

Report on Crop Nutrition & Crop Protection Industry

January 2024

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1. Economic Outlook

1.1 Indian Economy Outlook

1.1.1 GDP Growth and Outlook

Resilience to external shocks remains critical for near-term outlook

India's GDP grew by 9.1% in FY22 and stood at Rs. 149.3 trillion despite the pandemic and geopolitical Russia-Ukraine spillovers. In Q1FY23, India recorded 13.2% y-o-y growth in GDP, largely attributed to improved performance by the agriculture and services sectors. Following this double-digit growth, Q2FY23 witnessed 6.3% y-o-y growth, while Q3FY23 registered 4.5% y-o-y growth. The slowdown during Q2FY23 and Q3FY23 compared to Q1FY23 can be attributed to the normalization of the base and a contraction in the manufacturing sector's output.

Subsequently, Q4FY23 registered broad-based improvement across sectors compared to Q3FY23 with a growth of 6.1% y-o-y. The investments, as announced in the Union Budget 2022-23 on boosting public infrastructure through enhanced capital expenditure, have augmented growth and encouraged private investment through large multiplier effects in FY23. Supported by fixed investment and higher net exports, GDP for full-year FY23 was valued at Rs. 160.1 trillion registering an increase of 7.2% y-o-y.

Furthermore, in Q1FY24, the economic growth accelerated to 7.8%. The manufacturing sector maintained an encouraging pace of growth, given the favourable demand conditions and lower input prices. The growth was supplemented by a supportive base alongside robust services and construction activities.

GDP Growth Outlook

- During FY24, strong agricultural and allied activity prospects are likely to boost rural demands. However, El Nino is being predicted in the current fiscal which may lead to deficit rainfall in the country and impact agricultural output. However, a rebound in contact-intensive sectors and discretionary spending is expected to support urban consumption.
- Strong credit growth, resilient financial markets, and the government's continual push for capital spending and infrastructure are likely to create a compatible environment for investments.
- External demand is likely to remain subdued with a slowdown in global activities, thereby indicating adverse implications for exports. Additionally, heightened inflationary pressures and resultant policy tightening may pose a risk to the growth potential.

Taking all these factors into consideration, in August 2023, the RBI in its bi-monthly monetary policy meeting estimated a real GDP growth of 6.5% y-o-y for FY24.

GDP Growth Outlook

Table 1: RBI's GDP Growth Outlook (Q-o-Q %)

FY24 (complete year)	Q1FY24	Q2FY24	Q3FY24	Q4FY24	Q1FY25
6.5	8.0	6.5	6.0	5.7	6.6%

Source: Reserve Bank of India

1.1.2 Gross Value Added (GVA)

Gross value added (GVA) is the measure of the value of goods and services produced in an economy. GVA gives a picture of supply side whereas GDP represents consumption.

Industry and Services sector leading the recovery charge

- The gap between GDP and GVA growth turned positive in FY22 (after a gap of two years) due to robust tax collections. Of the three major sector heads, the service sector has been the fastest-growing sector in the last 5 years.
- The **agriculture sector** was holding growth momentum till FY18. In FY19, the acreage for the rabi crop was marginally lower than the previous year which affected the agricultural performance. Whereas FY20 witnessed growth on account of improved production. During the pandemic year FY21, the agriculture sector was largely insulated as timely and proactive exemptions from COVID-induced lockdowns to the sector facilitated uninterrupted harvesting of rabi crops and sowing of kharif crops. However, supply chain disruptions impacted the flow of agricultural goods leading to high food inflation and adverse initial impact on some major agricultural exports. However, performance remained steady in FY22.

Overall, the agriculture sector performed well despite weather-related disruptions, such as uneven monsoon and unseasonal rainfall, impacting yields of some major crops and clocked a growth of 4% y-o-y in FY23, garnering Rs. 22.3 trillion. Going forward, rising bank credit to the sector and increased exports will be the drivers for the agriculture sector. However, a deficient rainfall may impact the reservoir level weighing on prospects of rabi sowing. A downside risk exists in case the intensity of El Nino is significantly strong.

- The **industrial sector** witnessed a CAGR of 4.7% for the period FY16 to FY19. From March 2020 onwards, the nationwide lockdown due to the pandemic significantly impacted industrial activities. In FY20 and FY21, this sector felt turbulence due to the pandemic and recorded a decline of 1.4% and 0.9%, respectively, on a y-o-y basis. With the opening up of the economy and resumption of industrial activities, it registered 11.6% y-o-y growth in FY22, albeit on a lower base. Overall, the industrial sector is estimated to be valued at Rs. 45.2 trillion registering 4.4% growth in FY23.

The industrial growth was mainly supported by sustained momentum in the manufacturing and construction sectors. Within manufacturing (as captured by IIP numbers), industries such as pharma, non-metallic mineral products, rubber, plastic, metals, etc., witnessed higher production growth during the quarter.

- The **services sector** recorded a CAGR of 7.1% for the period FY16 to FY20, which was led by trade, hotels, transport, communication, and services related to broadcasting, finance, real estate, and professional services. This sector was the hardest hit by the pandemic and registered an 8.2% y-o-y decline in FY21. The easing of restrictions aided a fast rebound in this sector, with 8.8% y-o-y growth witnessed in FY22.

Overall, benefitting from the pent-up demand, the service sector was valued at Rs. 20.6 trillion and registered growth of 9.5% y-o-y in FY23. Within services, there was a broad-based improvement in growth across different sub-sectors. However, the sharpest jump was seen in financial, real estate, and professional services. Trade, hotels, and transport sub-sectors expanded at a healthy pace gaining from strength in discretionary demand. Accordingly, steady growth in various service sector indicators like air passenger traffic, port cargo traffic, GST collections, and retail credit are expected to support the services sector.

Table 2 : Sectoral Growth (Y-o-Y % Growth) - at Constant Prices

At constant Prices	FY18	FY19	FY20 (3RE)	FY21 (2RE)	FY22 (1RE)	FY23 (PE)
Agriculture, Forestry & Fishing	6.6	2.1	6.2	4.1	3.5	4
Industry	5.9	5.3	-1.4	-0.9	11.6	4.4
Mining & Quarrying	-5.6	-0.8	-3	-8.6	7.1	4.6
Manufacturing	7.5	5.4	-3	2.9	11.1	1.3
Electricity, Gas, Water Supply & Other Utility Services	10.6	7.9	2.3	-4.3	9.9	9
Construction	5.2	6.5	1.6	-5.7	14.8	10
Services	6.3	7.2	6.4	-8.2	8.8	9.5

At constant Prices	FY18	FY19	FY20	FY21	FY22	FY23 (PE)
			(3RE)	(2RE)	(1RE)	
Trade, Hotels, Transport, Communication & Broadcasting	10.3	7.2	6	-19.7	13.8	14
Financial, Real Estate & Professional Services	1.8	7	6.8	2.1	4.7	7.1
Public Administration, Defence and Other Services	8.3	7.5	6.6	-7.6	9.7	7.2
GVA at Basic Price	6.2	5.8	3.9	-4.2	8.8	7

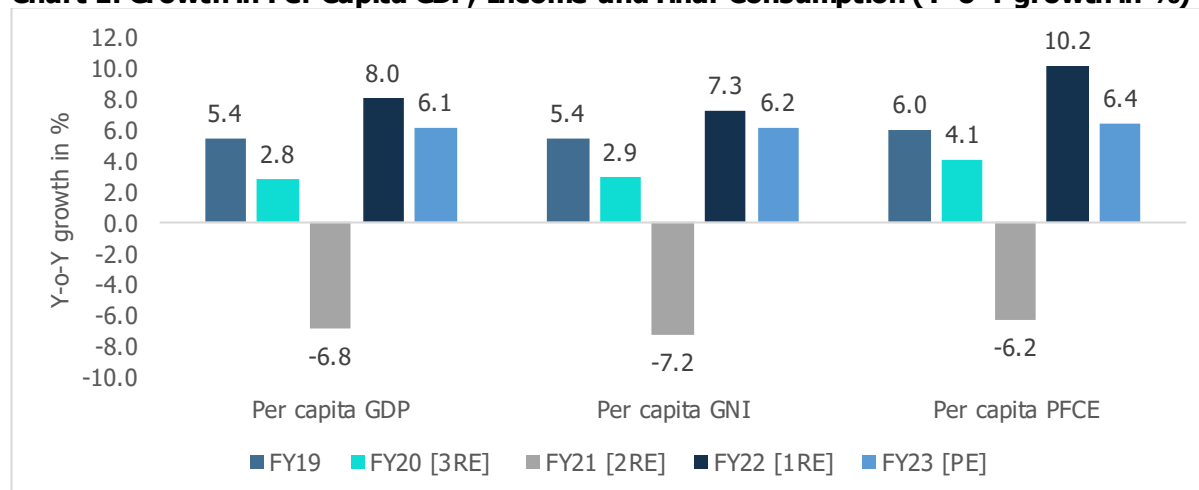
Note: 3RE – Third Revised Estimate, 2RE – Second Revised Estimates, 1RE – First Revised Estimates, PE – Provisional Estimate;
 Source: MOSPI

Per capita GDP, Per Capita GNI and Per Capita PFCE

India has a population of about 1.4 billion with a young demographic profile. The advantages associated with this demographic dividend are better economic growth, rapid industrialization and urbanization.

Gross Domestic Product (GDP) per capita is a measure of country's economic output per person. FY21 witnessed a significant de-growth due to the pandemic. However, in FY22 the economy paved its way towards recovery and the per capita GDP grew by 8.0%. This growth was moderated to 6.1% due to correction of base effect in FY23. The Gross national income (GNI) also increased by 7.3% in FY22 and 6.2% in FY23. The per capita private final consumption expenditure (PFCE), which represents consumer spending, increased by 10.2% in FY22 and 6.4% in FY23.

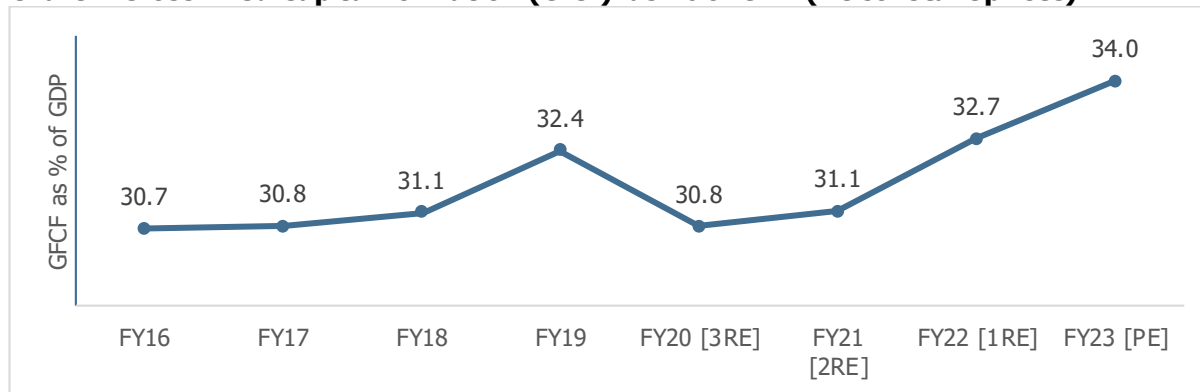
Chart 1: Growth in Per Capita GDP, Income and Final Consumption (Y-o-Y growth in %)



Note: 3RE – Third Revised Estimate, 2RE – Second Revised Estimates, 1RE – First Revised Estimates, PE – Provisional Estimate;
 Source: MOSPI

1.1.3 Investment Trend in infrastructure

Gross Fixed Capital Formation (GFCF), which is a measure of the net increase in physical assets, witnessed an improvement in FY22. As a proportion of GDP, it is estimated to be at 32.7%, which is the second-highest level in 7 years (since FY15). In FY23, the ratio of investment (GFCE) to GDP climbed up to its highest in the last decade at 34%, as per the advanced estimate released by the Ministry of Statistics and Programme Implementation (MOSPI).

Chart 2: Gross Fixed Capital Formation (GFCF) as % of GDP (At constant prices):

PE: Provisional Estimates, AE: Advanced Estimate; Source: MOSPI

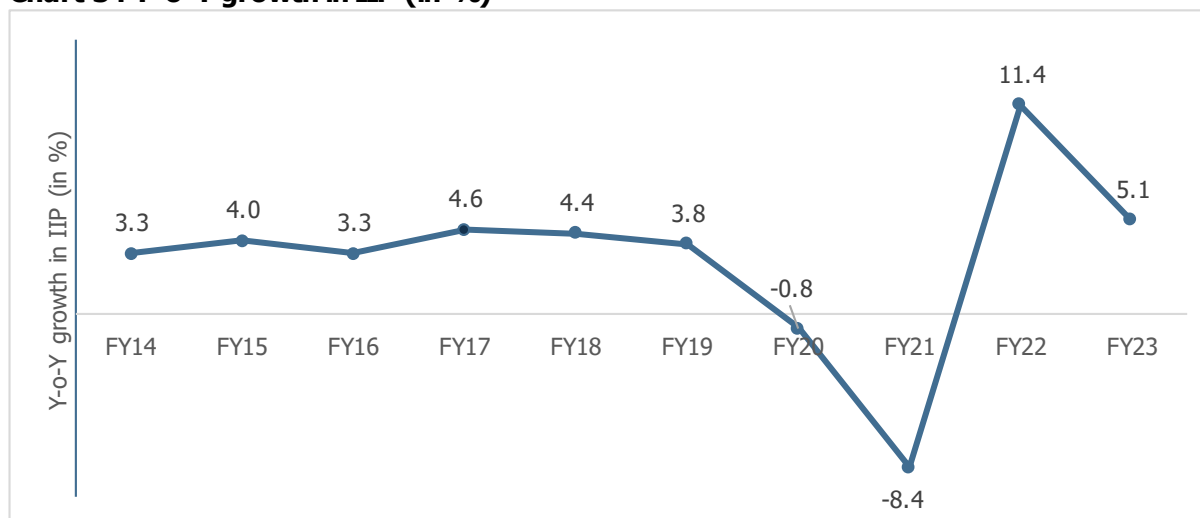
Overall, the support of public investment in infrastructure is likely to gain traction due to initiatives such as Atmanirbhar Bharat, Make in India, and Production-linked Incentive (PLI) scheme announced across various sectors.

1.1.4 Industrial Growth

Improved core sector and capital goods sector helps in IIP growth momentum

The Index of Industrial Production (IIP) is an index to track manufacturing activity in an economy. On a cumulative basis, IIP grew by 11.4% y-o-y in FY22 post declining by 0.8% y-o-y and 8.4% y-o-y, respectively, in FY20 and FY21. This high growth was mainly backed by a low base of FY21. FY22 IIP was higher by 2.0% when compared with the pre-pandemic level of FY20, indicating that while economic recovery was underway, it was still at very nascent stages.

During FY23, the industrial output recorded a growth of 5.1% y-o-y supported by a rebound in economic activities and robust expansion in production of electricity, followed by mining and manufacturing.

Chart 3 : Y-o-Y growth in IIP (in %)

Source: MOSPI

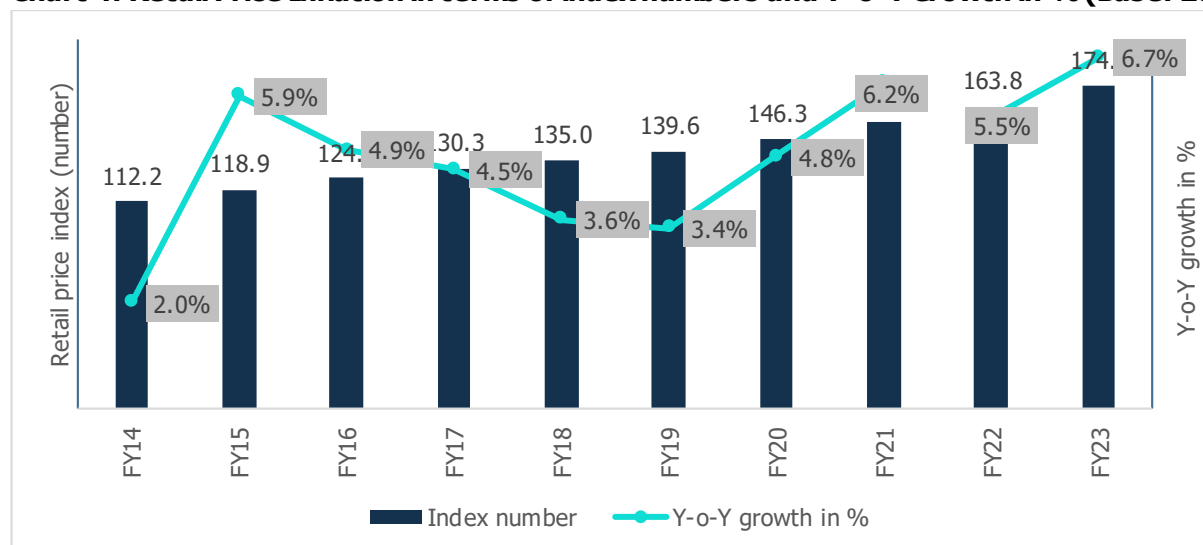
The rebound in industrial activity in July 2023 is encouraging. The healthy momentum recorded in the infrastructure and construction sector is likely to continue aided by the Government's focus on this segment. The consumption demand is likely to see an improvement in the upcoming festive season. However, the elevated food inflation and monsoon-related vagaries could pose a risk to consumption demand. Over a longer period of time, the unfolding of the domestic demand scenario remains critical for industrial activity. External demand is likely to remain weak and that will continue to cast a shadow on export-dependent sectors.

1.1.5 Consumer Price Index

India's consumer price index (CPI), which tracks retail price inflation, stood at an average of 5.5% in FY22 which was within RBI's targeted tolerance band of 6%. However, consumer inflation started to upswing from October 2021 onwards and reached a tolerance level of 6% in January 2022. Following this, CPI reached 6.9% in March 2022.

CPI remained elevated at an average of 6.7% in FY23, above the RBI's tolerance level. However, there was some respite toward the end of the fiscal wherein the retail inflation stood at 5.7% in March 2023, tracing back to the RBI's tolerance band. Apart from a favorable base effect, the relief in retail inflation came from a moderation in food inflation.

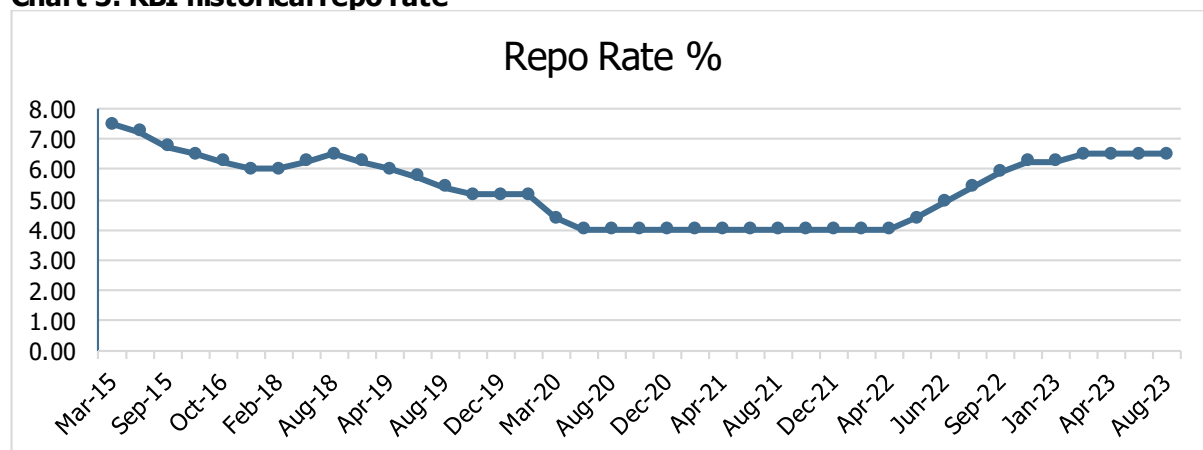
Chart 4: Retail Price Inflation in terms of index numbers and Y-o-Y Growth in % (Base: 2011-12=100)



Source: MOSPI

The CPI is primarily factored in by RBI while preparing their bi-monthly monetary policy. The RBI has increased the repo rates with the rise in inflation in the past year from 4% in April 2022 to 6.5% in January 2023.

Chart 5: RBI historical repo rate



Source: RBI

However, with the inflation easing over the last few months, RBI has kept the repo rate unchanged at 6.5% in the last three meetings of the Monetary Policy Committee. At the bi-monthly meeting held in August 2023, RBI projected inflation at 5.4% for FY24 with inflation during Q2FY24 at 6.2%, Q3FY24 at 5.7%, Q4FY24 at 5.2% and Q1FY25 at 5.2%.

In a meeting held in August 2023, RBI also maintained the liquidity adjustment facility (LAF) corridor by adjusting the standing deposit facility (SDF) rate of 6.25% as the floor and the marginal standing facility (MSF) at the upper end of the band at 6.75%.

Further, the central bank continued to remain focused on the withdrawal of its accommodative stance. With domestic economic activities gaining traction, RBI has shifted gears to prioritize controlling inflation. While RBI has paused on the policy rate front, it has also strongly reiterated its commitment to bringing down inflation close to its medium-term target of 4%. Given the uncertain global environment and lingering risks to inflation, the Central Bank has kept the window open for further monetary policy tightening in the future, if required.

1.1.6 Concluding Remarks

The major headwinds to global economic growth are escalating geopolitical tensions, volatile global commodity prices, and a shortage of key inputs. Despite the global economic growth uncertainties, the Indian economy is relatively better placed in terms of GDP growth compared to other emerging economies. It is expected to grow at 6.3% in CY24 compared to the world GDP growth projection of 3%. The bright spots for the economy are continued healthy domestic demand, support from the government towards capital expenditure, moderating inflation, and improving business confidence.

Likewise, several high-frequency growth indicators including the purchasing managers index, auto sales, bank credit, and GST collections have shown improvement in FY23. Moreover, normalizing the employment situation after the opening up of the economy is expected to improve and provide support to consumption expenditure.

Further, in line with the latest India Meteorological Department (IMD) projection, the rainfall activity has been muted during June 1, 2023 to September 20, 2023, with cumulative rainfall falling back to a 7% deficit. Also, weak-to-moderate El Nino conditions are expected to lead to a prolonged dry spell. A drop-in yield due to irregular monsoon and a lower acreage can lead to a demand-supply mismatch, further increasing the inflationary pressures on the food basket. Going ahead, consumption demand is expected to pick up during the festive season, but the quantum of rise in demand will be dependent on the extent of the impact of the irregular monsoon.

The main growth drivers for the agriculture sector are favorable government policy, Public and private (farmers') investments in building irrigation capacities, use of modern farm inputs like seeds and fertilizers and subsidies. For the long-term growth of Agriculture sector, advancement in science-led technology in agriculture, private sector participation in both pre and post-harvest phases and liberalized output market will act as some of the key contributing factors.

