties that can withstand climate change. Further, efforts should be made to reduce the disparity in fertilizer consumption and groundwater extraction across the districts, particularly in the tribal hinterlands.
- The recent announcement of a higher minimum support price for rice, along with bonuses, could further retard already stagnated crop diversification processes and could disrupt Odisha's AFS by encouraging more land to be shifted into paddy cultivation. Instead, incentives should be given to diversify crop agriculture into pulses and oilseeds. Ensuring parity across food production, income generation, and environmental sustainability is essential for a sustainable AFS. Besides crop diversification, efforts should be made to promote enterprise diversification.
- The Seafood Park in Bhubaneswar, Odisha, has been active in processing and exporting seafood from Odisha. Similar food parks should be established for other food commodities, such as organic aromatic rice, organic mango, pulses, and spices, for better price realization by the farming community from both domestic and export markets. Developing these food parks into major production hubs will facilitate post-harvest processing and marketing in Odisha. The government should encourage national and multinational companies to invest in these parks by offering them tax concessions.
- In Odisha, mechanization's correlation with paddy production is below expectation, as key tasks like planting, weeding, harvesting, and threshing are still done manually. Women primarily handle these tasks. Promoting control-intensive machinery would reduce labor, improve productivity, and reduce harvest losses. Additionally, encouraging women's entrepreneurship and promoting women-friendly farm tools will be essential for boosting productivity.
- The lack of import and export data on farm commodities in Odisha hampers effective policy intervention, especially during crises. To address this, there should be regular provision and analysis of such data to support decision-making. Additionally, efforts should focus on creating export markets for farm commodities produced by Odisha's farmers, which would help the farmers with better crop planning. Investment in market and logistics infrastructure, including roads, cold chains, and processing facilities, is crucial to increasing market efficiency, improving market access for farmers, and scaling up agricultural exports.

- The productivity of major crops in Odisha is low compared to national averages. Thus, yield-enhancing sustainable technologies need to be assessed and promoted to increase the marketable surplus of farm commodities. This will benefit the farmers in Odisha, the majority of whom are small and marginal farmers. Further, SHGs and FPOs should be strengthened by offering them financial incentives, loans, and subsidies to help their member farmers access quality inputs, realize better prices, and participate in more lucrative formal markets.

Acknowledgements

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Appendixes

Annex Table 1 Yield mean regression and variance regression for agroclimatic zones in Odisha

Variables	Mean			Variance		
	Paddy yield	Green gram yield growth	Maize yield growth	Log-yield paddy growth	Log-yield green gram growth	Log-maize yield growth
Paddy area ('000 ha)	0.906 (1.733)					
Maize area ('000 ha)			0.212 (0.510)			-0.055 (0.080)
Paddy area, growth				0.003 (0.004)		
Green gram area, growth		-0.030 (0.094)			-0.002 (0.012)	
Year average temperature (Celsius)	59.901 (111.868)	-1.413 (4.349)	-1.210 (3.137)	0.618* (0.350)	0.124 (0.468)	-0.241 (0.414)
Deviation in temperature	-3,136.660 (4,468.670)	-90.671 (164.385)	-76.177 (127.616)	24.044* (14.195)	22.189 (18.993)	-24.328 (16.805)
Year average rainfall (in mm)	-0.033 (0.416)	-0.007 (0.013)	0.004 (0.013)	-0.000 (0.001)	-0.000 (0.002)	-0.001 (0.001)
Rainfall intensity	-2,125.080 (1,329.790)	-159.550*** (50.497)	-21.801 (36.840)	-8.451* (4.665)	1.905 (6.252)	1.160 (5.550)
Trend	-33.236 (39.081)	2.052 (1.418)	1.369 (1.090)	0.152 (0.138)	-0.121 (0.187)	-0.236 (0.166)
Trend^2	2.882** (1.352)	-0.077 (0.051)	-0.049 (0.038)	-0.003 (0.005)	0.003 (0.006)	0.006 (0.006)
East and Southeastern Coastal Plain zone–mean temperature	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
North Central Plateau zone–mean temperature	59.627 (125.047)	0.901 (5.008)	-0.779 (3.289)	-0.373 (0.405)	0.061 (0.543)	-0.322 (0.479)
Western Undulating zone–mean temperature	24.565 (130.283)	1.611 (4.798)	3.082 (3.833)	-0.730* (0.422)	-0.618 (0.564)	0.817 (0.500)
East and Southeastern Coastal Plain zone–Rainfall	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)
North Central Plateau zone–rainfall	0.723 (0.598)	0.030 (0.018)	0.024 (0.017)	0.002 (0.002)	0.003 (0.002)	0.001 (0.002)
Western Undulating zone–Rainfall	1.188** (0.565)	0.027 (0.020)	-0.015 (0.016)	0.001 (0.002)	-0.001 (0.003)	-0.001 (0.002)
North Central Plateau zone–dummy	-385.749 (2,475.784)	-0.414 (90.944)	45.168 (68.747)	-12.907 (8.599)	-24.272** (11.697)	28.884*** (10.341)
Constant	4,501.697 (7,746.690)	188.837 (294.976)	113.276 (216.571)	-35.278 (24.370)	-23.113 (32.608)	39.127 (28.819)
Observations	78	75	75	75	75	75
R-squared	0.543	0.230	0.192	0.239	0.129	0.261
F-test	6.446	1.547	1.226	1.627	0.762	1.827
Prob>F	0.000	0.132	0.287	0.107	0.686	0.0630

Note: Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Annex Table 2 Budgetary allocation among major programs in the Odisha agriculture budget, 2023-24