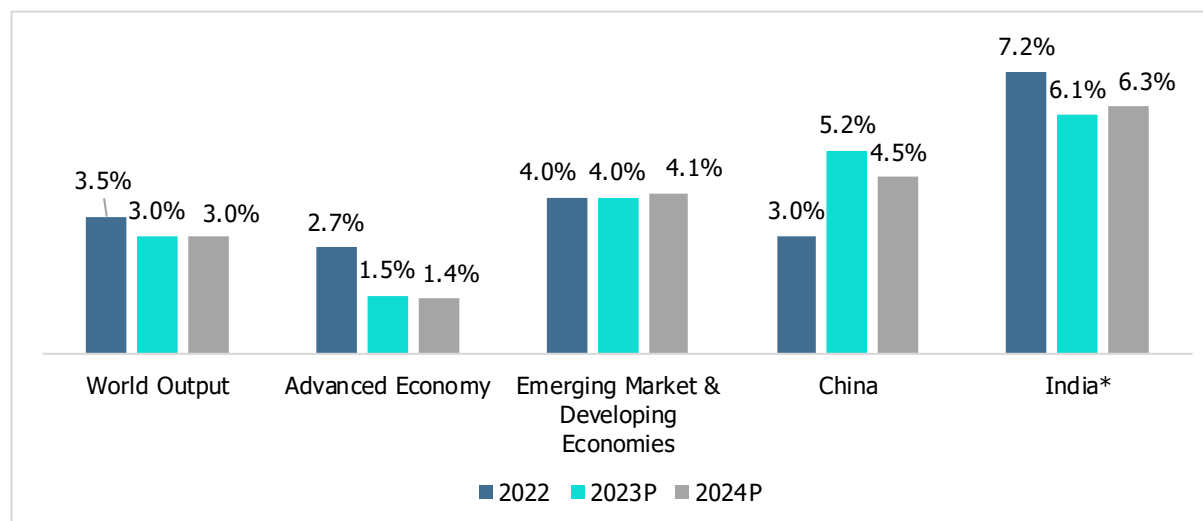
At the same time, public investment is expected to exhibit healthy growth as the government has allocated a strong capital expenditure of about Rs. 10 lakh crores for FY24. The private sector's intent to invest is also showing improvement as per the data announced on new project investments. However, volatile commodity prices and economic uncertainties emanating from global turbulence may slow down the improvement in private CapEx and investment cycle.

Furthermore, the industrial sector is expected to perform better among all sectors, as input costs are now moderating. With flagship programmes like 'Make in India' and the PLI schemes, the government is continuing to provide the necessary support to boost the industrial sector. Similarly, the service sector is expected to see continued growth in FY24. However, some segments in the service sector, like information technology, are likely to be impacted by the slowdown in the US and European economies.

1.2 Global Economy Outlook

As per the International Monetary Fund (IMF)'s World Economic Outlook growth projections released in July 2023, the global economic growth for CY22¹ stood at 3.5% on a year-on-year (y-o-y) basis, down from 6.3% in CY21 due to disruptions resulting from the Russia-Ukraine conflict and higher-than-expected inflation worldwide. On the other hand, the global economic growth for CY23 is projected to slow down further to 3.0%, attributed to compressing global financial conditions, expectant steeper interest rate hikes by major central banks to fight inflation, and spill-over effects from the Russia-Ukraine conflict, with gas supplies from Russia to Europe expected to remain tightened. Whereas growth in CY24 is projected to remain broadly stable at 3.0%, with notable shifts across regions. For the next 5 years, the IMF projects world economic growth in the range of 3.0%-3.2% on a y-o-y basis.

Chart 6: Global Growth Outlook Projections (Real GDP, Y-o-Y change in %)



Notes: P-Projection

*For India, data and forecasts are presented on a fiscal year basis and GDP from 2011 onward is based on GDP at market prices with fiscal year 2011/12 as a base year

Source: IMF – World Economic Outlook, July 2023

Advanced Economies Group

The major advanced economies registered GDP growth of 2.7% in CY22, down from 5.4% in CY21, which is further projected to decline to 1.5% in CY23. This forecast of low growth reflects increased central bank interest rates to fight inflation and the impact of the Russia-Ukraine war. About 93% of advanced economies are projected to witness declined GDP growth in CY23. In addition, this is further expected to decline to 1.4% in CY24.

One of the major countries from this group is the **United States**. The United States registered GDP growth of 2.1% in CY22 compared to 5.9% in CY21. Whereas, growth for CY23 and CY24 is projected at 1.8% and 1.0%, respectively. This is reflective of declining real disposable incomes and savings impacting consumer demand with higher interest rates taking a toll on spending.

Further, the **Euro Area** registered GDP growth of 3.5% in CY22 compared to 5.3% in CY21. However, the boost from the reopening of the economy after the pandemic appears to be fading. For CY23 and CY24, the growth is projected at 0.9% and 1.5%, respectively. The accelerated pace of rate increases by the Bank of England and the European Central Bank has tightened the financial conditions, resulting in the cooling of demands in the housing sector and beyond.

¹ CY- Calendar Year

Emerging Market and Developing Economies Group

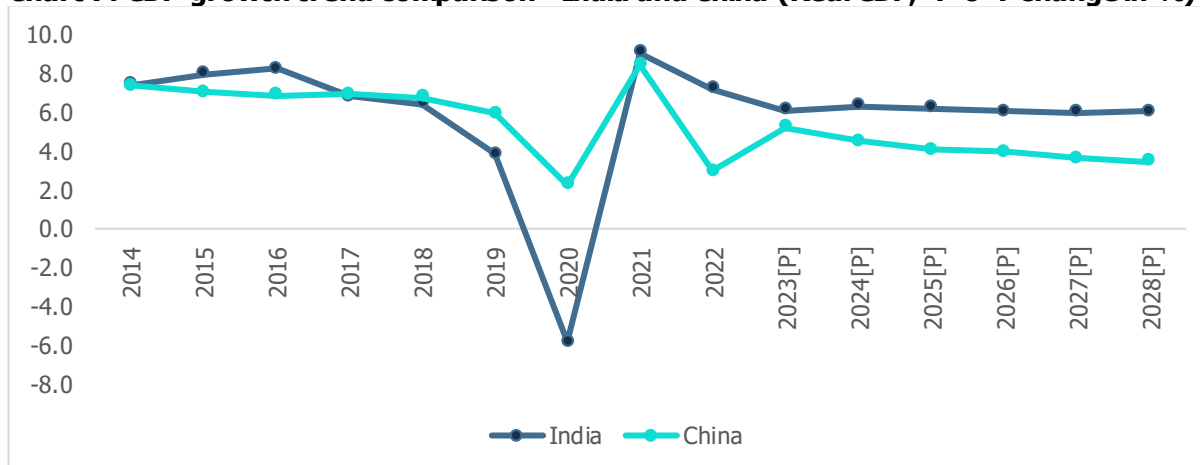
For the emerging market and developing economies group, GDP growth stood at 4.0% in CY22, compared to 6.8% in CY21. This growth is further projected at 4.0% in CY23 and 4.1% in CY24. The anticipated improvement in GDP growth in CY24 is attributed to the anticipation of gradual recovery. Whereas about 61% of economies, expected to progress rapidly in CY23, project stable growth. While the remaining economies, including the low-income countries, are expected to progress slower.

Further, in **China**, growth is expected to pick up to 5.2% with the full reopening in CY23 and subsequently moderate in CY24 to 4.5%. Whereas, India's GDP projections for CY23 and CY24 stand at 6.1% and 6.3%, respectively, with resilient domestic demands despite external headwinds.

India to remain the fastest growing economy transcending China

Despite the turmoil in the last 2-3 years, India bears good tidings to become a USD 5 trillion economy by CY27. According to the IMF dataset on Gross Domestic Product (GDP) at current prices, the GDP has been estimated to be at USD 3.4 trillion for CY22 and is projected to reach USD 5.2 trillion by CY27. India's expected GDP growth rate for coming years is almost double compared to the world economy.

Chart 7: GDP growth trend comparison - India and China (Real GDP, Y-o-Y change in %)



P- Projections; Source: IMF – World Economic Outlook (July 2023), World Economic Outlook Database (April 2023)

Besides, India stands out as the fastest-growing economy among the major economies. The country is expected to grow at more than 6% in the period of CY24-CY28, outshining China's growth rate. Accordingly, the Indian economy is paving its way towards becoming the largest economy globally. Currently, it is the third-largest economy globally in terms of Purchasing Power Parity (PPP) with a ~7% share in the global economy, with China [~18%] on the top followed by the United States [~15%].

Purchasing Power Parity is an economic performance indicator denoting the relative price of an average basket of goods and services that a household needs for livelihood in each country. Despite COVID-19's impact, high inflationary and interest rates globally, and the geo-political tensions in Europe, India has been a major contributor to world economic growth.

2. Significance of Agriculture in Indian Economy

Agriculture continues to remain the Backbone of Indian Economy

Agriculture is the primary source of livelihood for about 58% of India's population. As a result, the share of agriculture and allied sectors to the total economy's Gross Value Added (GVA) has been significant and has increased over the years as shown here in the table:

Table 3 : Percentage share of GVA of Agriculture and Allied Sectors to Total Economy

Year	% share
2018-19	17.6
2019-20	18.4
2020-21	20.2
2021-22*	15.6
2022-23#	15.1

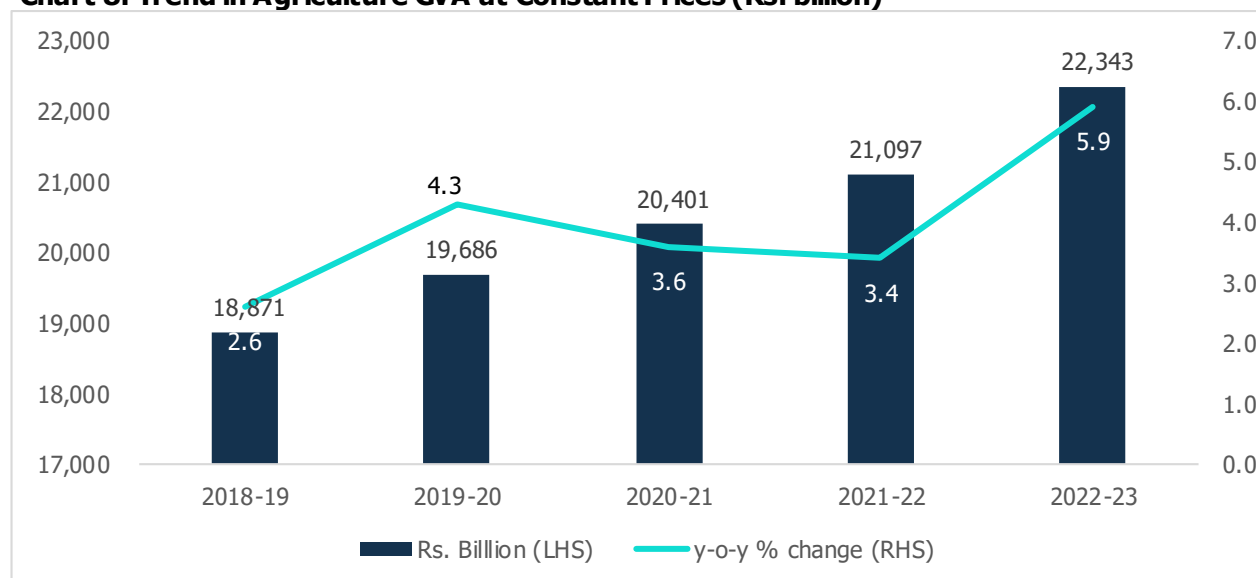
Source: PIB Release and Economic Survey 2021-22, MOSPI

Note: * denotes 1st Revised Estimates and # denotes Provisional Estimates

The agriculture sector has experienced steady growth in the past two years. As of 2022-23, the sector is the largest employer of the workforce and accounted for a sizeable 15.1% of the Gross Value Added (GVA) of the country. Growth in allied sectors including livestock, dairying, and fisheries has also been a major growth driver in the sector.

The expansion in the share of agriculture and allied sector's GVA is backed by an upward trend in the GVA of agriculture activities. During the five-year period 2018-19 to 2022-23, the GVA for agriculture increased at a CAGR of 4.3% from Rs.18,871 billion in 2018-19 to Rs.22,343 billion in 2022-23.

Chart 8: Trend in Agriculture GVA at Constant Prices (Rs. billion)



Source: MOSPI

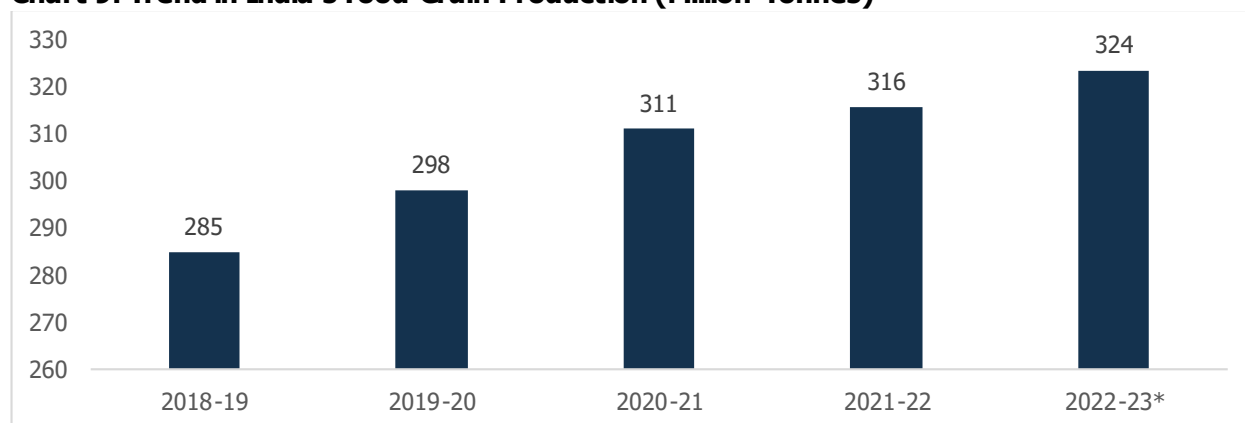
Further, the growth in agriculture GVA has been supported by various measures on credit, market reforms, and food processing. In addition to several measures aimed at increasing productivity and improving the marketing of agricultural produce, the government also carries out a large food management programme with significant financial implications in terms of food subsidies.

While agriculture continues to be a significant part of the Indian economy, the quantum of arable land in India has remained constant for almost a decade at around 154 million hectares. This is a fall of about 3.8% compared to around 160 million hectares of arable land in the 2000 period as per the World Bank. On the other hand, the

population in India has almost increased in every passing year. From 2000, when the population was at 1.06 billion, it has grown significantly to 1.4 billion in 2023.

With the upward trend in population, the demand for food grains will continue to rise in India. To meet the domestic demand, food grain production in India has increased over the years. For instance, in the last five years 2018-19 to 2022-23, total foodgrain production in India grew at a CAGR of 3.2% from 285 million tonnes in 2018-19 to 324 million tonnes in 2022-23. With the increase in population and the arable land remaining almost constant, the crop protection industry's role becomes very critical to ensure that food grain productivity is enhanced.

Chart 9: Trend in India's Food Grain Production (Million Tonnes)



Source: Government of India (Ministry of Agriculture and Farmers Welfare)

Note: * indicates Second Advance Estimates

To ensure that food grain production continues to rise with almost the same arable land and an expected increase in population, it becomes important for the Government to encourage farmers to focus on the farm productivity of India to ensure food security.

Minimum Support Price (MSP), agricultural marketing, food management, food processing sector, and natural farming (detailed below) are some of the steps taken by the Government for the betterment of farmers in the country as per the Economic Survey 2021-22.

2.1 Government's Steps Toward Doubling Farmers' Income

The Government is working towards doubling farmers income through:

- Constant hike in MSPs
- Agricultural marketing
- Food management
- Food processing sector
- Natural farming
- Promotion of new technologies such as usage of drones and other soil testing devices

• Minimum Support Price (MSP)

The government's price policy for major agricultural commodities seeks to ensure remunerative prices to the growers for their produce with a view to encourage higher investment and production and thereby safeguard the interest of consumers by making available supplies at reasonable prices.

The government fixes the MSP of 22 mandated agricultural crops on the basis of the recommendations of the Commission for Agricultural Costs & Prices (CACP) and after due consideration of the views of State Governments and the concerned Central Ministries/ Departments.

The 22 mandated crops include:

- 14 kharif crops viz. paddy, jowar, bajra, maize, ragi, tur (arhar), moong, urad, groundnut, soybean (yellow), sunflower seed, sesamum, nigerseed, cotton
- 6 rabi crops viz. wheat, barley, gram, masur (lentil), rapeseed and mustard, safflower
- 2 commercial crops viz. jute and copra

In addition to that, MSPs for toria and de-husked coconut are also fixed on the basis of MSPs for rapeseed & mustard and copra respectively.

While recommending MSPs, CACP considers important factors like cost of production, overall demand-supply conditions, domestic and international prices, inter-crop price parity, terms of trade between agricultural and non-agricultural sectors, the likely effect on the rest of the economy, besides ensuring rational utilization of land, water and other production resources, and a minimum of 50% as the margin over cost of production.

Accordingly, the government has increased the MSP for all mandated kharif, rabi, and other commercial crops with a return of at least 50% of overall India's weighted average cost of production from the agricultural year 2018-19 onwards. The MSPs announced for all the kharif and rabi crops for marketing season 2023-24 are given below.

Table 4: MSPs for all Kharif Crops for Marketing Season 2023-24 (Rs. / quintal)

S.No.	Crop	MSP 2022-23	MSP 2023-24	Cost of production 2023-24	Increase in MSP (Absolute)	Return over cost (in %)
1	Paddy (Common)	2,040	2,183	1,455	143	50
2	Paddy (Grade A) ^	2,060	2,203	-	143	-
3	Jowar (Hybrid)	2,970	3,180	2,120	210	50
4	Jowar (Maldandi)^	2,990	3,225	-	235	-
5	Bajra	2,350	2,500	1,371	150	82
6	Ragi	3,578	3,846	2,564	268	50
7	Maize	1,962	2,090	1,394	128	50
8	Tur (Arhar)	6,600	7,000	4,444	400	58
9	Moong	7,755	8,558	5,705	803	50
10	Urad	6,600	6,950	4,592	350	51
11	Groundnut	5,850	6,377	4,251	527	50
12	Sunflower Seed	6,400	6,760	4,505	360	50
13	Soyabean (yellow)	4,300	4,600	3,029	300	52
14	Sesamum	7,830	8,635	5,755	805	50
15	Nigerseed	7,287	7,734	5,156	447	50
16	Cotton (Medium Staple)	6,080	6,620	4,411	540	50
17	Cotton (Long Staple) ^	6,380	7,020	-	640	-

Source: PIB release

^Cost data are not separately compiled for Paddy (Grade A), Jowar (Maldandi) and Cotton (Long staple)

Table 5: MSPs for all Rabi for Marketing Season 2023-24 (Rs. / quintal)

S.No.	Crops	MSP 2022-23	MSP 2023-24	Cost of production 2023-24	Increase in MSP (Absolute)	Return over cost (in %)
1	Wheat	2,015	2,125	1,065	110	100
2	Barley	1,635	1,735	1,082	100	60
3	Gram	5,230	5,335	3,206	105	66

4	Lentil (Masur)	5,500	6,000	3,239	500	85
5	Rapeseed & Mustard	5,050	5,450	2,670	400	104
6	Safflower	5,441	5,650	3,765	209	50

Source: PIB release

• Agricultural Marketing

Wholesale agricultural marketing is undertaken by a network of 6,946 regulated wholesale markets, set up under the provision of the respective State Agricultural Produce Market Committee (APMC) Act. The Government of India has been working continuously and has taken several concrete steps to link the farmers with markets in order to help them trade and realize competitive and remunerative prices for their produce.

Further, the Government of India launched the National Agriculture Market (e-NAM) Scheme in 2016 with the objective of creating an online transparent competitive bidding system to facilitate farmers with remunerative prices for their produce. Under the e-NAM Scheme, the government is providing free software and assistance of Rs.75 Lakh per APMC mandi for related hardware including quality assaying equipment and the creation of infrastructure like cleaning, grading, sorting, packaging, compost units, etc.

As of 7th of December, 2023, 1,260 mandis of 22 States and 3 UTs have been integrated with the e-NAM platform. The Government of India has launched a Central Sector Scheme of "Formation and Promotion of 10,000 Farmer Producer Organizations (FPOs)" to form and promote 10,000 new FPOs till 2027-28. Under the scheme, the formation and promotion of FPO are based on the Produce Cluster Area approach and specialized commodity-based approach. While adopting a cluster-based approach, the formation of FPOs focuses on "One District One Product" to enable product specialization.

One of the objectives of the Scheme is to enhance productivity through efficient, cost-effective, and sustainable resource use, realize higher returns through better liquidity and market linkages for their produce, and become sustainable through collective action. As of January 2022, a total of 1,963 FPOs have been registered under the scheme. In addition, the government established a full-fledged Ministry of Cooperation in July 2021 with a view to providing greater focus to the cooperative sector.

• Food Management

The major objectives of food management are procurement of foodgrains from farmers at remunerative prices, distribution of foodgrains to consumers, particularly the vulnerable sections of society at affordable prices, and maintenance of food buffer stock for food security and price stability. The instruments used are procurement at MSP from farmers and sale at Central Issue Price (CIP) under the Targeted Public Distribution System (TPDS). The nodal agency which undertakes procurement, distribution, and storage of foodgrains is the Food Corporation of India (FCI). The distribution of food grains is undertaken primarily under the National Food Security Act, 2013 (NFSA) and other welfare schemes of the Government of India.

• Food Processing Sector

The government has placed focus on the food processing sector, which is not only a major market of agricultural produce but is also a significant employer of the surplus workforce engaged in agriculture. The government, therefore, facilitates food processing through various measures of infrastructure development, subsidised transportation, and support for the formalization of microfood enterprises. Also, India runs one of the largest food management programmes in the world. The government has further extended the coverage of the food security network through additional provisions of foodgrains through schemes like PM Gareeb Kalyan Yojana (PMGKY).

• Natural Farming

The main aim of natural farming is the promotion of good agronomic practices. Natural farming also aims to sustain agriculture production with eco-friendly processes in tune with nature to produce agricultural produce free of chemicals.

Soil fertility & soil organic matter are restored by natural farming practices. Natural farming systems require less water and are climate-friendly.

Natural farming in India is being promoted through a dedicated scheme of the Bharatiya Prakritik Krishi Paddhati Programme (BPKP). The scheme promotes on-farm biomass recycling with major stress on biomass mulching, use of on-farm cow dung-urine formulations, periodic soil aeration, and exclusion of all synthetic chemical inputs. Under BPKP, financial assistance of Rs 12,200/ha for 3 years has been provided for cluster formation, capacity building, and continuous handholding by trained personnel, certification, and residue analysis.

In addition to above, the Government of India supports agriculture through various schemes/ programmes which are mentioned as follows.

- Unprecedented enhancement in budget allocation
- Increase in procurement from farmers
- Income support to farmers through PM KISAN
- Pradhan Mantri Fasal BimaYojana (PMFBY)
- Institutional credit for agriculture sector
- Providing Soil Health Cards to farmers
- Promotion of organic farming in the country
- Neem Coating of Urea
- Agri Infrastructure Fund
- Promotion of FPOs Scheme
- National Bee and Honey Mission (NBHM)
- Pradhan Mantri Krishi Sinchai Yojana (PMKSY)
- Micro Irrigation Fund
- Agricultural Mechanization
- Changes in Disaster Relief Standards
- Improvement in farm produce logistics, Introduction of Kisan Rail
- Creation of a Start-up Eco system in agriculture and allied sector

2.2 India holds a Critical Position in World Agriculture

India holds a critical position in world agriculture. However, yield per hectare remains low. Apart from food grain production, India also produces oilseeds, fruits and vegetables and commercial crops. To understand the position of India better in world agriculture, the following table can be referred.

Table 6: India's Position in World Agriculture - 2019

Production	India	World	India's position		
			% share	Rank	Next to
1. Crop (million tonnes)					
A. Total cereals	324	2,979	10.9	Third	China, USA
Wheat	104	766	13.5	Second	China
Rice (Paddy)	178	755	23.5	Second	China
Total Pulses	22	88	24.3	First	
B. Oilseeds					
Groundnut (with shell)	7	49	13.8	Second	China
Rapeseed	9	71	13.1	Third	Canada, China

Production	India	World	India's position		
			% share	Rank	Next to
2. Fruits & vegetables (million tonnes)					
Vegetables & Melons*	127	1,169	10.8	Second	China
Fruits excluding melons*	88	689	12.8	Second	China
Potato	50	370	13.5	Second	China
Onion (Dry)	23	100	22.8	Second	China
3. Commercial crops (million tonnes)					
Sugarcane	405	1,949	20.8	Second	Brazil
Tea	1.4	6.5	21.4	Second	China
Coffee (Green)	0.32	10.04	3.2	Eight	Brazil, Vietnam, Colombia, Indonesia, Ethiopia, Honduras, Peru

Source: Fertilizers Association of India

Note: * Data for latest available year is used

From the above table, it can be seen that India holds one of the top 3 positions for most of the food items mentioned except for coffee, this shows significance of India in world agriculture. Even while India lead agriculture production in various food items, the yield per hectare of these crops in India is substantially lower than several other countries in the world.

2.3 Yield Per Hectare of Different Crops

It can be seen from the table below that the yield of crops in India is quite low compared to that of the countries that have maximum yield per hectare. Besides, the yield per hectare of crops like rice, paddy, wheat, maize, cereals, pulses is lower even than the average world yield.

Table 7: Yield per Hectare of Different Crops in kg – 2019

Crops	India's yield per hectare	Countries with maximum yield per hectare	Average world yield
Rice, Paddy	4,058	Australia - 8,771, USA - 8,374	4,662
Wheat	3,533	Belgium - 9,336, UK - 8,935	3,547
Maize	3,070	Iran - 23,224, Chile - 12,100	5,824
Cereals	3,405	Belgium - 8,989, Netherlands - 8,654	4,113
Pulses	698	Belgium - 4,164, Egypt - 3,890	992

Source: Fertilizers Association of India

Some of the reasons that have been affecting the crop yield in India includes uneven and uncertain rains, inadequate irrigation facilities, low fertility of soil among others. To improve the fertility of soils, application of micronutrients becomes very important in India and thus micronutrients have a significant demand potential going ahead.

2.4 Soil Fertility Status in India

○ Soil health and quality are a matter of great concern for the Government of India. Soil Health Card (SHC) scheme is a flagship programme launched in February 2015 under which there are uniform norms which are followed across different states for analysis of the soil and to diagnose fertility-related constraints and then make site-specific fertilizer recommendations accordingly.

- There were two cycles of this programme conducted namely; Cycle-I during 2015-17 and Cycle-II during 2017-19. And during the financial year 2019-20, Model Villages Programme has been taken up under Soil Health Card (SHC) Scheme on a pilot basis.
- This programme included adopting one village per block for landholding-based soil sampling, testing and distribution of soil health cards and then conducting SHC based demonstrations in each model village to scale awareness amongst the farmers across India.
- In the Model Village Programme, with farmer's participation, sample collection has been taken up at individual farm holding instead of sample collection at grids. The scheme is managed by Integrated Nutrient Management (INM) Division in the Ministry of Agriculture and Farmers Welfare, Government of India. Under the SHC scheme, soil health condition is assessed with respect to twelve important soil parameters;
 - Nitrogen (N), Phosphorous (P), Potassium (K) – primary macro-nutrients
 - Sulphur (S) – secondary macro-nutrient
 - Zinc (Zn), Iron (Fe), Copper (Cu), Manganese (Mn), Boron (B) – micro-nutrients
 - Electrical Conductivity (EC), Organic Carbon (OC), pH – physical parameters
- As per the norms provided in the scheme's operational guideline, the soil samples collected from different locations are then analyzed in the soil testing labs. The authorities provide a report to the farmers once in 3 years after observing the soil regularly.
- This examination of the farmer's soil helps in deciding the type of crops to be cultivated for more income generation and also gives the remedial measures. To enable comparison of level of soil fertility of one area with other, it is desirable to have single value for each nutrient, so Nutrient index (N.I) value is one such measure of nutrient supplying capacity of soil to plants. Nutrient Index is compiled using the assessment of soil fertility classified in three classes namely; low, medium and high.
- The nutrient index can then be calculated based on the information collected on the level of each nutrient using the following formula;

$$\text{Nutrient Index (N.I)} = (N_L \times 1 + N_M \times 2 + N_H \times 3) / N_T$$

where N_L : indicates the number of samples falling in the low class of nutrient status

N_M : indicates the number of samples falling in medium class of nutrient status

N_H : indicates the number of samples falling in the high class of nutrient status

N_T : indicates the total number of samples analyzed in a given area ($N_L + N_M + N_H$)

Interpretation of the different values of soil nutrient index is given in the table below:

Figure 1: Nutrient Index Interpretation

Nutrient Index	Value	Interpretation
Low	<1.67	Low fertility status of the area
Medium	1.67-2.33	Medium fertility status of the area
High	>2.33	High fertility status of the area

As on FY23, the state-wise distribution of soil nutrient indices is as follows:

State/UT	Fertility Status		
	Low	Medium	High
Andaman & Nicobar Islands	N, P, K, OC, Cu, S, Zn	B, Fe, Mn	-
Andhra Pradesh	N, OC, Zn	B, Cu, Fe, Mn, S	P, K
Arunachal Pradesh	-	-	-
Assam	P, K, B	N, Cu, Fe, Mn, S, Zn	OC
Bihar	N	P, K, OC, B, Cu, Fe, Mn, S, Zn	-
Chhattisgarh	N, P, OC, S	K, B, Cu, Fe, Mn, Zn	
Delhi	-	-	-
Goa	P, B, S	N, K, Cu, Fe, Mn, Zn	OC
Gujarat	N, B, Fe, Zn	P, OC, Cu, Mn, S	K
Haryana	N, P, OC, B	K, Cu, Fe, Mn, S, Zn	
Himachal Pradesh	N	P, K, B, Cu, Fe, Mn, S, Zn	OC
Jammu & Kashmir	P, B, Fe, Mn	N, K, Cu, S, Zn	OC
Jharkhand	N	P, K, OC, B, Cu, Fe, Mn, S, Zn	
Karnataka	N, OC, B, Fe, S, Zn	P, K, Cu, Mn	
Kerala	N, B	P, K, Cu, Fe, Mn, S, Zn	OC
Ladakh	-	-	-
Madhya Pradesh	N, P, Zn	K, OC, B, Cu, Fe, Mn, S	
Maharashtra	N, B, Fe, S, Zn	P, OC, Cu, Mn	K
Manipur	N, P, K		OC
Meghalaya	P, Mn	K, Cu, Fe, S, Zn	OC
Mizoram	N, P	K, OC	
Nagaland	-	-	-
Odisha	N, P, K, OC, B, S, Zn	Cu, Fe, Mn	
Puducherry	N, P, B, S	Cu, Fe, Mn, Zn	K
Punjab	N, P, B, Mn	K, OC, Cu, Fe, S, Zn	
Rajasthan	-	-	-
Sikkim	N, B, Zn	P, K, Cu, Fe, Mn, S	OC
Tamil Nadu	N, OC, B, Zn	P, Cu, Fe, Mn, S	K
Telangana	N, OC, Fe, Zn	P, K, B, Cu, Mn, S	
Dadra and Nagar Haveli & Daman and Diu	-	-	-
Tripura	N, K	P, OC, B, Cu, Fe, Mn, S, Zn	
Uttar Pradesh	N, P, OC	K, B, Cu, Fe, Mn, S, Zn	
Uttarakhand	N, B	P, K, OC, Cu, Fe, Mn, S, Zn	
West Bengal	-	-	-

Source: EnviStats India 2021, Soil Health Card, Government of India
 (Note: This '-' denotes data is not available for the respective states)

Some inferences that can be made from these indices are:

- Nitrogen fertility status has been generally low, except in the case of Meghalaya, Jammu & Kashmir, Goa and Assam
- Potassium fertility status has been medium in most of the states
- Phosphorous fertility status has either been low or medium in majority of the states
- As we can see above, the demand for Nitrogen, Potassium and Phosphorous fertilizers will remain stable for medium to long term as all the three nutrients are available in low to medium quantity only.

Bhu-Parikshak

To determine the nutrients, present in the soil, a rapid soil testing device based on IoT technology is used called Bhu-Parikshak. It helps in detecting the deficiency of nutrients in soil and then usage of correct fertilizers to increase the efficiency. These devices are portable in nature, provides result instantly on the smartphone and are highly affordable with one of the highest testing capacities. It is a very low power consuming device having battery backup which can analyse 120 soil samples in a single charge. Furthermore, the predicted life of the device is 5 years and is capable of analyzing 1 million samples.

The device based on near infrared spectroscopy technology that helps in the real-time soil analysis. It can detect the soil health in just 90 seconds through the embedded mobile application and the soil health report is generated. Bhu-Parikshak mobile application not only provides the report but also stores previous scans history and synchronizes cloud data. The accuracy of the device is more than 80%. With the help of this device, the farmers will come to know the recommended dose of fertilizers without having to go to the laboratory.

The analysis parameters are Available Nitrogen (N), Organic Carbon (OC), Available Phosphorous (P), Available Potassium (K), Cation Exchange Capacity (CEC) and clay contents. With only 5 grams of dry soil sample, the above-mentioned soil parameters can be analysed. To fetch fair market price for customers and providing market linkages, companies collaborate with various Farmer Producer Organisations (FPOs) and Farmer Producer Companies (FPCs). This device is also an effective tool to decrease the expenses and increase the efficiency of fertilizers.

Some of the advantages of the device are:

- Instant soil pictogram of the mentioned parameters
- Mapped field data availability in cloud storage for soil health and nutrient demand analysis
- Recommendation for precise nutrient requirement

A lot of soil testing devices are not portable and heavy but some companies with the help of new technologies are now developing portable, light-weight devices that also provide results within a minute.

2.5 Stakeholders involved in Agriculture

As discussed above, agriculture is crucial for the Indian economy and involves various stakeholders that support the operations of agriculture in the country. These stakeholders primarily include farmers, labourers, dealers, and the government.

Farmers: Farmers play a pivotal role in agriculture as they are producers of various food grains, fruits, vegetables, and various crops. The crops produced by farmers in India are distributed in two marketing seasons – kharif marketing season and rabi marketing season. To make the agricultural produce available to the population or consumers, farmers engage labourers and dealers in their operations.

As per the Department of Agriculture, Cooperation & Farmers' Welfare, the total number of eligible beneficiaries under Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) has been estimated at 12.5 crore (this indicates the farmer population in India). The number of eligible land-holding farmer families has been estimated on the basis of projections of the Agricultural Census 2015-16 data for the year 2018-19.

Labour: Labour forms a critical input in Indian agriculture as functions like sowing, ploughing, harvesting, levelling, weeding, sprinkling, spraying, etc., are done mainly by labour. Even with the advancement of technology, many operations like weeding, irrigation, seed bed production, harvesting, etc., require the hand of labour. However, a shift in labour towards other opportunities has been affecting the quantum of labour in the agriculture industry. Thus, to avoid the loss of agricultural production, there is an impetus towards farm mechanization, usage of technology, and application of fertilizers and pesticides in the agriculture industry. This, in turn, is aiding the momentum of agricultural equipment, tractors, drones, crop nutrition, and crop protection products in Indian agriculture.

Dealers: Dealers are important stakeholders in agriculture providing agricultural inputs like fertilizers, pesticides, and micronutrients to the farmers. They serve as a vital and credible source of information to the farmers. They are accessible and act as a linkage between the farmers and suppliers of agricultural inputs. Besides offering credit facilities to farmers, the dealers also provide agricultural education and technological information to the farmers. All these factors make dealers a very significant part of the agriculture industry. There are total 4,52,991 dealers in India.

Government: In addition to the above stakeholders, the government serves as an important contributor to agricultural operations. To augment agriculture facilities in India, the government has been taking various initiatives. As per Economic Survey 2022-23, Minimum Support Price (MSP), agricultural marketing, food management, food processing sector, and natural farming are some of the steps taken by the government for the betterment of farmers in the country.

The agriculture sector remained a bright spot even in the pandemic-affected FY21. The Agriculture, Forestry and Fishing sectors had posted growth (of 4.0%) during FY23 whereas sectors like industry and services recorded a growth of 4.4% and 9.5%, respectively, on a y-o-y basis. The growth in the agriculture sector will be backed by higher MSP for kharif and rabi crops for the marketing season 2022-23. Also, direct payment of MSP to farmers will lead to enhanced credit availability with the farmers thus aiding the growth in the agriculture sector.

3. Crop Nutrition Industry

The crop nutrition industry primarily consists of fertilizers (chemical, organic and bio-fertilizers) and bio-stimulants.

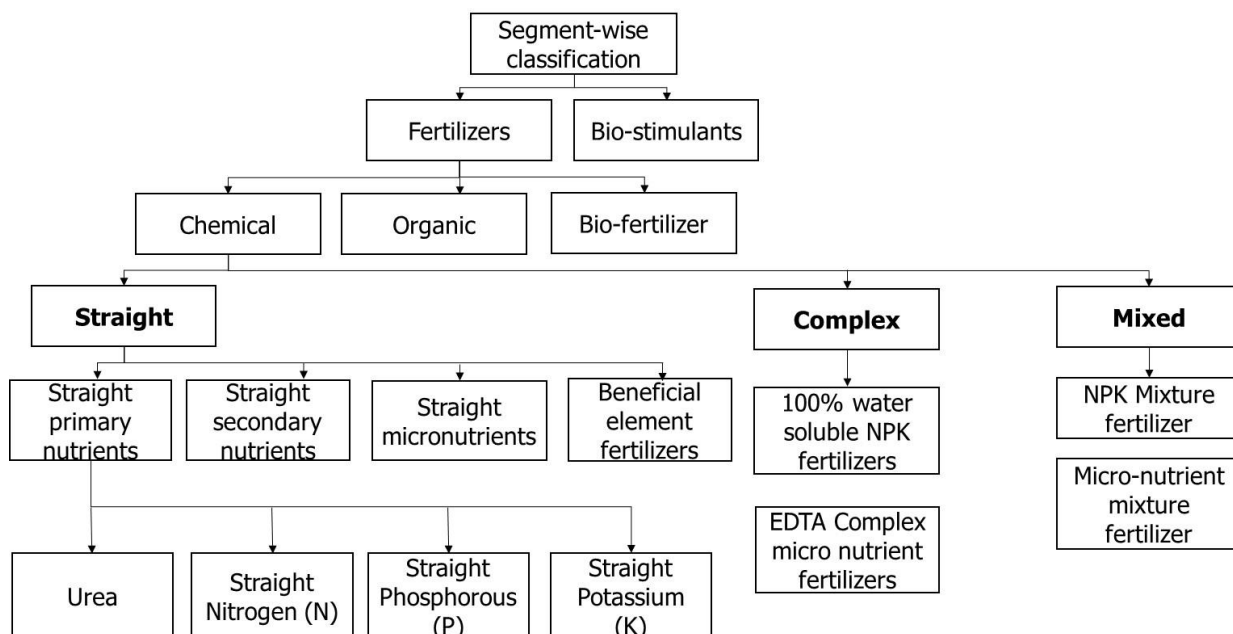
Overview and Types of Fertilizers

Fertilizer is any material of natural or synthetic origin that is applied to plant tissues or soil to supply plant nutrients. For most modern agricultural practices, fertilization focuses on three main macronutrients: Nitrogen (N), Phosphorous (P), and Potassium (K).

Fertilizers are mainly classified as:

- Chemical fertilizers
- Organic fertilizers
- Biofertilizers

Figure 2: Classification of Fertilizers



Source: CareEdge Research based on Industry Sources

Chemical fertilizers are the artificial fertilizers manufactured in the industries. Some examples of chemical fertilizers are ammonium phosphate and potassium sulphate. Chemical fertilizers are further classified into urea and non-urea fertilizers. The total production of chemical fertilizers as of March 2023 was 48.6 million tonnes. Of this, 28.5 million tonnes was urea and 20.1 million tonnes was non-urea fertilizers.

Biofertilizers are substances containing microbes that enhance plant nutrition or increase nutrient availability in soils. For example, azospirillum and rhizobium.

Organic fertilizers are natural products used by farmers to provide plant nutrients for crops. They increase the organic matter in the soil, which further releases plant food in the available form for the use of crops.

A. Fertilizers

3.1 Chemical Fertilizers in India

Chemical fertilizers are primarily further classified into straight, complex, and mixture fertilizers:

1. Straight Fertilizers

- These kinds of fertilizers are those that only supply either of the primary plant nutrients like nitrogen or phosphorous or potassium.
- Some examples are urea, ammonium sulphate, potassium chloride, and potassium sulphate.
- Apart from this, straight fertilizers also include straight primary nutrients, straight secondary nutrients, straight micronutrients, and beneficial element fertilizers:

a) Primary Nutrients

These are usually required in the largest amounts and are also known as macronutrients. These are carbon, hydrogen, oxygen, nitrogen, phosphorous, and potassium. Nitrogen, phosphorus, and potassium together comprise over 75% of the mineral nutrients found in the plant.

b) Secondary Nutrients

These nutrients are usually needed in moderate amounts compared to essential primary nutrients. These are namely, calcium, magnesium, and sulphur.

c) Micro or Trace Nutrients

They are required in smaller quantities compared to primary or secondary nutrients. These are boron, chlorine, copper, iron, manganese, molybdenum, and zinc.

d) Beneficial Element Fertilizers

These fertilizers have elements that stimulate the growth of the plant but are not essential or are essential only for certain plant species or under specific conditions. These elements are namely, aluminium, cobalt, sodium, silicon, and selenium.

2. Complex Fertilizers

- These kinds of fertilizers contain two or three primary plant nutrients of which two primary nutrients are in a chemical combination. They are usually produced in granular form. Some examples are diammonium phosphate, nitro phosphates and ammonium phosphate.

- According to the number of components present, complex fertilizers are classified as dual, for example containing phosphorous-potassium, nitrogen-phosphorous, nitrogen-potassium and triple, containing nitrogen, potassium and phosphorous.

- The advantage of complex fertilizers is that there is high content of nutrients but the production cost of complex fertilizers (in terms of nutrients per unit) is higher. But at the same time, the cost of delivery, storage and application is much lower.

• EDTA Complex Micronutrient Fertilizers

EDTA (Ethylene Diamine Tetra Acetic Acid) is an organic molecule that works as a chelating agent to bind nutrients. The chelated product is meant to keep the nutrient in a soluble but stable form till the nutrient is absorbed by the root. These are namely Iron EDTA, Manganese EDTA, Zinc EDTA, Copper EDTA, and Boron EDTA.

• 100% Water Soluble NPK Fertilizers

These fertilizers have varying ratios of primary, secondary, and micronutrients with low salt index and are compatible with other agrochemicals. The FCO has created a separate category of 100% water-soluble fertilizers where several NK/PK/NPK grades with 100% solubility in water are described.

3. Mixed Fertilizers

- A mixed fertilizer is a mixture of two or more straight fertilizers. For example, to get a mixed fertilizer, ammonium sulphate and a single superphosphate may be thoroughly mixed. They are mixed manually or mechanically. Mixed fertilizers are marketed as wheat fertilizer mixtures, paddy fertilizer mixtures, etc. There is no subsidy given for these fertilizers.

• NPK Mixture Fertilizers

These fertilizers contain two or more elements out of nitrogen, phosphorous and potassium, which are essentially good for plant growth and ensure higher crop yield.

• Micro-Nutrient Mixture Fertilizers

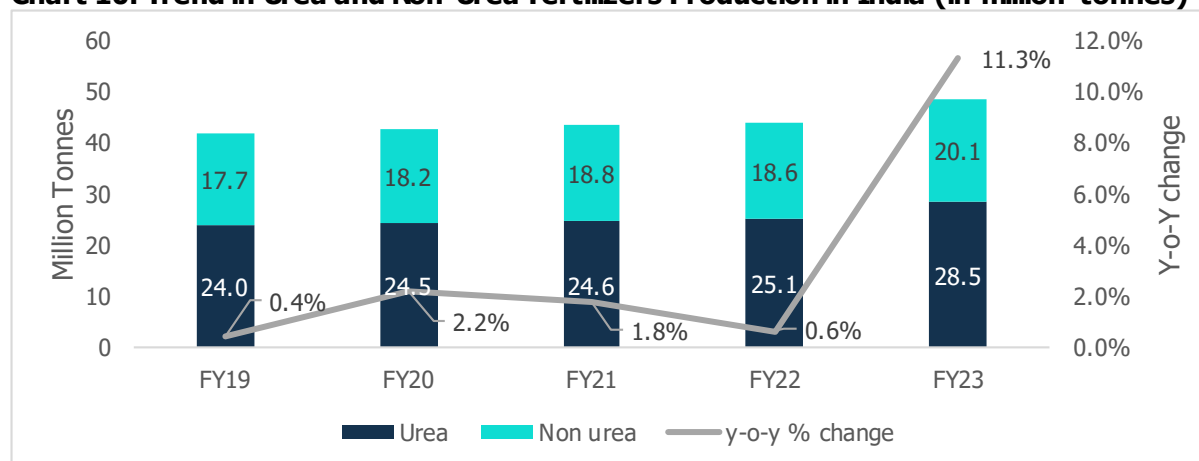
Micro-nutrient mixture fertilizers are the most effective source of correcting micro-nutrient deficiencies, ensuring better and balanced crop nutrition.

3.1.1 Chemical Fertilizers Production in India

a. Urea and Non-Urea Fertilizers

During the five-year period FY19 to FY23, fertilizers output in India increased at a Compound Annual Growth Rate (CAGR) of 3.9% from 41.7 million tonnes in FY19 to 48.6 million tonnes in FY23. The fertilizers production is primarily divided into broad categories, urea and non-urea fertilizers, where urea dominates the total output with an average share of 59% and non-urea contributing the remaining 41% on average.

Chart 10: Trend in Urea and Non-Urea Fertilizers Production in India (in million tonnes)



Source: CMIE

During the same period FY19 to FY23, while the production of non-urea fertilizers grew at a CAGR of 3.2%, the output of urea fertilizers increased at a faster CAGR of 4.4%. This is majorly on account of the growing demand for urea over the years in the country.