Plans or programs	Allocation (crores Rs)	Percentage share of total agriculture budget
Allocation of funds for Pradhan Mantri Krishi Sinchayee Yojana irrigation extension scheme, Mega lift Irrigation Project, Accelerated Irrigation Benefits Program, Command Area Development Programme, Minor and Medium Irrigation, and In-stream Storage Structures	5,788.23	31.4
Farmers' welfare (Kalia Yojana)	1,977.87	10.7
Infrastructure development	1,532.41	8.3
Interest subvention for providing crop loans	736.67	4.1
Indemnity towards crop insurance	600.00	3.3
Shree Anna Abhiyan (the Special Programme for Promotion of Millets in Tribal Areas of Odisha)	497.04	2.7
Fisheries Development and Fishermen Welfare	402.07	2.2
Horticulture development	385.80	2.1
Climate resilient agriculture	335.00	1.8
Rashtriya Krushi Vikas Yojana program for risk mitigation and promoting agribusiness entrepreneurship	306.15	1.7
Input subsidy for agriculture and horticulture activities	263.00	1.4
Farm mechanization	223.28	1.2
Poultry development	156.75	0.9
Livestock and dairy development including fodder development	155.04	0.8
National Food Security Mission	135.05	0.7
Other schemes	4,936.44	26.8
Total	18,430.80	100.0

Note: The agriculture budget consists of both plan and non-plan expenditures of four departments—Department of Agriculture and Farmers' Empowerment, Cooperation Department, Water Resources Department and Fisheries and Animal Resources Development Department. Crore = 10,000,000.

Annex Table 3 Krishi Vigyan Kendra (KVK), agricultural extension center initiatives in capacity building of farmers and extension officers in Odisha, 2015-16 to 2022-23

Year	Training			On-farm testing		Frontline demonstrations	Messages under the Kissan Mobile Advisory Service		
	Farmers	Rural youth	Extension officers	No.	Farmers	No.	Farmers	Farmers	Extension officers
2015-16	35,336	5,395	3,251	425	4,767	441	4,201		
2016-17	26,022	3,424	2,164	443	4,407	448	4,341		
2017-18	32,559	4,147	2,803	235	2,106	426	4,399	1,107,325	18,433
2018-19	37,448	3,224	2,216	241	1,935	440	4,501	-	-
2019-20	38,901	4,854	2,678	271	2,105	542	5,393	1,605,211	8,248
2020-21	37,792	5,072	2,854	263	2,031	553	5,692	1,335,545	4,100
2021-22	41,062	5,348	2,854	251	2,017	534	5,819	2,554,009	24,193
2022-23	44,194	6,315	4,419	254	2,686	484	5,287	1,528,747	10,293

Source: OUAT (various)

Annex Table 4 Odisha Rural Development and Marketing Society facilitation for the marketing of products of self-help groups in Odisha, 2003-04 to 2019-20

Year	Exhibitions organized	Self-help-groups or other institutions participated	Participants	Total sales (Rs lakhs)
2003-04	6	1,060	2,642	150.39
2004-05	10	1,144	2,765	252.45
2005-06	9	2,051	2,267	332.72
2006-07	20	3,310	6,078	1,206.34
2007-08	20	3,120	5,820	1,006.34
2008-09	22	3,348	7,365	1,468.51
2009-10	28	4,128	8,307	1,728.28
2010-11	28	4,020	7,573	1,723.98
2011-12	28	3,940	6,854	2,007.19
2012-13	27	4,500	8,702	2,911.23
2013-14	22	3,535	7,365	3,347.31
2014-15	28	4,604	9,244	3,913.77
2015-16	30	5,181	10,052	5,148.37
2016-17	26	4,596	8,067	5,569.30
2017-18	28	4,866	9,863	6,371.90
2018-19	29	4,340	9,383	7,583.95
2019-20	28	5,130	9,423	8,427.35
Total	389	62,873	121,770	53,149.38

Source: Odisha Rural Development and Marketing Society report

Note: Lakh = 100,000.

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INTERNATIONAL
FOOD POLICY
RESEARCH
INSTITUTE

Sarba Narayan Mishra, Professor and Head, Department of Agricultural Economics, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, sarbanmishra@ouat.ac.in

Subhrajyoti Mishra, Senior Consultant, Agriculture Consultancy Support Service Cell (ACSSC), OUAT, Bhubaneswar, subhrajyotimishra66@gmail.com

Manmeet Ajmani, Senior Research Analyst, International Food Policy Research Institute, m.ajmani@cgiar.org

K.R. Ashok, Senior Consultant, ACSSC, OUAT, Bhubaneswar, ashok10tnau@yahoo.com

Debdutt Behura, Senior Consultant, ACSSC, OUAT, Bhubaneswar, d_behura05@yahoo.co.in

Manoj Kumar Das, Senior Consultant, ACSSC, OUAT, manoj.d@srisriuniversity.edu.in

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FOOD POLICY
RESEARCH
INSTITUTE



Sarba Narayan Mishra, Professor and Head, Department of Agricultural Economics, Odisha University of Agriculture and Technology (OUAT), Bhubaneswar, sarbanmishra@ouat.ac.in

Subhrajyoti Mishra, Senior Consultant, Agriculture Consultancy Support Service Cell (ACSSC), OUAT, Bhubaneswar, subhrajyotimishra66@gmail.com

Manmeet Ajmani, Senior Research Analyst, International Food Policy Research Institute, m.ajmani@cgiar.org

K.R. Ashok, Senior Consultant, ACSSC, OUAT, Bhubaneswar, ashok10tnau@yahoo.com

Debdutt Behura, Senior Consultant, ACSSC, OUAT, Bhubaneswar, d_behura05@yahoo.co.in

Manoj Kumar Das, Senior Consultant, ACSSC, OUAT, manoj.d@srisriuniversity.edu.in

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