Table 8: Total production of urea and non-urea fertilizers (in '000 tonnes)

Years	FY19	FY20	FY21	FY22	FY23
Urea (A)	24,000	24,455	24,603	25,072	28,495
Non-Urea Fertilizers (B)					
NPK Fertilizers	8,998	8,661	9,321	8,327	9,295
Ammonium Nitrate	566	468	484	548	542
Ammonium Sulphate	187	248	273	167	276

Diammonium Phosphate	3,899	4,550	3,774	4,222	4,349
Super Phosphate	4,072	4,253	4,935	5,334	5,644
Total Non-Urea Fertilizers	17,721	18,180	18,787	18,598	20,106
Total production (A+B)	41,720	42,635	43,390	43,670	48,601

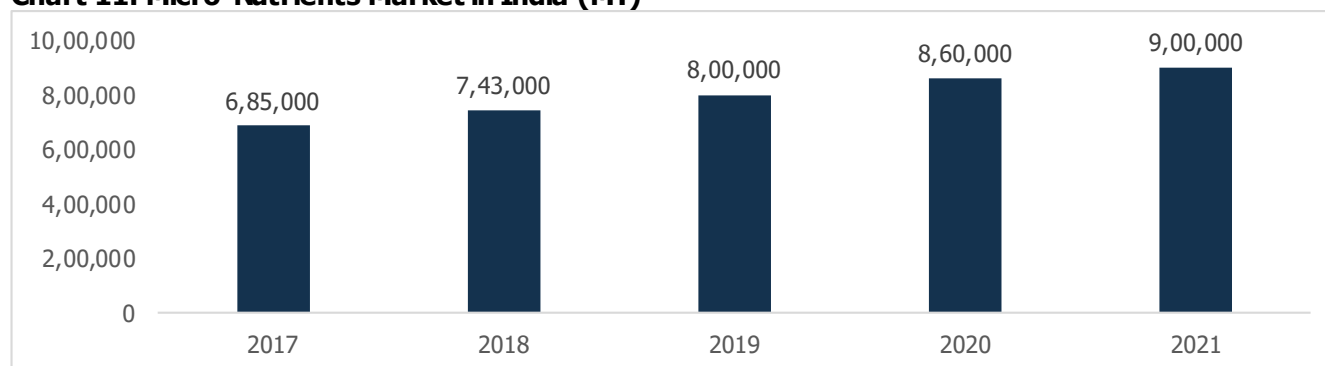
Source: CMIE

These fertilizers receive huge amounts of subsidy from the government. However, their market has stagnated. Accordingly, the government is also on the path to discourage subsidies and promote alternative fertilizers like the ones mentioned below. Hence, farmers will also be more inclined to the usage of alternative fertilizers.

b. Micronutrients

- Micronutrients are crucial for plant growth and play an important role in balancing crop nutrition. The deficiency is visible on the crops and the soil & plant tissues can be tested for it.
- Micronutrient formulations are easily soluble in water, improve plant resistance, enhance plant health and yield, control immature flower or fruit drop, and provide a strong growth action, thereby acting as a natural chelating agent and assuring quicker absorption in the plants.
- It supplies plants with micronutrients to the level that fulfils plant requirements by preventing deficiencies that occur due to the absence of micronutrients such as Zinc, Manganese, and Boron. It is used for crops such as chilli, tomato, cotton, paddy, groundnuts, pulses, vegetables, etc.

Chart 11: Micro-Nutrients Market in India (MT)



Source: Indian Micro-fertilizers Manufacturers Association

The micronutrient market has grown at a Compound Annual Growth Rate (CAGR) of 7.1% from 6,85,000 MT in FY17 to 9,00,000 MT in FY21. The Indian agricultural micro-nutrient market size was USD 538.4 million in 2021. Going forward, the market size is likely to grow at a CAGR of around 8%-10% by 2025. Given that various micronutrients have the ability to deal with a wide range of soil conditions & problems and the fortification of fertilizers with essential micronutrients will help eliminate various problems efficiently, this market is expected to see further growth.

Some of the factors promoting the growth of the micronutrients market are:

• Rising Micronutrient Deficiencies in Agricultural Soils of India

Intensive farming and changing environmental conditions like global warming have depleted micronutrients in the soil. Hence, crop cultivation and crop yield have been adversely affected, thus leading to crop losses. Also, sustainable production of agricultural crops in India has been hampered due to the lack of adoption of soil testing.

• Substantial Demand for High-Value Crops and Increasing Government Support to Boost Growth

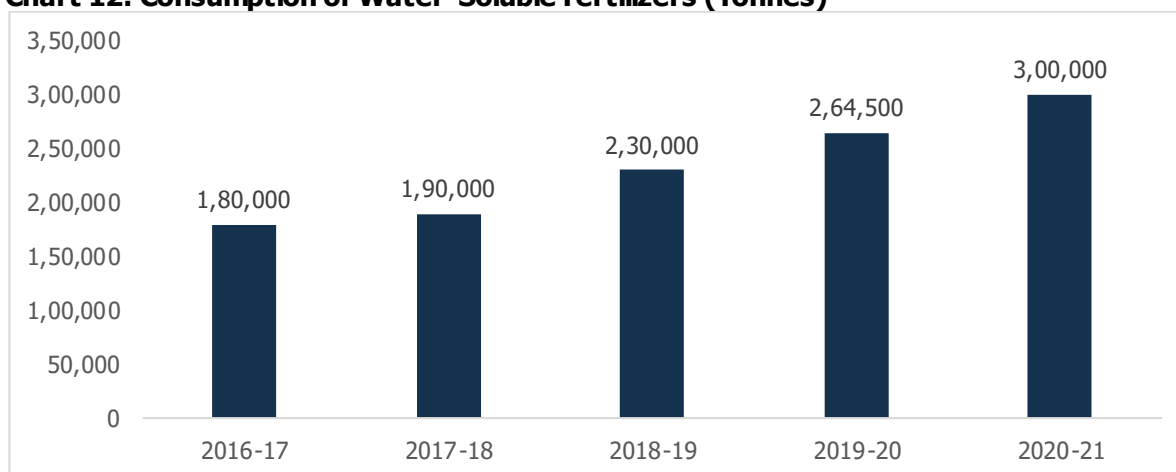
In the Indian agriculture industry, the demand for high-value crops such as nutrient-rich fruits and vegetables has increased. Also, the rising knowledge about the relationship between healthy crops and increased yield has amplified the agricultural micronutrient market growth.

Further, the Indian government is taking initiatives to educate farmers about soil health by launching lucrative agricultural schemes and promoting the adoption of micronutrients. For instance, in 2020, the Government of India implemented the Nutrient Based Subsidy (NBS) scheme and promoted fortified and customized fertilizers. Along with other primary nutrients, the government has offered additional subsidies on zinc and boron.

c. Water-Soluble NPK Fertilizers

- This is the kind of water-soluble fertilizer with a varied combination of nitrogen, phosphorous, and potassium percentages. It is best suited for drip irrigation and foliar application of fertilizer.
- These fertilizers promote cell division and elongation, which is vital for plant growth and provide uniform shape, size, and colour to the produce. It increases yield both in quantity and quality while improving drought resistance.
- It focuses on crops like cereals, pulses, and flower and fruit crops and commercial vegetable crops.

Chart 12: Consumption of Water-Soluble Fertilizers (Tonnes)



Source: Fertilizer Association of India

The consumption of water-soluble fertilizers has grown at a Compound Annual Growth Rate (CAGR) of 13.6% from 1,80,000 tonnes in FY17 to 3,00,000 tonnes in FY21 and is expected to see further traction.

Some of the factors promoting the growth of the water-soluble fertilizers (WSFs) market are:

- The exponential increase in the area under drip irrigation is due to scarcity of water, constraints in power, and labour availability. Water-soluble fertilizers applied through drip irrigation enhance the nutrient use efficiency, uptake efficiency, and uptake speed of the nutrients. Thus, the wide adoption of water-soluble fertilizers application in field crops through foliar feeding is driving the market for WSFs.
- The increasing rural income and the bright outlook of the Indian economy are also major growth drivers as the government is holding awareness campaigns (on the benefits of WSFs) and how investing in drip irrigation will not only save costs but also lead to increased rural income.

Table 9: Import of Some Fertilizers by India (in '000 tonnes)

	FY18	FY19	FY20	FY21	FY22	CAGR
Other mineral/Chemical fertilizers (in '000)	42,426	49,352	52,233	63,787	58,712	8.5
Value (Rs. Lakhs)	19,446	26,110	26,619	32,889	36,227	16.8
Mineral or chemical fertilizers containing two fertilizer elements phosphorus and potassium ('000)	25,683	29,877	29,991	43,069	39,108	11.1
Value (Rs. Lakhs)	16,997	23,125	23,469	34,800	42,077	25.4

Potassium Sulphate ('000) Value (Rs. Lakhs)	68,069 21,003	39,199 14,024	58,747 20,440	61,967 21,560	56,463 24,470	-4.6 3.9
Mineral or chemical fertilizers containing three fertilizer elements nitrogen, phosphorus and potassium ('000) Value (Rs. Lakhs)	3,02,690 68,876	6,19,733 1,60,704	5,25,036 1,37,316	8,43,526 2,06,492	10,08,604 3,85,952	35.1 53.9
Mixtures thereof with diammonium phosp ('000) Value (Rs. Lakhs)	1,45,729 41,247	1,92,239 65,161	1,70,667 52,872	1,50,229 50,440	2,07,501 1,20,780	9.2 30.8

Source: Ministry of Commerce and Industry

Certain fertilizers that are used in the manufacturing of WSFs are also imported. The imports of these fertilizers during the period FY18 to FY22 have increased over the years in the range of 8%-35% except for potassium sulphate which has declined at a CAGR of 4.6%. An increase in imports of these fertilizers indicates a growing demand for these fertilizers.

Growing Significance of Liquid Fertilizers

Liquid fertilizer capacity utilization has improved over the years, but the capacity is still underutilized. For example, due to the solid essence of granulated urea, the ammonia escapes into the atmosphere and interacts with the oxygen to form nitrous oxide, a greenhouse gas, which is harmful to the environment.

Liquid fertilizers ensure higher crop yields and better food quality. Also, they are environment-friendly and easier to transport and store.

With the help of substituting conventional solid fertilizers for liquid fertilizers, the government can avoid paying for transportation, storage space, subsidies, and imports. Indian Farmers Fertiliser Cooperative Limited (IFFCO) is the only nano fertilizer approved by the Government of India and included in the Fertilizer Control Order. During FY21-22, IFFCO sold 2.15 crore bottles of nano urea, which is equivalent to 9.67 lakh MT of conventional urea.

As per IFFCO, the application of 1 bottle of nano urea can effectively replace at least 1 bag of urea. When sprayed on leaves, nanourea easily enters through stomata and other openings and is assimilated by the plant cells. It is easily distributed through the phloem from source to sink inside the plant as per its need. Unutilized nitrogen is stored in the plant vacuole and is slowly released for proper growth and development of the plant.

Recent Developments

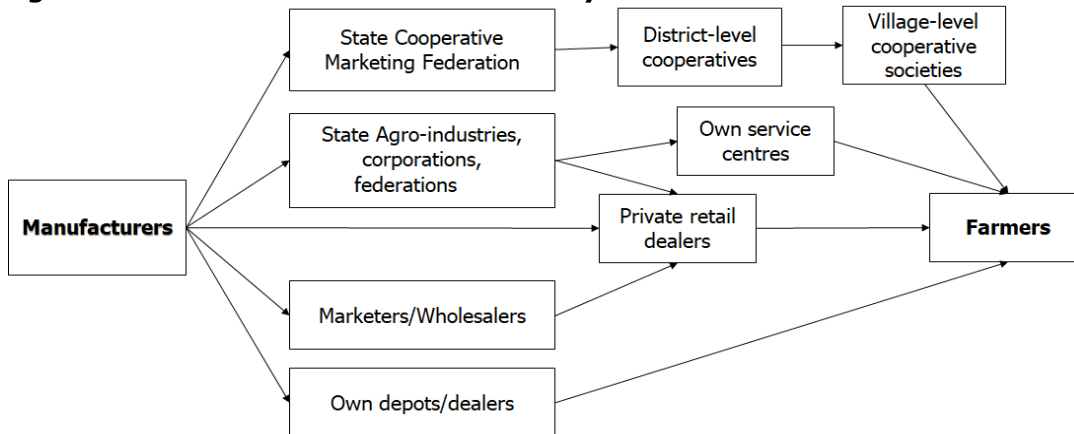
Indian Council of Agricultural Research (ICAR) has informed that IFFCO and CIL have developed nano DAP and have conducted preliminary field trials on selected crops in selected ICAR Institutes/SAU's. The report indicated that with the use of nano DAP as seed treatment and foliar application, there is a possibility of saving of granular DAP conventionally applied.

Accordingly, Government of India has also notified Nano DAP under the Fertilizer Control Order (FCO) – 1985 on the basis of the bio efficacy trials and toxicology tests and M/s Coromandel International Limited (CIL) and M/s Indian Farmers Fertiliser Cooperative Limited (IFFCO) have been granted permission to manufacture Nano DAP.

3.1.2 Value-Chain of Fertilizers

The system of fertilizer marketing and distribution in India is represented in the figure below. Indigenous fertilizers are distributed through institutional channels like cooperative societies, agro-industries corporations, state commodity federations, and private dealers.

Figure 3: Value-chain of Fertilizers Industry in India



Source: CareEdge Research

The value chain of fertilizers (which do not form part of subsidies) is similar to the one above. The fertilizers that are not subsidized are distributed through two chains, i.e., from manufacturers, wholesalers, and dealers to farmers and directly from manufacturers to dealers and then farmers.

While distributors are a large portion of the system, the trend is shifting and manufacturers are moving to engage directly with dealers. This is expected to make the supply chain more effective going forward as it will reduce time as well as cost for the players.

3.1.3 Government Regulations for the Fertilizers Industry

Subsidy Budget for 2023-24

For FY24, the upfront subsidy budget is Rs. 1.75 lakh crore as compared to Rs. 2.25 lakh crore in the previous year. The raw material prices were high in the previous fiscal year. However, in this fiscal, the subsidy budget is lowered on account of reduced prices of raw materials and natural gas. The urea subsidy for FY23-24 is Rs. 1.31 lakh crore, which is 14.9% less compared to last year's amount. The total nutrient based subsidy budget for P & K fertilizers is Rs. 44,000 crores.

Fertilizer Control Order, 1985

- To ensure adequate availability of right quality of fertilizers at right time and at right price to farmers, the fertilizer was declared as an essential commodity and Fertilizer Control Order (FCO) was promulgated under Section 3 of Essential Commodities Act (ECA), 1955 to regulate, trade, price, quality and distribution of fertilizers in the country.
- The FCO provides for compulsory registration of fertilizer manufacturers, importers and dealers, specification of all fertilizers manufactured/imported and sold in the country, regulation on manufacture of fertilizer mixtures, packing and marking on the fertilizer bags, appointment of enforcement agencies, setting up of quality control laboratories and prohibition on manufacture/import and sale of non-standard/spurious/adulterated fertilizers.
- Furthermore, there are 74 Fertilizer Quality Control Laboratories in the Country which includes 4 set up by Central Government as CFQC&TI (Central Fertilizer Quality Control & Training Institute), Faridabad and its three Regional Laboratories.

- The order also provides for cancellation of authorization letter/registration certificates of dealers and mixture manufacturers and also imprisonment from 3 months to 7 years with fine to offenders under ECA. The FCO offence has also been declared as cognizable.
- The enforcement of this Order has primarily been entrusted to State Governments. The Central Government provides training facilities and technical guidance to States and supplements their efforts through random inspection of manufacturing units and their distribution network through the Inspectors.
- The latest amendment is the 6th Amendment and it came into effect in September 2021. It had amendments related to micro nutrient zinc polyphosphate and liquid fertilizer potassium thiosulphate and calcium thiosulphate, magnesium, lead, arsenic, cadmium. It includes the method of analysis, procedure and calculation related to it.

In addition to the above-mentioned points, the FCO also deals with the following:

• **Price Control**

Fixation of prices of fertilisers - the Central Government may, with a view to regulating equitable distribution of fertilisers and making fertilisers available at fair prices, by notification in the Official Gazette, fix the maximum prices or rates at which any fertiliser may be sold by a dealer, manufacturer, importer or a pool handling agency.

• **Control on Distribution of Fertilisers by Manufacturer/Importer**

Any manufacturer/importer may be directed, by notification in the Official Gazette, by the Central Government, with a view to secure equitable distribution and availability of fertilisers to the farmers in time in any such state or states and within such period as may be specified in the said notification.

• **Authorisation or registration of dealers**

Registration of industrial dealers and authorization of other dealers: No person shall sell, offer for sale or carry on the business of selling of fertilizer at any place as wholesale dealer or retail dealer except under and in accordance with clause 8.

• **Manufacture of mixtures of fertilisers, organic fertilisers and bio-fertilisers**

Restriction on preparation of mixtures: Except under and in accordance with terms and conditions of a certificate of manufacture granted to a person under clause 15 or 16, no person shall carry on the business of preparing any mixture of fertilisers or special mixture of fertilisers, bio-fertilisers or organic fertilisers.

Standards of mixtures of fertilisers: No person shall manufacture any mixture of fertilisers whether solid or liquid form specified in Part A of schedule I unless such mixtures conform to the standards set out in the notification issued by the Central Government in the Official Gazette. No person shall manufacture any biofertiliser unless such biofertiliser conforms to the standards set out in the part A of Schedule-III or part A of Schedule IV.

Application for certificate of manufacture of mixtures of fertilizers: Any person desiring to obtain a certificate of manufacture for preparation of any mixture of fertilisers or special mixture of fertilisers should possess such qualifications as may be prescribed by the State Government or employ a person possessing such qualifications for the preparation of such mixtures and possess the minimum laboratory facility as specified in clause 21 A of the order. An application should be made to the registering authority. Every person desiring to obtain a certificate of manufacture for preparation of organic fertiliser or biofertiliser shall make an application in Form D, in duplicate, together with a fee prescribed under clause 36 to Registering Authority. Where the manufacturer of organic fertiliser is a State government or a municipality, it shall not be necessary to obtain a certificate of manufacture. It won't be necessary to obtain a certificate of manufacture for preparation of vermi-compost if the manufacturer other than state government or municipality has annual production capacity less than 50 metric tonnes.

• **Grant or refusal of certificate of manufacture for preparation of mixtures of fertilizers, bio-fertilisers or organic fertiliser**

On receipt of an application, the registering authority shall, in writing either grant or refuse to grant the certificate of manufacture and should within 45 days from the date of receipt of application, furnish to applicant a copy of the order so passed.

Where an application for a certificate of manufacture is not refused, the registering authority shall grant a certificate of manufacture in Form F, and such authority shall within 45 days from the date of receipt of application grant a certificate of manufacture to the applicant in Form G.

• Conditions for grant of certificate of manufacture in respect of special mixture of fertilizers and period of validity of certificate

Unless an applicant holds a valid certificate of manufacture under this order, no certificate of manufacture in respect of any special mixture of fertilizers will be granted.

Every certificate of manufacture granted in respect of any special mixture of fertilizers shall be valid for a period of 6 months from the date of its issue.

If the registering authority feels it is necessary to extend the said period, they can however the total period shall not exceed 12 months.

Every certificate of manufacture granted for preparation of fertilizers, biofertilizer or organic fertilizer shall be valid for a period of 3 years from the date of issue, unless suspended or cancelled.

• Renewal of certificate of manufacture for preparation of mixtures of fertilizers, biofertilizer or organic fertilizer

Before the date of expiry, if the applicant desires to renew the certificate of manufacture, he should make an application to registering authority in Form D in duplicate, together with the fee prescribed under the clause 36. On receipt of application, after keeping in view the performance of the applicant and other relevant circumstances, the registering authority may decide to renew the certificate by making an endorsement in Form F and if it is not renewed, the registering authority shall record his reasons in writing for the same. If an application for renewal is not made before the expiry but it is made within one month from the date of expiry, the certificate may be renewed on payment of such additional fee as prescribed by the State Government for this purpose. If an application for renewal is not made within the stipulated period, the certificate shall be deemed to have expired immediately and any business carried on after the date shall be deemed to have carried on in contravention of the clause.

• Restrictions on manufacture/import, sale, etc of fertilizer

There are various restrictions on manufacture/import, sale and distribution of fertilizers. No person by himself or by any other person on his behalf will be allowed to manufacture/import for sale, sell, offer for sale, stock or exhibit for sale or distribute any fertilizer which is not of prescribed standard or special mixtures of fertilizers that do not conform to the particulars specified in the certificate of manufacture granted to him under the order in respect of special mixture.

Restrictions are also on:

- Any fertilizer which is not packed and marked in a manner laid down in the order.
- Any fertilizer which is a substitute for another fertilizer under the name of it sold.
- Any fertilizer that is adulterated.
- Any substance as a fertilizer which substance is not that of a fertilizer
- Any fertilizer for which the label or container bears a statement containing a false claim for the fertilizer which is misleading or false

Central government may by an order publish in Official Gazette fix separate specifications in respect of imported fertilizers. And in case of a provisional fertilizers and customized fertilizer, the government can notify specifications valid for not exceeding 3 years.

Manufacturers/importers pool handling agencies need to comply with certain requirements in regard to packing and marking. The requirements are as follows:

- Every container in which fertilizer is packed shall be superscribed with the word 'FERTILISER'. If the gross weight of container is 5kg or less, no such printing shall be necessary.
- Every container in which biofertilizer or organic fertilizer is packed shall be superscribed with the word 'BIOFERTILISER/ORGANIC FERTILISER OR NON-EDIBLE DE-OILED CAKE FERTILISER'.
- Every container should be packed and sealed properly and the contents should not be tampered with without breaking the seal.

Manufacturers are also required to comply with certain requirements for laboratory facilities. Bulk sale of fertilizers can be done as follows:

- A retail dealer may retain at any time one bag or container of each variety of fertilizer in an open and unsealed condition for the purpose of sale.
- A manufacturer/importer may sell the fertilizer manufactured/imported by him in bulk to a manufacture of mixture of fertilizers compound / complex fertilisers or special mixture of fertilisers.

An application for the disposal of non-standard fertilisers in Form H is submitted to the Notified authority to grant a certificate of authorisation for sale of such fertilisers and a certificate of authorisation with regard to their disposal and price is obtained in Form I. Such non-standard fertilizers shall be sold only to the manufacturers of mixtures of fertilizers or special mixtures of fertilizers or research farms of Government or Universities or such bodies.

To comply with the provisions of this order, the Central Government may appoint an officer who shall be responsible.

There is also restriction on sale/use of fertilizers, which are as follows:

- No person shall, except with the prior permission of the Central Government and subject to such terms and conditions as may be imposed by such Government, sell or use fertiliser, for purposes other than fertilization of soils and increasing productivity of crops.
- Provided that the price of fertilizers permitted for sale for industrial use shall be price, excluding all subsidies at the production, import, handling or on sale for agricultural consumers;
- Provided further that wherever customs or excise duties are chargeable, these may be added to the price so fixed.

The State Government, or the Central Government may, by notification in the Official Gazette appoint such number of persons, as it thinks necessary, to be inspectors of fertilisers for the purpose of this Order, and may, in any such notification, define the limits of local area within which each such inspector shall exercise his jurisdictions.

Following this, the applicants or manufacturers also have to go through the process of scrutiny as it becomes important for the issue of manufacturing license and storage and selling of fertilizers in the industry.

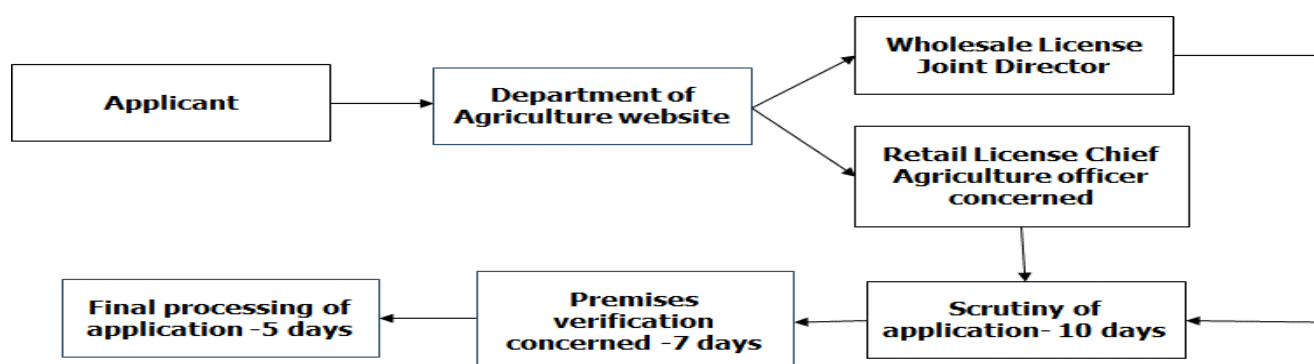
Process for Obtaining the Approval of Manufacturing Fertilizers

The applicant has to reach out to the licensing officer of the state agriculture department requesting the application form for manufacturing license. After receiving the prescribed fee from the applicant, the licensing officer grants the application form. The applicant then gets an intimation for inspection of premises where the fertilizer will be manufactured. If all the criteria is satisfied, the license is granted to the manufacturing unit.

Figure 4: Process for Obtaining the Approval of Manufacturing Fertilizers


Process for Selling and Storage of Fertilizers

An applicant has to follow the below process for selling and storage of fertilizers where the scrutiny of application takes 10 days followed by premises verification which takes 7 days and final processing of application that takes 5 days.

Figure 5: Process for Selling and Storage Of Fertilizers


Total period of issuance of license= 22 days

Integrated Plant Nutrition Management Bill 2022

This bill is to promote the development and sustainable use of balanced fertilizers, including bio-fertilizers, bio-stimulates, nano-fertilisers and organic fertilizers for the purpose of sustaining India's food and nutritional security without causing adverse harm to the quality of the environment and health of the soil. This bill encourages the promotion of research and innovation of high-yielding and climate smart systems for agriculture which will in turn improve the ease of doing business. It also supports the welfare of farmers.

The bill is not passed yet and is still in the draft form. The fertilizer industry is of the view that if this bill is hastened, it could repulse the farmers and other stakeholders.

The bill covers the regulations pertaining to these areas:

- It will ensure equitable distribution of fertilizers and making them available at fair prices and also fix the maximum price or rates at which the fertilizer may be sold by a dealer, manufacturer, importer or a fertilizer marketing entity.
- The government will determine the list of fertilizers which are to be displayed at the place of business by every dealer selling or offering to sell any fertilizer.

- No person shall himself, or by any person on their behalf, manufacture, import for sale, sell, exhibit for sale or distribute any fertilizer which does not meet the standards as may be provided under the act.
- Every person wanting to manufacture, sell, import for sale, or market should obtain appropriate registration in the manner provided under the act.
- Import of any spurious or misbranded or sub-standard fertilizer or any product containing fertilizer for the import of which license is required and rules and regulations are to be followed, if not followed, it will be considered as a serious offence and the person responsible shall be penalized.
- There is restriction on preparation of customized fertilizers. No person shall carry on the business of preparing any customized fertilizer, except according to the act and rules and regulations made thereunder.
- The government may, through rules, prescribe the manner in which fertilizers may be moved from one state to another.
- No advertisement shall be made of any fertilizer which is misleading or deceiving or contravenes the provisions of this act.
- Every manufacturer is also required to furnish a list of associated dealers and retailers to the authority in the manner specified by way of regulations by the authority.
- The registration of dealers and retailers is mandatory and no person shall carry on business without it. Every dealer/retailer that has been registered or granted an authorization letter under the provisions of the fertilizer (control) order, 1985 shall be permitted to continue the business of selling fertilizers for the duration of validity of the authorization letter. Upon the expiry of the term of the authorization letter, the dealer or retailer shall re-apply for a fresh registration in the manner that the order states.

In addition to these regulations, the Government also provides subsidies on fertilizers to support the farmers. This, however, increases the Government expenditure. Moreover, India is highly dependent on fertilizer imports to meet the consumption needs which, in turn, leads to outflow of foreign reserves. Considering the fund outflow (with respect to subsidies and imports) and the benefits that organic fertilizers and biofertilizers provides, the Government is supporting its usage and thus its production in the country.

3.2 Bio-Fertilizers Industry

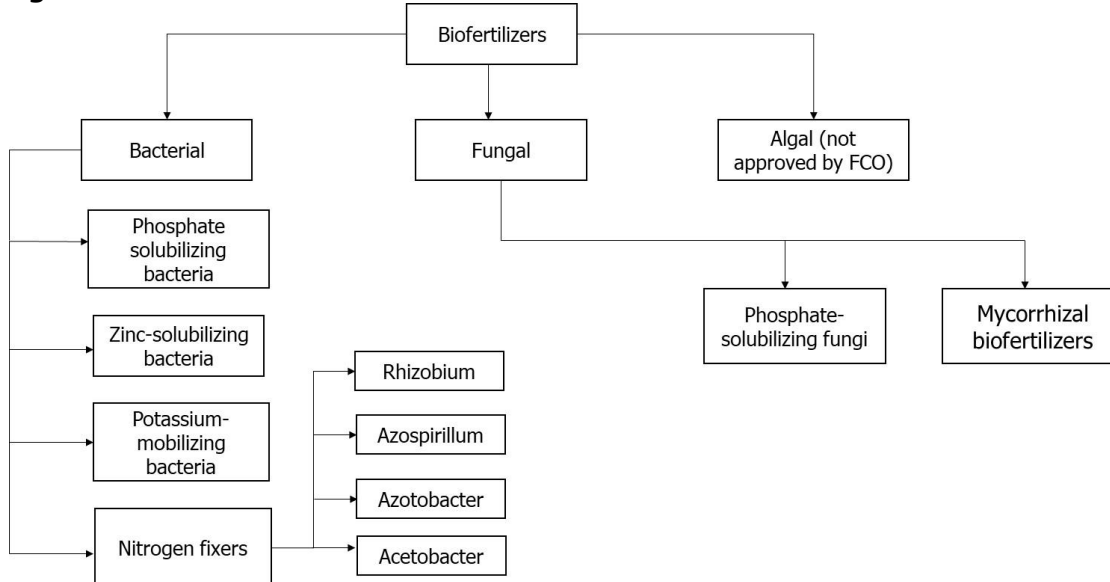
3.2.1 Overview and Key Types of Bio-Fertilizers

As per several studies conducted by Centre of Science & Environment, crops no longer respond to chemical fertilizers as they used to. The fertilizer response ratio used to be 13.4 in 1970 which further reduced to 2.7 by 2015. Due to heavy subsidies provided for nitrogen, the nitrogen-phosphorous-potassium ratio has been skewed toward nitrogen. However, the continuous use of nitrogenous fertilizers adversely affected the soil health in India. The crops displayed symptoms of deficiencies in macro and micronutrients. This became a growing concern and led to the search for alternative non-chemical choices, which included biofertilizers and organic fertilizers.

Biofertilizers contain microbes that enhance plant nutrition or increase nutrient availability in soils. E.g. azospirillum, rhizobium, etc. They are regulated under the Fertiliser Control Order (FCO).

Biofertilizers are primarily classified into two types:

- Bacterial Biofertilizers
- Fungal Biofertilizers

Figure 6: Classification of BioFertilizers

Source: CareEdge Research

Bacterial Biofertilizers

Of the two types of biofertilizers, bacterial biofertilizers account for a major share while fungal biofertilizers account for a relatively smaller share. This is because bacterial biofertilizers include nitrogen fixers that are used largely to fix the nitrogen levels of plants. As nitrogen fixers are used in large quantities, their application is made convenient with two physical forms – carrier-based and liquid-based. This is explained in detail later in the chapter.

Apart from nitrogen fixers, bacterial biofertilizers include phosphate-solubilizing, zinc-solubilizing, and potassium-mobilizing biofertilizers. The application of these biofertilizers however is low compared to that of nitrogen fixers.

Some of the types of bacterial biofertilizers are:**1. Nitrogen Fixers**

- **Rhizobium:**

- This belongs to a bacterial group and a classic example is symbiotic nitrogen fixation. The bacteria infect the legume root and form root nodules within which they reduce molecular nitrogen to ammonia further utilized by the plant to produce valuable vitamins, proteins, and other nitrogen-containing compounds.

- It is a relatively more effective and widely used biofertilizer. The rhizobium population in the soil is dependent on the presence of legume crops in the field. When there is an absence of legumes, the population of rhizobium in the soil diminishes.

- **Azotobacter:**

- It is a common soil bacterium. Soil organic matter is an important factor that decides the growth of this bacteria.

- It is well known as a free-living nitrogen-fixing aerobic bacterium and is used as a biofertilizer for all non-leguminous plants, especially rice, cotton, vegetables, etc.

- **Azospirillum:**

- This is known to have a close associative symbiosis with the higher plant system.

- It is known to fix the considerable quantity of nitrogen in the rhizosphere in non-leguminous plants such as cereals, millets, oilseeds, cotton, and other minor millets and fodder grasses.

2. Phosphate Solubilizing Bacteria (PSB)

These bacteria are beneficial in solubilizing inorganic phosphorous from insoluble compounds. One of the most important traits associated with plant phosphate nutrition is the solubilization ability of rhizosphere microorganisms. Phosphorous is a major essential macronutrient for plants, and hence, is applied to soil in the form of phosphate fertilizers. The main purpose of managing soil phosphorous is to optimize crop production and minimize the loss of phosphorous from soils.

The other types of bacterial biofertilizers are zinc-solubilizing bacteria and potassium-mobilizing bacteria. However, these are not as widely used as the aforementioned.

Fungal Biofertilizers

Fungal biofertilizers are of two types, phosphate solubilizing and mycorrhizal. Both are essential for plants as phosphorous is a major essential macronutrient. These biofertilizers manage soil phosphorous to optimize crop production, minimize loss of phosphorous, and protect plants from nematodes or worms.

- **Vesicular Arbuscular Mycorrhiza (VAM):**

- VAM associates symbiotically with the roots of the plants and helps in increased absorption of phosphorous. It is an effective soil inoculant. Mycorrhizae in nature are obligate and require a living host for its survival.

- Further, it protects the plants from nematodes or worms and pathogenic fungi and acts as an accessory to the root hairs in the process of nutrient absorption and mobilization. VAM is used as a biofertilizer for fibre and sugar crops, cereals, millets, pulses, fruits, vegetables, etc.

Another type of fungal biofertilizer used is phosphate-solubilizing fungal bacteria.

Furthermore, biofertilizers are disseminated through two modes –

a) Carrier-Based Fertilizers

In this category of fertilizers, biofertilizers are supplied as carrier-based microbial inoculants to the soil to provide extra immunity and/or enrich soil fertility. The carrier is a medium that under specified conditions carries microorganisms in sufficient quantities and keeps them viable. One crucial factor for the production of good-quality biofertilizers is ensuring that the ideal carrier material is used.

An ideal carrier material should have the following characteristics:

- It should be highly-absorptive and easy to process
- Non-toxic to microorganisms
- Should be easily sterilizable
- Available in low-cost and ample amounts
- Provide good adhesion to seeds
- Should have a good buffering capacity
- Should have high organic matter content and a water-holding capacity of more than 50%

Biofertilizers are supplied to the soil by seed inoculation in which the bacteria-carrier mixture is mixed with water to make a slurry and then mixed with seeds or by soil inoculation, wherein it is spread over the field during cultivation.

b) Liquid Biofertilizers

In this category of fertilizers, as the name suggests the formulation is liquid and contains the dormant form of desired microorganisms and their nutrients alongside a few other substances that enable the formation of cysts or resting spores for longer shelf-life and tolerance to adverse conditions.

On reaching the soil, the dormant forms germinate to produce a fresh batch of active cells. Further, with the help of a carbon source in the soil or root exudates, the cells grow and multiply. These biofertilizers are more advantageous compared to conventional carrier-based biofertilizers.

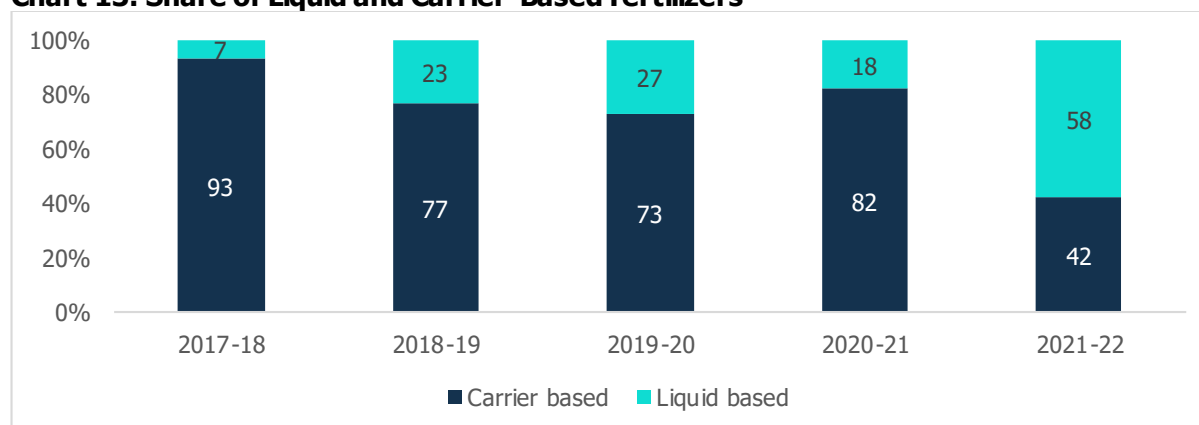
Some of the advantages of liquid biofertilizers over conventional carrier-based biofertilizers are:

- Longer shelf life, typically 12-24 months
- No contamination
- No loss of properties takes place as the storage is up to 45 degrees Celsius
- Can be identified easily as it has a typical fermented smell
- A lot of cost is saved on carrier material, pulverization, neutralization, sterilization, packing, and support
- Quality control protocols are easy and quick
- Can be easily used by the farmer
- High commercial revenues and export potential

❖ Different kinds of carrier-based and liquid biofertilizers are listed below. These are the most commonly used biofertilizers in the country.

3.2.2 Share of Liquid and Solid Carrier Bio-Fertilizers

Chart 13: Share of Liquid and Carrier-Based Fertilizers



Source: Biofertilizer Statistics 2019-20, Fertilizer Association of India, Department of Agriculture & Farmers Welfare

Out of both the biofertilizers produced, liquid and carrier-based, the production of carrier-based is more compared to the liquid fertilizer. However, this trend changed in 2021-22. The carrier-based biofertilizers produced were 1,69,379 tonnes and the liquid fertilizers produced were 2,32,934 kilolitres in 2021-22.

Further, the share of carrier-based fertilizer in the total production of fertilizers is more in all the years ranging from 2018-2021. However, in 2021-22, the share of carrier-based fertilizer contracted to 42% y-o-y and that of liquid-based fertilizer contracted to 58% y-o-y.

Carrier-based fertilizers are less efficient, and hence, to enhance and increase the yield of the crops, there was a need to raise the production of liquid fertilizers. The share of liquid fertilizers has been increasing on account of growing demand for high-efficiency fertilizers, convenience of use and application, and adoption of precision farming and protected agriculture. Liquid fertilizers get easily absorbed and offer faster outcomes.

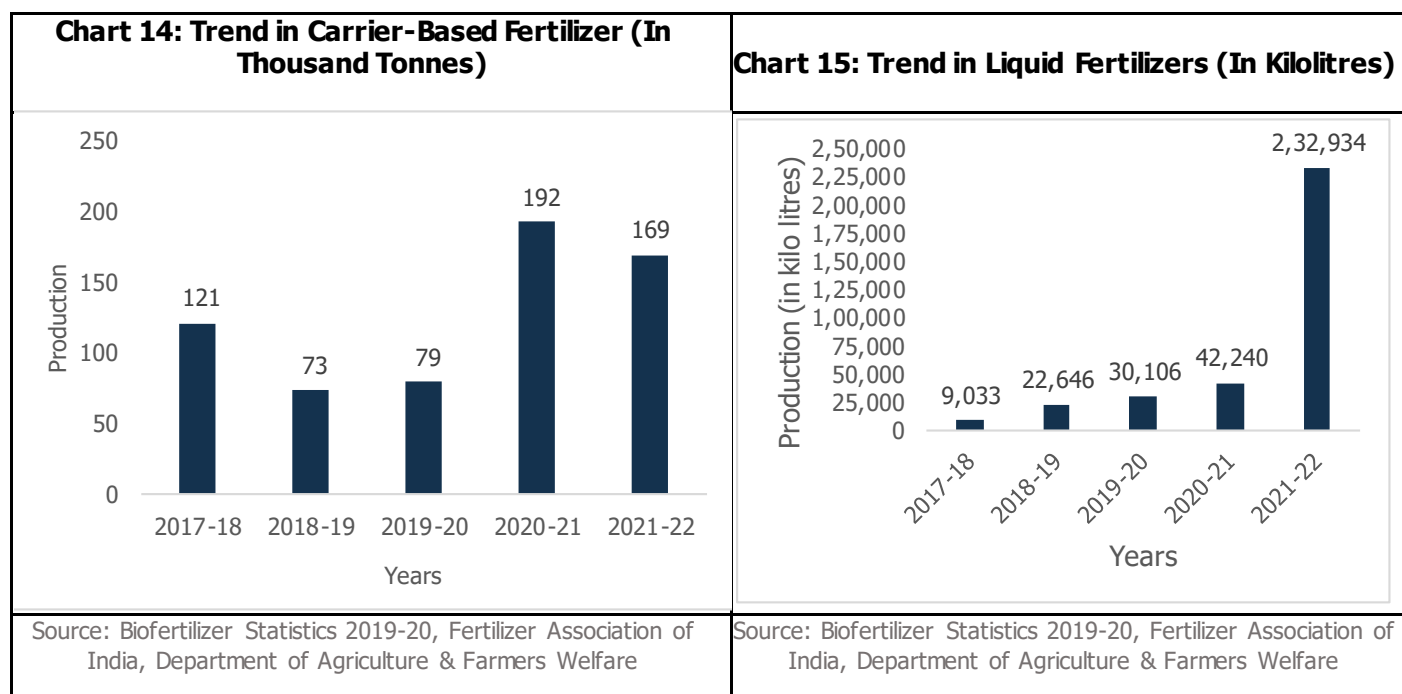
Moreover, the other major growth drivers of the liquid fertilizer market are the need for micro-nutrients, investment by government and private players, and increasing research & development activities. The handling and storage costs of liquid fertilizers are higher compared to carrier-based fertilizers, and hence, during the pandemic, the production and demand for liquid fertilizers were reduced.

Furthermore, between 2023 to 2025, carrier-based biofertilizer production is expected to shrink at a CAGR of around 15-20% and liquid biofertilizers are expected to grow at a CAGR of around 10-15%.

3.2.3 Trend in Bio-Fertilizer Production and Outlook

The total production in 2021-22 of carrier-based solid biofertilizers in India was about 169 thousand tonnes. This marked a growth of about 40% from 2018-19. It increased at a CAGR of 8.7% during 2017-18 to 2021-22.

In the case of liquid fertilizers, India produced about 2,32,934 kiloliters of liquid biofertilizers in 2021-22. This marked a growth of about 2479% from 9,033 kiloliters in 2017-18. This segment grew by a higher 125% CAGR during 2017-18 to 2021-22.



The following reasons are attributed to the growth in the production of carrier-based fertilizers as well as liquid fertilizers:

1. Development of New Eco-Friendly Technologies for Production:

Development of new technologies like the development of mixed inoculants has taken place. This is considered an important approach as different microbial strains facilitate combined biofertilization effect and help plants to promote better uptake of nutrients.

Such technologies will overcome the shortcomings of conventional chemical-based farming and have a positive influence on both soil sustainability and plant growth.

2. Rising Government Support to Promote Biofertilizers:

The government has taken various initiatives and programmes such as the National Food Security Mission (NFSM), which assists of up to Rs.300 per hectare for the promotion of various biofertilizers such as rhizobium, azospirillum, azotobacter, phosphate-solubilizing bacteria, potash-mobilizing bacteria, zinc-solubilizing bacteria, and mycorrhiza culture.

Under the Capital Investment Subsidy Scheme (CISS) of Soil Health Management Scheme (SHM) of National Mission of Sustainable Agriculture (NMSA), Government is aiding for setting up of state of art liquid/ carrier-based bio-fertilizer/ bio-pesticide units of 200 Ton Per Annum (TPA) capacity. 100% assistance is provided to State Government / Government agencies up to a maximum limit of Rs.160.00 lakh/unit. Similarly, for individuals/ private agencies assistance up to 25% of cost limited to Rs.40 lakh/unit as capital investment is provided through NABARD.

3. Increasing Emphasis on Organic Culture:

The excessive use of synthetic fertilizers has led to the contamination of soil and the destruction of microorganisms. To reduce the increasing pollution of soil, organic farming is being adopted.

The rising demand for organic food is further motivating farmers to adopt biofertilizers. Also, the general population is increasingly concerned about the quality of food they consume and are willing to pay for the same. Thus, farmers too consider investing in bio-fertilizers.

4. Increased Demand for Cereals and Grains:

The demand for cereals and grains has increased and rhizobium is widely used as a biofertilizer and crop enhancer for cereal. It has been found that rhizobia can make an association with gramineous plants without forming nodule-like structures or any disease symptoms.

Outlook:

The market for biofertilizers is expected to continue to grow in the coming years. This will be backed by a higher understanding of environmental hazards caused by the use of synthetic agrichemicals, primarily the pollution and contamination of soil, and growing health concerns that come along with it. As evidenced by past trends, liquid-based biofertilizers are expected to increase at a faster rate than carrier-based biofertilizers.

Also, there is an urgent need for a shift to more sustainable agricultural production methods with a greater focus on promoting sustainable mechanisms. Accordingly, biofertilizers are considered one of the best strategies and a possible solution to meet the parallel challenges of global food security and environmental stability.

Similarly, factors like increased plant nutrient absorption, improved soil fertility, and lower human health risks associated with the product are some of the factors that will help in augmenting the biofertilizer industry market growth.

3.2.4 Region-Wise Split of Bio-Fertilizer Production for the year 2020-21

The production of carrier-based and liquid fertilizers can be looked at zone wise as given below:

❖ **South Zone:** In the south, Tamil Nadu produced most of the carrier-based fertilizers and Karnataka was responsible for the highest production of liquid fertilizers.

Table 10: Zone-Wise Production of Fertilizers (South)

Types of bio-fertilizers (2020-21)	States					
	Andhra Pradesh	Karnataka	Kerala	Puducherry	Tamil Nadu	Telangana
Carrier-based fertilizers (in tonnes)	181	1,866	97	76	64,384	320
Liquid fertilizers (in kiloliters)	99	9,713	2,112	2	732	150

Source: State of Biofertilizers & Organic fertilizers in India, Centre for Science & Environment (CSE)

❖ **West Zone:** In the west, Maharashtra produced most of the carrier-based fertilizers after Gujarat. Gujarat, along with carrier-based fertilizers was also the highest liquid fertilizers producing state.

Table 11: Zone-Wise Production of Fertilizers (West)

Types of bio-fertilizers (2020-21)	States					
	Chhattisgarh	Gujarat	Goa	Madhya Pradesh	Maharashtra	Rajasthan
Carrier-based fertilizers (in tonnes)	56	19,108	30	1,748	15,591	1,570
Liquid fertilizers (in kiloliters)	163	8,056	-	262	2,141	-

Source: State of Biofertilizers & Organic fertilizers in India, Centre for Science & Environment (CSE)

❖ **North Zone:** In the north, Uttar Pradesh was responsible for the highest production of carrier-based fertilizers and Uttarakhand was responsible for the highest production of liquid fertilizers.

Table 12: Zone-Wise Production of Fertilizers (North)

Types of bio-fertilizers (2020-21)	States						
	Delhi	Chandigarh	Haryana	Himachal Pradesh	Punjab	Uttar Pradesh	Uttarakhand
Carrier-based fertilizers (in tonnes)	347	-	8,517	200	-	13,724	2,692
Liquid fertilizers (in kiloliters)	-	-	108	0	157	593	1,151

Source: State of Biofertilizers & Organic fertilizers in India, Centre for Science & Environment (CSE)

❖ **East Zone:** In the east, West Bengal was the highest carrier-based fertilizers producing state followed by Odisha. Whereas, Odisha was the highest liquid fertilizer producing state.

Table 13: Zone-Wise Production of Fertilizers (East)

Types of bio-fertilizers (2020-21)	States			
	Bihar	Jharkhand	Odisha	West Bengal
Carrier-based fertilizers (in tonnes)	162	15	1,405	2,235
Liquid fertilizers (in kiloliters)	2	-	860	34

Source: State of Biofertilizers & Organic fertilizers in India, Centre for Science & Environment (CSE)

❖ **North-East Zone:** For the north-east, according to the past year data, Assam and Tripura are the highest carrier-based fertilizer producing states whereas Assam and Sikkim are the highest liquid fertilizer producing states.

3.2.5 Usage of Bio-Fertilizers in Crops and Plantations

Biofertilizers like bacterial biofertilizers include nitrogen fixers that are used largely to fix the nitrogen levels of plants which is generally low in Indian states. Despite India holding a prominent position in the production of crops like rice and cotton, the level of nitrogen for these crops continues to be a barrier. The usage of biofertilizers helps in improving the crop yield, aids in nutrition absorption, and is environment-friendly unlike chemical fertilizers (which are also used to fix the nitrogen levels).

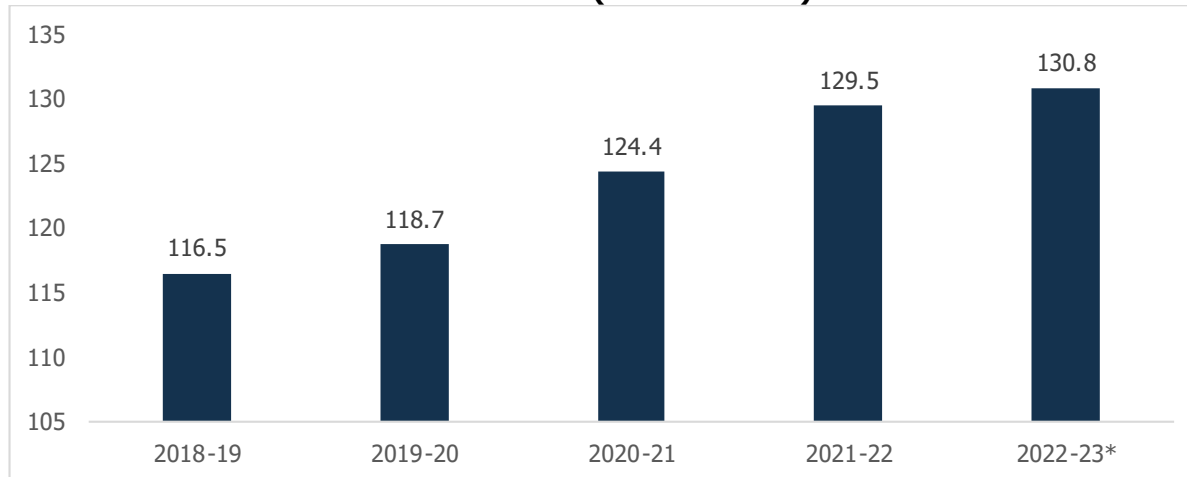
1. Rice

Application of Biofertilizers in Rice

Symbiotic systems such as the Azolla and Anabaena complex and that of leguminous green manures with rhizobium and azo rhizobium association are of value to wetland rice crops and supplement inorganic nitrogen for cereals.

Further, Azotobacter can be applied to rice through seed or seedling or soil to fix the nitrogen in the soil. Inoculation with Azospirillum promotes early tillering and growth of rice. It also significantly increases the filling rate of grain and the grain per weight per plant at harvest.

The production of rice as of 2022-23 is estimated to be 130.8 million tonnes as per the 2nd Advance Estimates released by the Ministry of Agriculture and Farmers Welfare. Andhra Pradesh accounts for around 7% of the total rice production in India.

Chart 16: Production Trend of Rice in India (million tonnes)

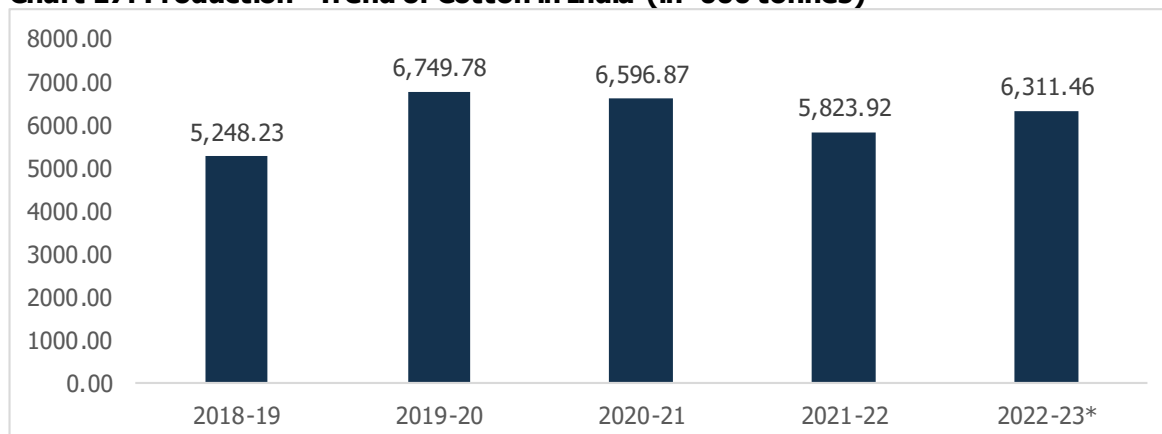
Source: National Food Security Mission, Ministry of Agriculture & Farmers Welfare

Note: * As per 2nd Advance Estimates

2. Cotton

Application of Biofertilizers in Cotton

When the crop preceding cotton is heavily fertilised, it reduces the nitrogen recommendation by 25%. The seeds are treated with 600g/ha of azospirillum and 600g/ha of phosphobacteria or 1200g/ha of azophos. Additionally, 2000g/ha of azospirillum and phosphobacteria or azophos (4000g/ha) each is mixed with 25kg of farmyard manure and 25kg of soil on the seed line. This saves 25% nitrogen and also increases the yield. Whereas to increase the germination and vigour, the seeds are coated with arappu leaf powder, DAP, micronutrient mixture, azospirillum, phosphobacteria, azophos, and maida solution or gruel as an adhesive.

Chart 17: Production Trend of Cotton in India (in '000 tonnes)

Source: Cotton Association of India

Note: * indicates estimate

The production of cotton as on 2021-22 was 5,823 thousand tonnes and it is estimated to be 6,311 thousand tonnes in 2022-23.

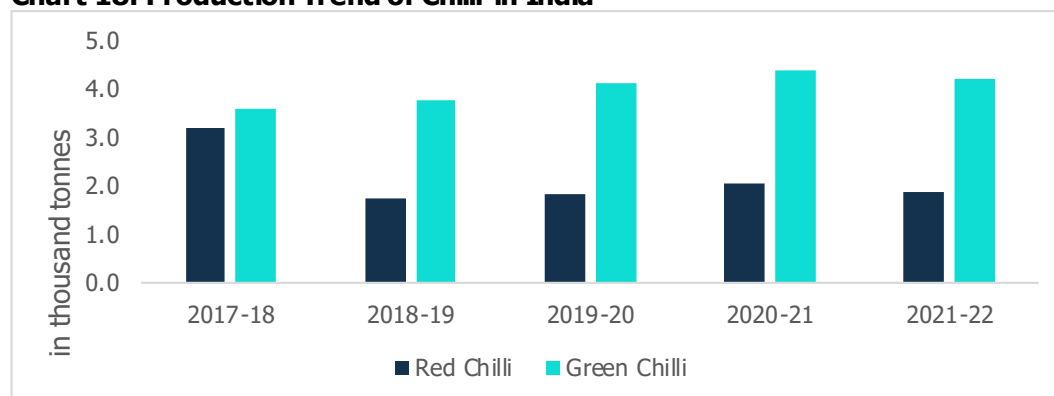
In addition to crops like rice and cotton, chilli also requires high levels of nitrogen for its growth.

3. Chilli

Application of Biofertilizers in chilli

Earlier, little fertilizer was used on chillies but the development of early maturing varieties with high yield potentials and growing chillies under irrigated conditions resulted in increased use of fertilizers. Chillies heavily use Nitrogen (N), Phosphorous (P) and Potassium (K). When nitrogen is applied heavily, there is an increase in vegetative growth and the maturity is delayed. It also delays flowering by 5 days while application of phosphorous reduces flowering days to 13 days.

Chart 18: Production Trend of Chilli in India



Source: APEDA (Agricultural and Processes food products Export Development Authority)

The production of green chilli as on 2021-22 was 4,220.7 thousand tonnes and of red chilli was 1,874 thousand tonnes.

Table 14: Production of Red Chilli in 2021-22 ('000 tonnes)

State	Production	Share (%)
Andhra Pradesh	700	37.35
Telangana	433.12	23.11
Madhya Pradesh	296.69	15.83
Karnataka	184.53	9.85
Orissa	69.26	3.7
Maharashtra	23.73	1.27
Gujarat	22.36	1.19
Tamil Nadu	21.59	1.15
Assam	19.65	1.05
Punjab	15.88	0.85
Others	87.2	4.65
Total	1874.01	100.00

Table 15: Production of Green Chilli in 2021-22 ('000 tonnes)

State	Production	Share (%)
Karnataka	1,006.96	23.86
Madhya Pradesh	726.9	17.22
Andhra Pradesh	506.87	12.01
Bihar	481.33	11.4
Maharashtra	353.33	8.37
Jharkhand	256.36	6.07
West Bengal	213.53	5.06
Chhattisgarh	206.88	4.9
Haryana	141.65	3.36
Telangana	98.19	2.33
Others	228.72	5.42
Total	4220.72	100.00

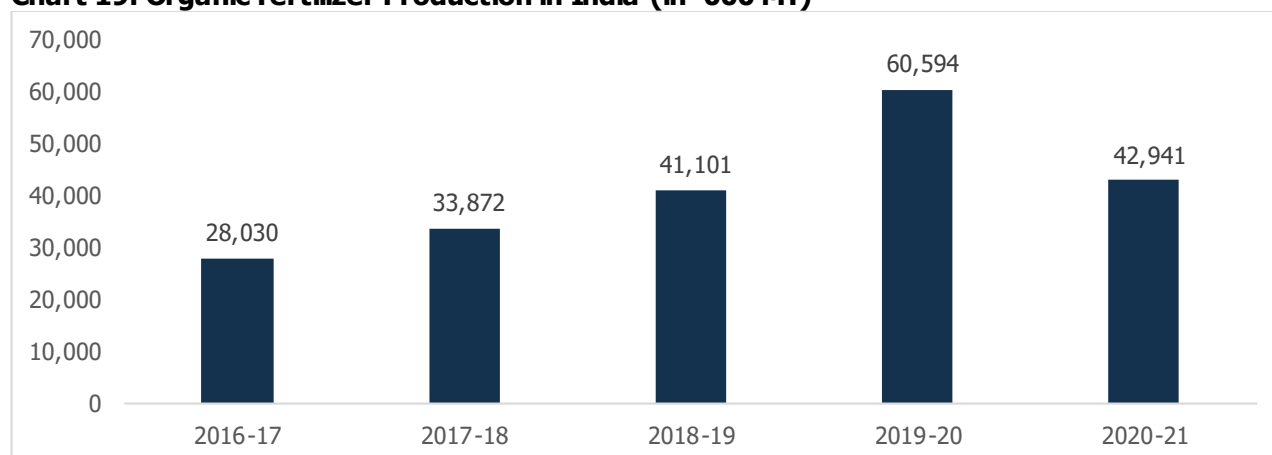
Source: APEDA (Agricultural and Processes food products Export Development Authority)

3.3 Overview of Organic fertilizers

Organic fertilizers are natural products used by farmers to provide plant nutrients for crops. They increase the organic matter in soil which in turn releases plant food in available form for the use of crops. They also enable the soil to hold more water and help in improving the drainage in clay soils.

Organic Fertilizer Production in India

Chart 19: Organic Fertilizer Production in India (in '000 MT)

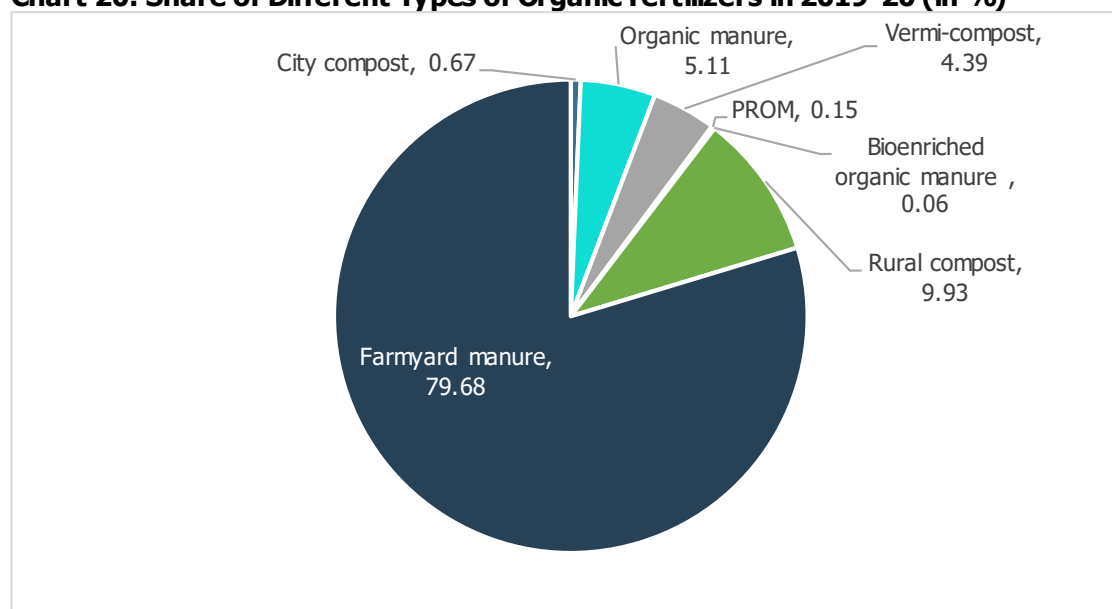


Source: National Centre for Organic and Natural Farming

During the five-year period 2017-2021, the production of organic fertilizers has grown at a Compound Annual Growth Rate (CAGR) of 11.3% from 28,030 million tonnes in 2017 to 42,941 million tonnes in 2021.

The most widely-used organic fertilizer is farmyard manure, holding approximately 80% share followed by rural compost which is around 10%.

Chart 20: Share of Different Types of Organic Fertilizers in 2019-20 (in %)



Source: National Centre for Organic and Natural Farming

Some of the organic fertilizers are:

• Farmyard Manure

It refers to the decomposed mixture of dung and urine of farm animals alongside litter and left-over material from roughages or fodder fed to the cattle. Several vegetable crops like potato, tomato, sweet potato, carrot, radish, onion, etc., respond well to farmyard manure.

• Vermicompost

In this process, earthworms are used for composting organic residues. Earthworms are capable of consuming practically all kinds of organic matter and they can eat as much as their own body weight per day. The excreta or casting of earthworms is rich in nutrients such as nitrogen, phosphorous, potassium, and manganese alongside bacterial and actinomycetes populations. This whole process of collecting vermicast along with microbially degraded organic compost is known as vermicompost.

- **Phosphate Rich Organic Manure (PROM)**

PROM is enriching manure with phosphate minerals that improve the level of nutrient elements in them. It is produced by co-composting organic manure with high-grade (32% phosphorous pentoxide) rock phosphate mineral in fine (min 80% finer than 74 microns) size.

The addition of phosphate-solubilizing microorganisms enhances the effect. Usage of PROM reduces the cost of fertilization to the farmers and also leads to the conservation of phosphate minerals, a non-renewable resource, due to the high residual effect.

Some of the benefits of using PROM are:

- Cheaper than chemical fertilizers
- Enriches the soil to its natural cultivable source
- Saves soil from becoming dead due to inorganic fertilizer utilization
- Helps in soil rejuvenation and is sustainable
- Suitable to neutral and alkaline soils, which is proving to be a boon to Indian farmers

3.3.1 Organic Manure

Organic manure is a well-decomposed material used in organic agriculture. It is free from chemicals, harmful chemicals, organisms, and weed seeds and the origin is from either plant or animal. Organic manure increases the organic matter in the soil, and in turn, releases the plant food available for the use of crops.

- **Phospho-Compost**

It is produced from crop residues, cattle dung, urine and other similar organic matter. Phosphorous-rich rock phosphates or pyrite enriched with phosphate solubilising microbes are mixed with the organic residues. This enables the non-solubilised nutritional factors like phosphorous to get solubilised, which can easily be taken up by plants from the soil. Traditionally prepared compost is very low in nitrogen and phosphorous but phospho-compost contains these ingredients 2-8 times more.

- **Oil Cakes**

After extracting oil from oilseeds, the remaining solid portion is dried as a cake which can then be used as manure. After mineralization, the nutrients present in oil cakes are made available to crops 7 to 10 days after application. It is very important for the oil cakes to be well powdered before application to ensure even distribution and quicker decomposition.

There are two types of oil cakes:

- Edible Oil Cakes - These oil cakes can be safely fed to the livestock. Examples include Groundnut cake and coconut cake.
- Non-Edible Oil Cakes - These oil cakes are not fit for feeding livestock. Examples include Castor cake and mahua cake. They are used as manures for horticultural crops.

- **Enriched Composting**

In this type of composting, recycled green materials such as garden cuttings are used. It is a kind of soil improver suitable for mixing with soil but can also be used as topdressing, a mulch or in 'no-dig' approaches.

Some of the key benefits of using enriched composting are:

- Improves soil structure
- Weed free
- Suitable for organic growing
- Easy to work with and spread
- Reduces the risk of plant failure
- Improves soil drought resistance

• Green Manuring

The practice of ploughing or turning the soil into undecomposed green plant tissues for the purpose of improving the soil's physical, chemical, and biological environment is known as green manuring.

According to suitable soil and climatic conditions of a particular area, green manuring is performed in different ways.

Broadly, the practice of green manuring in India can be divided into two types:

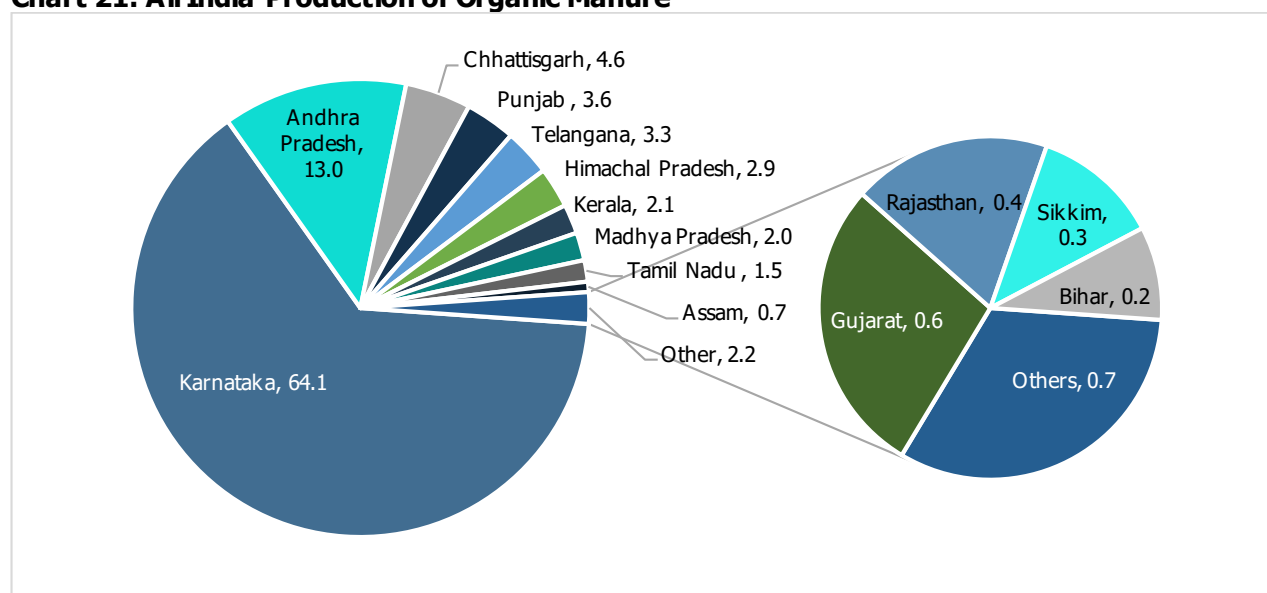
- **Green Manuring in Situ:** It is a system in which green manure crops are grown and incorporated into the soil of the same field that is to be green manured, either as a pure crop or an intercrop with the main crop. Common green manure crops in this system are sun hemp, dhaincha, guar, etc.
- **Green Manuring through a Collection of Green Plant Tissues from Other Places:** It refers to turning into the soil green leaves and tender green twigs collected from outside the shrubs and trees grown on bunds, wastelands, and nearby forest areas. E.g. Glyricidia, karanj.

The advantages of green manuring include the addition of organic matter to the soil and simulating soil micro-organisms, improving the structure of the soil, decreasing run-off and erosion caused by rain, and increasing the availability of certain plant nutrients like calcium, manganese, iron, etc.

All India Production of Organic Manure

In 2020, Karnataka was the highest organic manure-producing state. It had a share of 64.1% of the total production of organic manure. After Karnataka, Andhra Pradesh is the second-highest organic manure-producing state, it holds a share of 13% and the third-highest organic manure-producing state is Chhattisgarh with a share of 4.6%. Accordingly, it can be inferred that organic fertilizer production is the highest in the southern part of India.

Chart 21: All India Production of Organic Manure



Source: National Centre for Organic and Natural Farming

(Note: The 'others' category of the state comprises of the following states: Maharashtra, Nagaland, West Bengal, Odisha, Tripura, Jammu & Kashmir, Meghalaya, Puducherry, Arunachal Pradesh, Jharkhand, Goa, Delhi, Uttar Pradesh, Uttarakhand and Haryana)

3.4 Rise in Exports for Organic Production

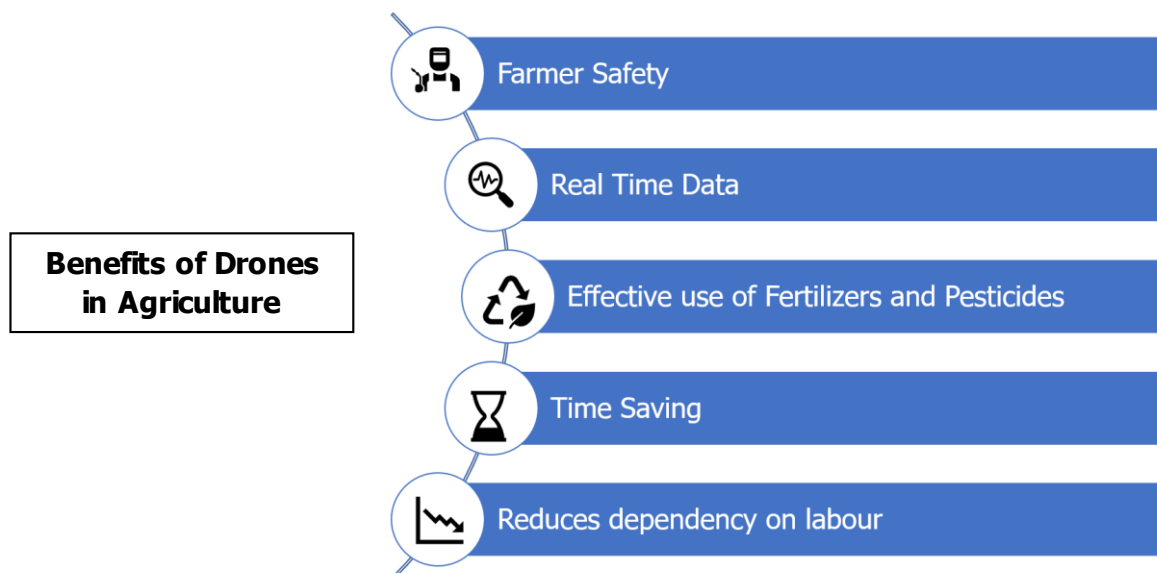
The total exports stood at 4,60,320 metric tonnes in the year 2021-22 and in 2022-23, it stood at 3,12,800 metric tonnes. During 2022-23, there was a significant degrowth of 32% in the exports. The top 3 entities to whom exports were made are the USA, the European Union, and Canada and the top 3 products exported were processed food, oil seeds, and cereals & millets.

Also, Shipments to several countries were sent for the first time. These include Trinidad & Tobago, Indonesia, Colombia, and French Guiana. The demand for a lot of products like ginger, turmeric, and quinoa is rising and this demand has grown majorly post-pandemic.

3.5 Key Growth Drivers for Biofertilizers and Organic Fertilizers Industry

3.5.1 Introduction and promotion of new technologies such as usage of drones:

- The necessity of increasing food production to meet the demand of the ever-increasing population in India needs no emphasis, but doing so while maintaining soil nutrients and fertility is more crucial.
- The use of conventional methods for application of fertilizer has its own limitations and challenges of labor shortage, energy, low input use efficiency. Furthermore, the conventional machines used for crop nutrient spraying are heavy and may compact the soil along with mechanical damage to the crop.
- This is when Unmanned Aerial Vehicles (UAVs) which are usually known as drones become a vital alternative to overcome these challenges. Drones can be used for targeted input application, timely diagnosis of nutrient deficiency, crop health monitoring, rapid assessment of crop yield and crop losses. There is a variety of imaging technologies which includes multi spectral, hyper spectral and thermal imaging, with the help of which farmers are able to get a better picture of farms and fields.
- Some of the features of drones are:
 - It can be used to spray up to 35 acres in a day
 - Drones spray evenly on crop surfaces without the wastage of chemicals
 - When drones are used, the farmers don't come in direct contact with the chemicals and hence, risk of respiratory diseases and cancer can be reduced to a great extent
 - They're capable of sensing the trees, poles and mountains around it and can divert itself and spray in other way
 - Can be of great use in places where labour is not readily available
- Crop nutrient spraying through drone ensures rapid application and can be used to treat large areas quickly. The drones also have the capability to fly at low height (1-3m) over the canopy of the crop and this makes them even more suitable for spraying crop nutrient and is more viable compared to aerial spray. This also saves input cost and environment.
- Drones use multiple batteries and it is very beneficial for farmers as it helps in saving effort, time and dependencies on labor. It is also helpful for tall crops like sugarcane, bushy crops like cotton and fields like paddy.
- Drones can be more effectively used in hilly regions where it is difficult for another farm equipment to reach. Drones not only encourage farmers to solve other problems and receive plenty of benefits through precision agriculture but enhances the overall performance of the farmers, crop and soil.
- Drones with special features like lasers, sensors, reservoirs can be filled with fertilizer and pesticide for spraying on the crops and for planting seedlings since they have flexibility and can maneuver over the desired locations. Further, drones can also provide accurate information, quantify and identify risks faster and safely. Hence it is used in insurance to assess the extent of damage based on visuals provided by the drones and in monitoring for timely harvest, aversion of pest attacks etc. Drones can prove to be vital for agriculture as they provide real time information which can improve the health of crop.



Source: CareEdge Research

To promote the use of drones in agriculture, the Department of Agriculture & Farmers Welfare (DA&FW) has released the Standard Operating Procedures (SOPs) which provides instructions for use of drones in pesticide and nutrient applications. The Central Insecticides Board & Registration Committee has prescribed the guidelines/protocols for registration requirement of pesticides for drone application. Further, the following provisions have been made under the guidelines of Sub-Mission on Agricultural Mechanization (SMAM) being implemented by DA&FW:

- Financial assistance at 100% of the cost of agricultural drones, up to a maximum of Rs 10 lakh per drone, is provided for purchase of drones by institutes under Indian Council of Agricultural Research, Krishi Vigyan Kendras (KVKs), State Agriculture Universities (SAUs), State and other Central Government Agricultural Institutions/Departments and Public Sector Undertakings (PSUs) of Government of India engaged in agricultural activities.
- The Farmers Producers Organizations (FPOs) are provided grants up to 75% of the cost of agriculture drone for its demonstrations on the farmers' fields.
- A contingency expenditure of Rs 6,000 per hectare is provided to implementing agencies that do not want to purchase drones but will hire drones for demonstrations from custom hiring centres, hi-tech hubs, drone manufacturers and start-ups. The contingent expenditure to implementing agencies that purchase drones for drone demonstrations is limited to Rs 3,000 per hectare.
- In order to make drone services available to farmers on rental basis, financial assistance of 40%, up to a maximum of Rs 4 lakh, is provided for purchase of drones by custom hiring centers under Cooperative Society of Farmers, FPOs and rural entrepreneurs.
- Agriculture graduates establishing custom hiring centers are eligible to receive financial assistance at 50% of the cost of drone up to a maximum of Rs 5 lakh per drone.
- For individual purchase of drones, the Small and Marginal, Scheduled Caste/Scheduled Tribe, Women and North Eastern State farmers are provided financial assistance at 50% of the cost up to a maximum of Rs 5 lakhs and other farmers at 40% up to a maximum of Rs 4 lakh.
- Funds amounting to Rs 52.50 crore have been released to the Indian Council of Agricultural Research (ICAR) for taking up of large-scale demonstration of drone technology on the farmers' fields in the country through 100 Kishi Vigyan Kendras, 75 institutions under ICAR and 25 State Agricultural Universities. Funds amounting to Rs 70.88 crore have also been released to various State Governments for demonstration, providing subsidy to the farmers and establishment of custom hiring centres for providing drone services to the farmers.

The agriculture segment has already started adopting drones for multiple purposes and following are certain instances where drones have been used in agriculture in India:

- A fintech driven agriculture ecosystem company, Unnati (Akshamaala Solutions Private Limited) is providing drones for farmers for spray service. These drones are approved by DGCA, the cost of spraying the insecticide by using drones is less and the times it takes is also less.
- With the help of drones, tree plantation has been carried out in Telangana. The costs was lower than 10 times while covering more areas of land with minimal risks.
- Mahindra and Mahindra allowed the use of drones for trials in agriculture for precision spraying on crops in Telangana and Andhra Pradesh.
- The Government of India had flagged 100 Kisan drones across India for spraying pesticides on farms. These drones will promote demand for drones in crop assessment, digitization of land records and spraying of fertilizers and pesticides.
- The agriculture department of Rajasthan recently deployed drones for the purpose of spraying chemicals and fight locust swarms.
- Andhra Pradesh is set to procure 200 Kisan drones for solving the problem of labor shortage and health hazard.
- A tender was floated by Department of Agriculture Research and Education (DARE) for spraying through drones.

Backed by various central and state government initiatives and incentives and the inherent benefits, the use of drones in agriculture is expected to see higher penetration.

The Ministry of Civil Aviation on 25th August 2021 published the Drone Rules and on 26th January 2022 the Certification Scheme for Unmanned Aircraft Systems.

The classification of drones is based on weight and payload and it is as follows:

- Nano unmanned aircraft system: weighing less than or equal to 250 grams
- Micro unmanned aircraft system: weighing more than 250 grams, but less than or equal to 2 kilograms
- Small unmanned aircraft system: weighing more than 2 kilograms, but less than or equal to 25 kilograms. Agricultural drones fall under this category.
- Medium unmanned aircraft system: weighing more than 25 kilograms, but less than or equal to 150 kilograms
- Large unmanned aircraft system: weighing more than 150 kilograms

Registration of unmanned aircraft system

- No person shall operate an unmanned aircraft system without first registering it on digital sky platform and obtaining a unique identification number, unless exempted from the requirement of a unique identification number under Drone Rules, 2021.
- The Director General of all such unmanned aircraft systems to which unique identification number has been issued under Drone Rules 2021, should maintain a registration record.
- It shall be the responsibility of the person operating an unmanned aircraft system to ensure that such unmanned aircraft system conforms to a valid type certificate.

Remote pilot license

- **General:** No individual other than the holder of a valid remote pilot license enlisted on the digital sky platform shall operate an unmanned aircraft system.
- **Classification:** A remote pilot license shall specifically mention the category, sub-category and classification of the unmanned aircraft system or a combination of these, for which it is issued.
- **Eligibility:**
 - An individual should not be less than 18 years of age and not more than 65 years of age
 - The individual has passed class tenth examination or its equivalent from a recognized board
 - The individual has successfully completed such training as may be specified by the Director General, from any authorized remote pilot training organization

Government's push towards adoption of drones in agriculture to go a long way in modernising agricultural practices in the country

Over the years, Indian agriculture has benefitted from adoption of new technologies by farmers. Technologies such as drip irrigation, mechanised farming etc. are being used for sustainable farming in India. However, many small and marginalised farmers are still conducting agriculture work via old ways leading to hassles, low productivity and wastage. Government has acknowledged these concerns and has been continuously making policy changes in order to address the issue.

While, technology is rapidly evolving, drones are one of the emerging technologies that has been embraced across the globe. In India itself, drones have found utility in various sectors, agriculture being one of the major potential sectors. Use of drone in agriculture has gained prominence and government is actively engaged in checking the suitability of this new technology in agriculture. Drones will be critical for increasing efficiency of crop protection with chemicals, reduce manpower, reducing the volume of water and saving drift to environment along with reducing exposure to humans to harmful pesticides.

Government acknowledges that drones will emerge as gamechanger in the agriculture sector and has taken several policy initiatives to promote the adoption of drones in farming. Following are the steps taken by the government to promote drones in the sector –

- Production Linked Incentives (PLI) scheme of Rs 120 crore for drones and drone's component manufacturer
- Granting up to 100% of the cost of agriculture drone or Rs. 10 lakhs, whichever is less, as grant for purchase of drones by the Farm Machinery Training & Testing Institutes, ICAR institutes, Krishi Vigyan Kendras and State Agriculture Universities for taking up large scale demonstrations of this technology on the farmers' fields
- Farmers' producer associations could obtain a grant for up to 75% of the drone's cost for forwarding demonstrations
- The government will also pay implementing agencies Rs 6,000 per hectare if they hire drones for demonstrations rather than buying them
- 40% of the basic cost of drone and its attachments or Rs.4 lakhs, whichever less would be available as financial assistance for drone purchase by existing Custom Hiring Centres (CHCs)

These initiatives will go a long way in implementing new technology in the agriculture space. Moreover, Directorate General of Civil Aviation (DGCA) and Ministry of Civil Aviation has framed rules to allow usage of drones in India and also segregated different zones based on security inputs. These rules are reviewed time to time and the government has been trying to make the policy more liberal to promote usage of drones. While the current adoption of drones in agriculture is very limited, it is expected to grow strongly in the coming future. Nova Agri Tech in collaboration with IoTech World Aviation was among the first to get DGCA approval for their agricultural drone named Agribot.

Drone adoption to exponentially rise worldwide across various sectors, including agriculture

Drones are used across multiple sectors for multiple applications ranging from photography/videography, emergency rescue and relief, land surveys, spraying of pesticides, e-commerce delivery and the list has been continuously increasing. In India as well, drones have found usage across many sectors, however, government envisions agriculture to be the biggest beneficiary through the adoption of this technology in the future.

According to a Ministry of Aviation estimate, India's drone sector will achieve a turnover of Rs 12,000-15,000 crore by 2026, from about Rs 80 crore in 2021. Government is taking necessary steps to support the sector and make India the global hub for drone manufacturing. While China continues to remain the largest drone supplier, with China plus one trend catching up, India is well poised to take advantage and increase the share in the global market.

Production-Linked Incentive (PLI) scheme for drones and its components

The PLI scheme is a follow through of the liberalised Drone Rules, 2021 released on August 25, 2021 by Central Government. The Central Government notified about this scheme on September 30, 2021.

The drones and drone components manufacturing industry may see an investment of over Rs.5000 crores over the next 3 years. For the drone manufacturing industry, the annual sales turnover may grow from Rs.60 crores in FY20-21 to over Rs.900 crores in FY23-24.

Penalty for Non-Compliance

If the Director-General or an officer authorized by the Central Government, State Government or Union Territory Administration is satisfied that a person has failed to comply with the provision of these rules, he may be levied with a penalty of not exceeding one lakh in accordance with Section 10A of the Aircraft Act, 1934 and the reasons need to be recorded in writing. They can also cancel or suspend any license, certificate, authorisation or approval granted under these rules.

Recent Developments

1. Digital Sky Platform: A unique unmanned traffic management (UTM) system was launched by the Ministry of Civil Aviation which will facilitate registration and licensing of drones and operators in addition to giving instant online clearances to operators for every flight. It will enable online registration of pilots, devices, service providers, and no permission, no take-off (NPNT).

2. Government is working as an enabler by creating demand and structure for drones: Drones play a crucial role in connecting people from the length and breadth of the country. The government is now working as an enabler and not a regulator and they are now making evidence-based policies for drones.

3. Doon Drone Mela in Uttarakhand: In 2021, Shri Jyotiaditya M. Scindia along with the minister of state in the Ministry of Civil Aviation, General (Retd) Dr. V.K Singh flagged off the Doon Drone Mela in Dehradun, Uttarakhand. He interacted with drone companies who exhibited their prototypes at the mela. He then talked about government enabling opportunities with a liberalized drone policy and the launch of Production Linked Incentive (PLI) Scheme.

4. Drone schools to be setup: There was a drone mela organised at Gwalior jointly by Ministry of Civil Aviation, Government of India, Government of Madhya Pradesh, Federation of Indian Chambers of Commerce & Industry (FICCI). The programme was a gathering of drone manufacturers, service providers, drone enthusiasts and user communities, especially students, farmers, and common man of the city. It included drone exhibition, demonstration, user interactions and launches.

Nova Agribot launched by the Nova Group is the first Directorate General of Civil Aviation (DGCA) approved agricultural drone and it is also QCI (Quality Council of India) certified.

3.5.2 Other Key Growth Drivers:

Changing Perception

There is an increased awareness about the harmful effects of chemical fertilizers on the environment in recent times. People are now more focused on their well-being and what goes into their food. They are willing to pay more alongside wanting to do better for the environment. Such aspects have led to the increased use of biofertilizers.

Farm Mechanization

Farm mechanization is the process of using agricultural machinery to mechanize the work of agriculture, which greatly increases farmer productivity. It helps in increasing farm labour efficiency and reducing workload. It is estimated that farm mechanization can help reduce time by approximately 15-20%.

Additionally, farm mechanization helps in improving the harvest and reducing post-harvest losses alongside improving the quality of cultivation. These benefits help in the reduction of production costs and allow farmers to earn more income. As of June 2019, the percentage of farmers accessing technical advice was 42% and the percentage of farmers who adopted the advice was 90%. This means farmers are willing to adopt technical advice and assistance for improving the crop yield, as well as their income.

Further, the cost of deploying labour is also increasing substantially and farm mechanization is the only way to reduce labour costs, and thus, the cost of cultivation. It also helps in the conversion of uncultivable land to agricultural land

through advanced tilling techniques, improvement in the safety of farm practices, and helps encourage the youth to join farming, attracting more people to work and live in rural areas. However, the increasing levels of mechanization do not necessarily mean big investments.

Besides, women play an important role in farming-based communities and more percentage of total farm labour comprises women. This implies the power sources should be chosen accordingly (human, animal, or motor-based), depending on the work to be done. Accordingly, taking into consideration technologies that are apt to women's needs and improving their access to appropriate forms of farm power can reduce drudgery and lead to sustainable mechanization.

Government Initiatives

Declining soil quality due to overuse of chemical fertilizers and their ill effects on human health is a rising concern, and thus, has encouraged the government to opt for various plans, schemes, and other initiatives to encourage the adoption of bio-based fertilizers among farmers. For instance, regular training courses and frontline demonstrations are organized by the National Center for Organic Farming (NCOF) and the Indian Council of Agricultural Research (ICAR) to educate farmers about biological fertilizers.

Surging Demand for Cereals and Grains

Biofertilizers help to fix atmospheric nitrogen in the soil and root nodules of legume crops. Rhizobium is used as a biofertilizer and crop enhancer for increased cereal production. It has been found that rhizobia can make an association with gramineous plants such as wheat, rice, maize, barley, and other cereals without forming any nodule-like structure or causing any disease symptoms. Hence, the increase in demand for cereals and grains will also result in increasing use of biofertilizers.

Increasing Farm Incomes

The National Statistical Office (NSO) has conducted a survey twice since 2003 and the farmer's average monthly income has increased over a period of time. In 2013, income increased from Rs.969 to Rs.6,426 and as of 2019, income stood at Rs.10,218.

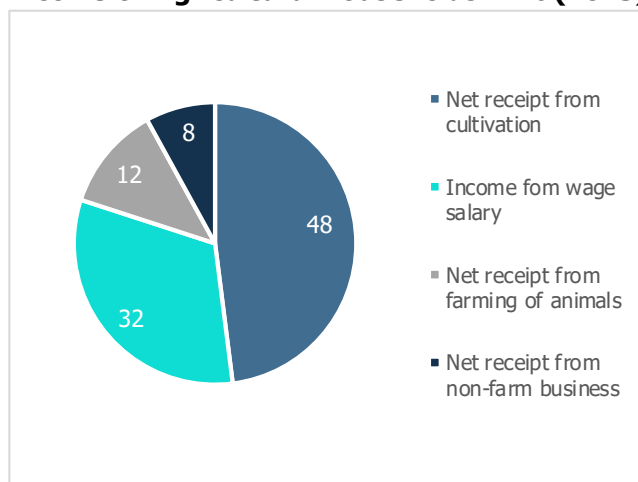
Average Monthly Income of Farmers in India (in Rs.)

Year	2003	2013	2019
Income (Rs.)	969	6,426	10,218

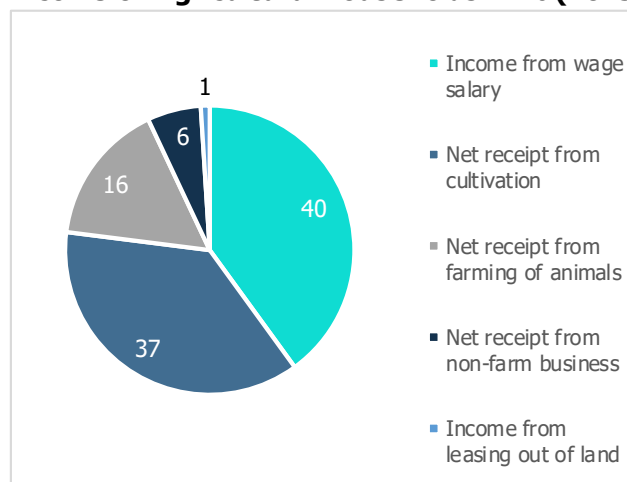
Source: National Statistical Office (NSO)

Similarly, the income of agricultural households has increased over the years backed by growth in income from farm activities and farm-allied activities as shown in the chart below and MSP fixed by the government has been supporting farmer's income over the years. The MSPs are primarily linked to market prices and have been very important in passing better prices to farmers.

MSP has also encouraged farmers to move towards crops that provide better yield and value. Apart from this, agricultural marketing, food management practices, and encouragement of the food processing sector coupled with various initiatives by the government have been aiding the income of agricultural households.

Chart 22: Composition of Average Monthly Income of Agricultural Households in % (2013)


Source: Economic Survey 2021-22

Chart 23: Composition of Average Monthly Income of Agricultural Households in % (2019)


Source: Economic Survey 2021-22

The above charts show class-wise distribution of sources of incomes among the agricultural households and depicts that there is a visible diversification in the sources of income of the farmers. The net receipts from cultivation (crop production) continued to account for a major share of agricultural household income and contributed 37% of the agricultural household income. The income from cultivation increased by 22.6% to Rs.3,781 in 2019 from Rs.3,084 in 2013. The net receipts from other sources (excluding income from cultivation) increased by 92.6% where total income grew by 59%. However, the income still remains very low due to which usage of pesticides also remains lower compared to developed nations. Government's support and impetus to improve the situation of farmer income, is likely to help the industry.

Kisan Programmes

There are several business segments of companies wherein the aim is to create a bridge between the point of research to farmer fields to attain its objective of generating revenue by adding more satisfied loyal customers by providing need-based solutions with production, technologies, and usage skills. With the help of such applications, data related to farmers are collected, which can be used to connect and provide support further.

The role of people involved is to provide information about a product, help in identifying the problem, and help in solving it. The problem is fed into the system, identification is done and the solution is provided accordingly. Furthermore, feedback is taken if the problem still persists. It is addressed again.

Some of the companies that have such initiatives are:

Indian Farmers Fertiliser Cooperative (IFFCO Kisan Sanchar Ltd)

Nova Agri Tech Limited (Nova Kisan Seva Kendra)

Increasing Emphasis on Organic Agriculture

One of the fastest-growing agricultural methods is organic farming. The excessive use of synthetic fertilizers has led to the contamination of soil and the destruction of microorganisms. To reduce the increasing pollution of soil, organic farming is being adopted. Besides, the rising demand for organic food is further motivating farmers to adopt biofertilizers.

3.6 Key Challenges for Biofertilizers and Organic Fertilizers Industries

• Lack of Awareness and Low Adoption Rates due to High Production Costs

Farmers are not aware of the usefulness of biofertilizers and how they increase crop yields sustainably. Their lack of awareness about the concentration, time, and method of biofertilizer application and the efficacy of biofertilizers compared to their familiarity with the use of conventional fertilizers is a serious challenge of their wide-scale application and adoption. Also, specific machinery and equipment are needed for the production and storage of biofertilizers, which, in turn, increases production costs. This further leads to lower adoption rate, limiting the growth of the biofertilizer market.

• Poor Infrastructure

Non-availability of suitable facilities for production is a major infrastructural constraint. In addition to this, inadequate availability of inputs and unavailability of inputs at appropriate times is another problem. Also, the shortage of essential equipment, power supply and less space availability for the laboratory is also a major constraint.

• Staff Competence

The lack of technically qualified staff in production units is a serious problem and this constraint is in direct connection with the lack of proper training and adoption of technical qualifications for the production of biofertilizers. Improving the technical and human capacity for quality control of biofertilizers also has been identified as critical for adequate biofertilizer market realization.

• Lack of Regulations

The lack of effective regulation on biofertilizers is among the greatest contributors to the low availability and adoption of the products. Due to the absence of a supportive regulatory and policy framework the research to improve the agricultural application of biofertilizers is often disrupted. Whereas effective regulatory environments can significantly reveal the potential of biofertilizer use.

In addition, the lack of such an environment leads to poor facilitation of production, distribution, and use of biofertilizers. Poor management of fertilizers and supplements registration further raises more problems, leading to low accessibility to novel products.

• Low Shelf-Life

To increase the shelf-life of biofertilizers there are other processes to be followed adding to an extra cost to the farmer. For storing biofertilizers, a cool place is required. In areas where temperatures are hot and proper care of storage is not taken, the quality gets reduced as microbial count decreases.

• Seasonal Demand for Bio-Fertilizers

Bio-fertilizer demands are seasonal in nature and so are the requirements of its supply. Hence, the production and distribution are done only a few months in a year. The bio-fertilizer producers thus face a challenge to design improved formulations tailored to local conditions and supply them in a mode that satisfies the variability of crop responses. Thus, extensive research on technology to develop formulations that can satisfy these requirements is necessary and without this research, the producers will not benefit from the full potential of bio-fertilizers.

B. Bio-Stimulants

Bio-stimulants are compounds or products that include microorganisms, whose function when applied to plants/seeds/ rhizosphere is to enhance and regulate the crop's physiological process to improve input use efficiency, growth, yield, quality, and stress tolerance. These bio-stimulants may include products of plants/ animals or microbial origin.

It not only enhances plant immunity but is also effective in the management of pests and withstanding abiotic as well as biotic stress. It shows an immense effect on pests like leaf-eating caterpillars and borers that last for a long time. There are many categories of bio-stimulants.

Some of the widely used bio-stimulants are:

- Humic and Fulvic Acids: This has parts of soil organic matter resulting from the decomposition of plant, animal, and microbial residues.
- Seaweed Extracts: These are insoluble powder or liquid form and are derived through different extraction processes.

Amino-Chelated Fertilizers

Amino-chelated fertilizers contain micronutrients based on key amino acids that increase nitrogen using efficiency and optimize overall plant metabolism by improving crop production. These helps accelerate the growth of the plant by inducing stress resistance and tolerance and significantly enhancing seedling growth, postponing plant deterioration with age and increasing plant canopy.

Further, amino-chelated fertilizers help in increasing the pollen germination rate and length of the pollen tube. It focuses on crops like chilli, cotton, tomato, paddy, tobacco, cereals, pulses, creeper vegetables, etc. In addition, these act as a deficiency corrector and assist in the rapid and healthy growth of plants, which results in good quality high yields. These fertilizers focus on crops like chilli, jasmine, rose, rice, sugarcane, red gram, melon, etc.

4 Crop Protection Industry

The crop protection industry primarily consists pesticides which is discussed briefly in the following sections.

4.1 Segments and Structure of the Global Pesticides Industry

The global pesticide industry is dominated by the herbicides segment followed by the fungicides and insecticides segments. Of the global market size of around USD 81 billion in the year 2022, herbicides accounted for the highest share of about USD 29 billion (around 35% of the industry). The other two major segments fungicides and insecticides contributed approximately USD 18 billion and USD 17 billion, respectively, towards the global pesticides industry during the year.

The major three segments of the global pesticides industry are listed in the table below:

Table 16: Segment of the Global Pesticide Industry and Outlook (in USD billion)

Segments (USD billion)	2022	2028P	Outlook CAGR
Crop market			
Herbicides	29	~40	4.5%-5.5%
Fungicides	18	~25	4.5%-5.5%
Insecticides	17	~23	4.5%-5.5%
Others	6	~7	1.5%-2.0%
Total crop market	70	~95	5.0%-6.0%
Non-crop market	11	~14	4.1%-5.0%
Total global pesticides market	81	~109	5.0%-6.0%

Source: CareEdge Research estimates based on industry sources

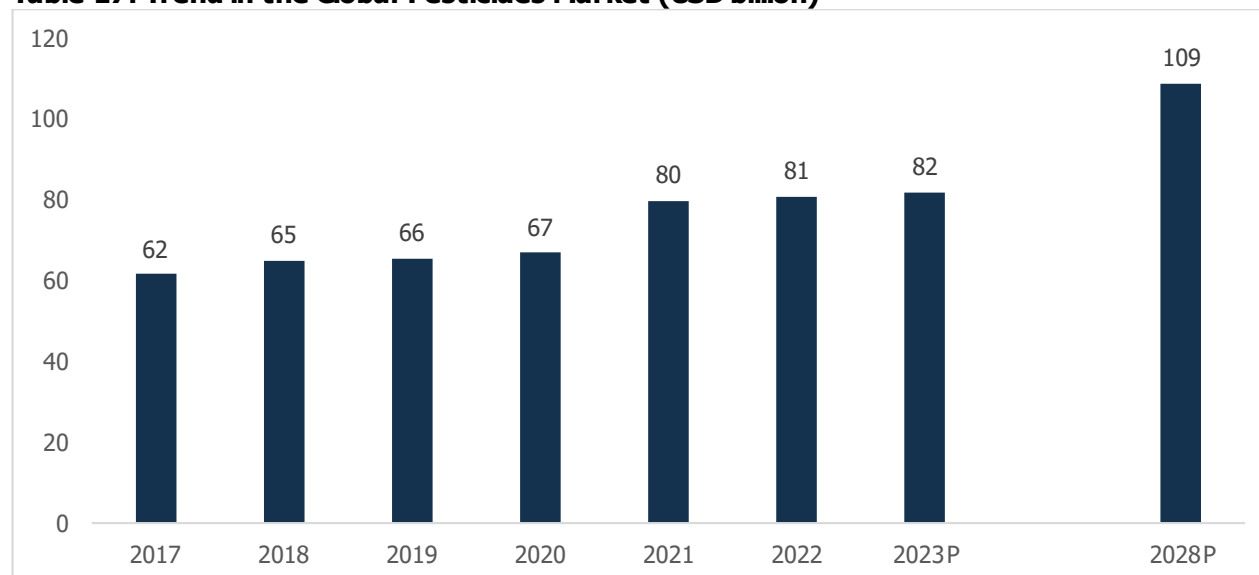
Note: 2022 data is estimate

Apart from the crop market, another segment that has contributed to the global pesticides market includes the non-crop market. This segment had a market size of about USD 11 billion in 2023. These pesticides find their application in homes & gardens, turfs & ornamentals, pest control operations, industrial vegetation management, forestry, public health, and aquatic, among others. They are used for control of weeds, diseases, insects, and other pests. Also, they are used for plant growth regulation.

With the expected increase in the application of these pesticides on account of the benefits offered by them, the crop market is estimated to grow at a faster CAGR compared to that of global non-crop. Accordingly, the global non-crop market is expected to rise at a CAGR of about 4.1%-5% by 2028 and is estimated to reach the level of approximately USD 14 billion.

4.2 Trend in the Global Pesticides Industry

During 2017-2022, the global pesticides market is estimated to have grown at a Compound Annual Growth Rate (CAGR) of 5.1% from USD 62 billion in 2017 to USD 81 billion in 2022. Post 2021 demand has been soft due to various reasons. There were geopolitical tensions and supply chain issues globally due to which raw material prices were high and demand was soft. And in 2023, after export restrictions were eased in China, the supply increased resulting in declining prices and subdued demand.

Table 17: Trend in the Global Pesticides Market (USD billion)

Source: CareEdge Research based on industry sources

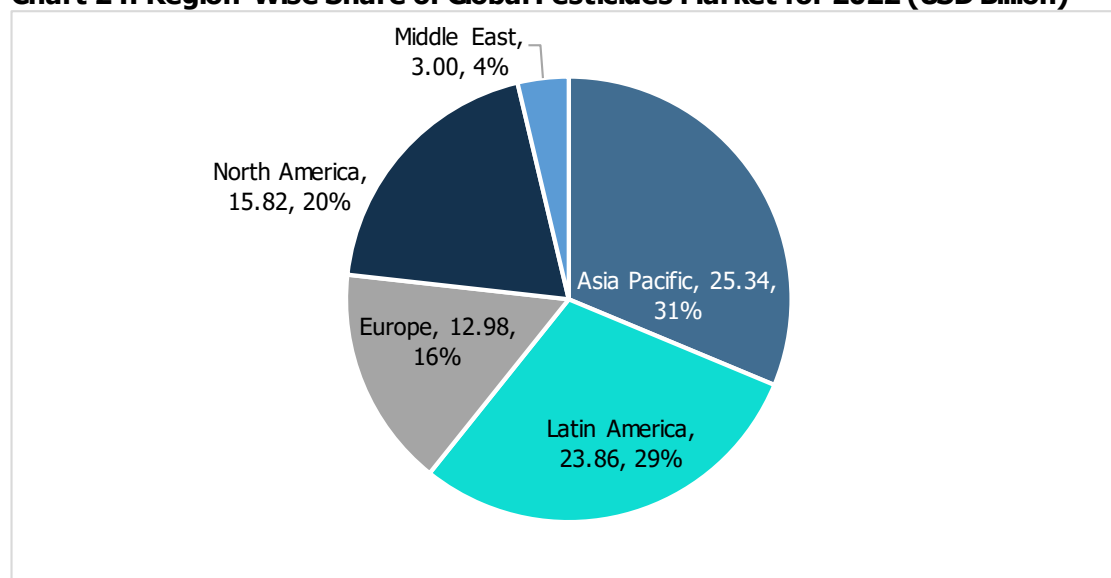
P is projected

Pesticides, also called agrochemicals, are used in agriculture to support the growth and safety of plants, protect crops from pests, and increase the yields of crops. They also protect crops from insects, diseases, and weeds. These pests when not controlled affect the volume and quality of food crops. The mentioned benefits are the primary reasons that have supported the growth of this industry globally over the years. In addition to this, the sufficiency of global food production in the world to meet the requirements of the increasing world population has also been supporting the market of the pesticides industry globally.

Moreover, the above-mentioned factors are expected to continue to provide support to the global pesticides industry. Thus, this market is expected to register a growth in the range of 5.0-6.0% during 2023-2028 and is likely to reach approximately USD 109 billion by 2028.

4.3 Region-Wise Global Pesticides Market

Chart 24: Region-Wise Share of Global Pesticides Market for 2022 (USD Billion)



Source: CareEdge Research estimates based on industry sources

Outlook

Asia Pacific will continue to be the largest market for the global pesticide industry and is expected to grow at the fastest CAGR of 6.0-6.5% by 2028 among all the regions of the industry. This is likely to augment the share of the Asia Pacific region in the international market to around 34% by 2028 from an estimated share of 32% in 2022.

The other pesticides market Latin America, North America, and the Middle East & Africa are likely to increase at a CAGR of 4.5%-5.5% by 2028. The pesticides market in Europe, on the other hand, is estimated to increase at a CAGR of 2.0%-2.4% during the forecasted period.

Table 18: Region-Wise Outlook Estimates for Global Pesticides Industry

Region-wise market (USD billion)	2022*	2028P	CAGR
Asia Pacific	25.3	~37	6.0%-6.5%
Latin America	23.8	~32	4.5%-5.5%
Europe	12.9	~15	2.2 to 2.4%
North America	15.8	~21	4.7% to 5.8%
Middle East and Africa	3.0	~4	4.5% to 5.0%
Total	81	~109	5.0 to 6.0%

Source: CareEdge Research estimates based on industry sources

P is projected Note: 2022* data is estimate

4.4 Growth Drivers for the Global Pesticides Industry

The growth in global pesticides industry as mentioned above will be supported by the driving factors that are listed below:

Asia Pacific Market

The Asia Pacific market that accounts for the largest share of the global pesticide industry includes populous countries like India and China with an increasing population that demands food security. This, in turn, prompts these countries to better their productivity levels to meet the needs of food requirements. In addition to this, agriculture forms an important part of these countries' economies, requiring these nations to focus on productivity levels. Thus, it is expected that the pesticides market in this region will grow at a faster CAGR of 6.0-6.5% by 2028 compared to other regions.

Intensive Farming

Farmers across the world are opting for intensive farming techniques to improve the productivity of the crops per hectare, thus driving the consumption of pesticides. Intensive farming is an agricultural augmentation and mechanization system with the intention to maximize yields from available land by means of more use of pesticides and chemical fertilizers. These techniques aid in meeting the growth in food demand from the rise in population and avert food shortages.

Growth in the Global Population

The growth in the global population is one of the demand drivers for pesticide usage as an increase in the world population implies more food requirements with the available land. This, in turn, calls for pesticide usage to increase the productivity of the crop to get more output from it.

5 Crop Protection Industry in India

5.1 Evolution of Pesticides Industry in India

- The evolution of pesticides in India was led by the Green Revolution. In 1943, India saw one of the worst food disasters during the Bengal famine. Food shortages have resulted in the death of around 40 lakh people in the eastern part of India. The problem of food shortage in India continued even after independence during different time periods and the frequent food scarcity issue led to the beginning of the Green Revolution in India.
- Around the 1960s the Green Revolution was launched by the Government of India with the support of M.S. Swaminathan, a geneticist, who is now referred to as the father of India's Green Revolution. The revolution started in 1967 and continued till 1978.
- The Green Revolution in India resulted in growth in agricultural production, primarily in the states of Haryana, Punjab, and Uttar Pradesh. The main achievement in this revolution was the development of a high-yielding variety of seeds of wheat and rust-resistant strains of wheat.

Aspects of Green Revolution in India

- High Yielding Varieties (HYV)
- Mechanization of Agriculture
- Use of Chemical Fertilizers and Pesticides
- Irrigation
 - The Green Revolution that engaged agricultural production with the usage of modern tools and techniques involved the aspect of pesticides and chemical fertilizers. This revolution resulted in the conversion of agricultural systems into industrial systems. This further required the utilization of modern methodologies like high-yielding variety seeds, tractors, pesticides, fertilizers, and irrigation facilities. Until 1967, the government primarily focused on augmenting the farming areas. However, the rapid growth in population compared to food production demanded a major and immediate requirement to raise yield, which resulted in the evolution of the Green Revolution.
 - The Green Revolution started around the world in several countries between the 1950s and the late 1960s. This resulted in various research technology transfer initiatives throughout the world, which in turn, focused on increasing agricultural production. The revolution started with Norman Borlaug's genetic testing. A hybrid wheat plant that could withstand diseases and fungi (in addition to high yield) was created by him. He is also known as the father of the Green Revolution.

5.2 Types of Pesticides and Their Applications

The Indian agrochemicals industry can be primarily divided into the following types:

- a. Insecticides
- b. Fungicides
- c. Herbicides

a. Insecticides

Insecticides enable protection of the crops from insects by either preventing their attack or destroying them. They help in controlling the pest population below a desired threshold level.

They can be further classified based on their mode of action:

- Contact insecticides: Insects get killed on direct contact with these insecticides and they leave marginal residual activity which affects the environment minimally.
- Systemic insecticides: Plant tissues absorb these insecticides and destroy insects when the insects feed on plants. These are generally related to long-term residual activity.

b. Fungicides

Fungicides are used to prevent fungi attacks on crops and to tackle crop diseases. Protectants and eradicants are

two types of fungicides. Protectants protect or hinder fungal growth and eradicants destroy the diseases on usage. This results in better productivity, contraction in crop blemishes, and increased storage life.

c. Herbicides

Herbicides, also known as weedicides, are used to destroy unwanted plants. The unavailability of cheap labour leads to the major usage of herbicides in rice and wheat crops. The demand for herbicides is seasonal as they develop in damp, warm climates, and perishes in cold spells. They are of two types depending on the way of action, selective and non-selective. Selective herbicides destroy specific weeds not harming the desired crop and non-selective herbicides are used for widespread ground clearance to handle weeds pre-crop planting.

Based on the usage, there are three types of herbicides:

1. Application prior to sowing of the crop (pre-planting)
2. Application post-development of weeds (pre-emergence)
3. Application right away subsequent to sowing (post-emergence)

d. Bio-Pesticides

These are the new-age chemicals produced from substances of nature like plants, animal waste, bacteria, and minerals. Bio-pesticides have a small share in the agrochemicals market in India, which is expected to grow, backed by government support and increased awareness about pesticides that are eco-friendly. These pesticides are environment-friendly and easy to use.

e. Others

This others segment comprises fumigants, biostimulants, nematocides, rodenticides, and plant growth regulators (PGR). Plant growth regulators are chemicals used to modify and enhance plant growth such as increasing branching, suppressing shoot growth, increasing return bloom, removing excess fruit, or altering fruit maturity. Various factors such as how well the chemical is absorbed by the plant, tree vigour, and age, dose, timing, and weather conditions before, during, and after application affect the PGR performance. They prevent crops from attacking pests at the time of crop storage.

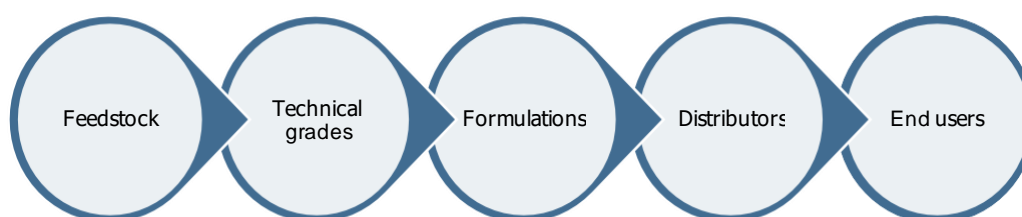
5.3 Overview of Pesticide Value Chain

The value chain of the pesticide industry involves five stages as shown in the chart below. The chain starts with intermediates moves to technical grades, formulations, and distributors and concludes at end-users.

The intermediates consists of petrochemical derivatives, natural feedstock, and chemicals that go into the making of technical grades. Once the technical grade or active ingredient is synthesized, the process moves to formulations.

Chemical synthesis is the method of transforming a reactant or starting material into a product or several products by one or more chemical reactions. The active ingredient controls pests and gives controlling action to the pesticides. This ingredient repels, destroys, or alleviates pests. It is also known as a pesticide's technical grade. The active ingredient is the technical grade of the pure pesticide.

Figure 7: Pesticide Value Chain



Pesticides are generally not applied in their pure form. It is usually formulated by adding inert ingredients that improve storage, handling, application, effectiveness, or safety. The inert ingredients, which involve solvents, adjuvants, and fillers aid in the handling, application, storage, effectiveness, or safety of the pesticides. This is the formulation process of pesticides.

While the active ingredient destroys the pest, the inert ingredient facilitates ease of handling, spraying, and coating on plants. Following this, formulations are available to distributors who sell them to the end-users like farmers.

Enhanced Supply Chain Efficiency in the Agrochemical Space

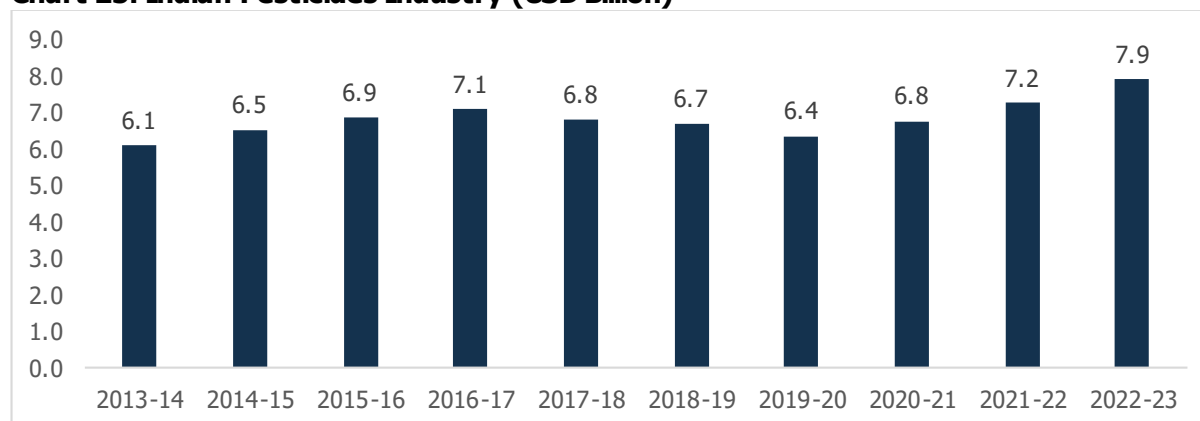
The Agrochemical supply chain has been considered as one of the most complex activities due to factors like seasonal demand, unpredictability of pest attacks, and high dependency on monsoons, which hinder the inventory and distribution of products. The Indian Agrochemical supply chain entails technical grade manufacturers, formulators producing end products, distributors, dealers, and retailers. An effective distribution channel plays a critical role in determining the growth of players in the industry.

While distributors are a large portion of the system, the trend is shifting and manufacturers are moving to deal directly with dealers. This is further expected to make the supply chain more effective going forward as it will reduce time as well as cost for the players.

a. Trend in Growth of Indian Pesticides Industry Review

The overall Indian pesticides market grew at a CAGR of 6.6% from Rs.368 billion in 2013-14 to Rs. 655 billion in 2022-23*. In terms of USD, the Indian market increased at a CAGR of 3.0% from USD 6.1 billion in 2013-14 to USD 7.9 billion in 2022-23.

Chart 25: Indian Pesticides Industry (USD Billion)



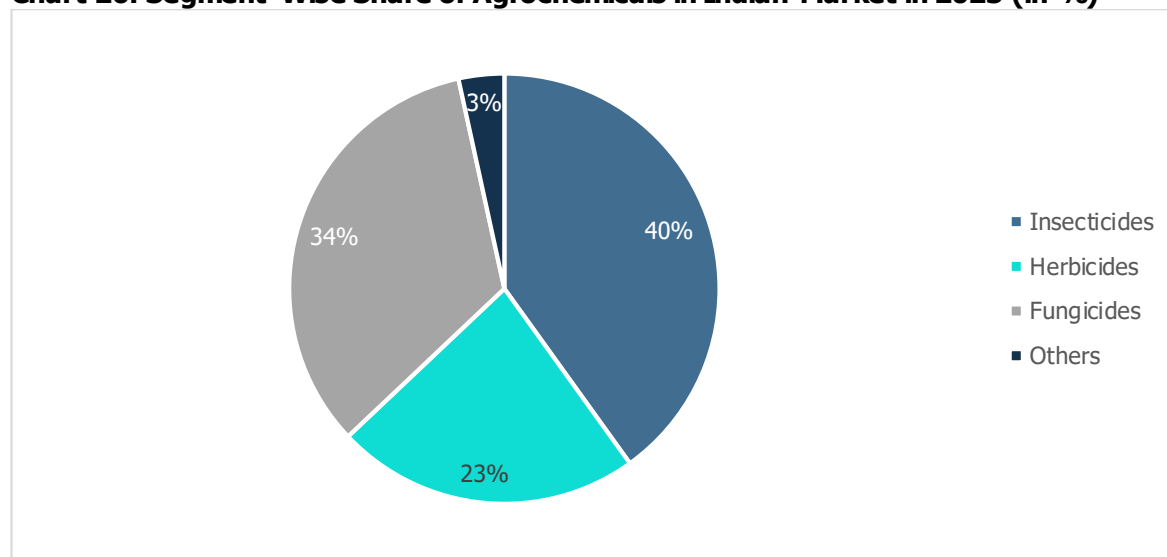
Source: Department of Chemicals and Petrochemicals

Note: The market size of industry for years 2020-21, 2021-22 and 2022-23 are CAREEDGE Research estimates

The Indian pesticide industry can be primarily divided into the following types:

- a. Insecticides
- b. Fungicides
- c. Herbicides

Insecticides account for a major share of around 40% followed by fungicides and herbicides, with an approximate share of 34% and 23%, respectively.

Chart 26: Segment-Wise Share of Agrochemicals in Indian Market in 2023 (in %)

Source: Based on Industry sources, CareEdge Research estimates, Directorate of Plant Protection, Quarantine & Storage

Outlook

The overall Indian pesticide industry is estimated to increase at a CAGR of around 6.0%-6.5% by 2027-28 on account of an upward growth expected in the international market and a likely increase in domestic usage of pesticides in India.

Table 19: Outlook of Pesticides Industry Size in India (USD million)

Segment	2023E	2028P	Outlook CAGR
Insecticides	3,167	4,169	5.5%-6.0%
Herbicides	1,806	2,489	6.5%-7.0%
Fungicides	2,656	3,626	6.0%-6.5%
Others	271	381	6.5%-7.0%
Total	7,900	10,665	6.0%-6.5%

Source: CareEdge Research estimates, E is estimate and P is projected

While the demand for India's pesticides is likely to remain high, India aims to strengthen the process of backward integration for industry. This is because India is dependent on China for some of the technical insecticides, and thus, any disruptions at this source destination (like a chemical plant shutdown in China to reduce pollution) have the potential to affect India's supply chain. While such situations also provide an opportunity for India to increase the exports of pesticides, it does impact the supply chain of the industry. To avoid such instances, the Indian government said that it is considering increasing the scope of the Production Linked Incentive (PLI) scheme to include the domestic manufacturing of agrochemicals.

If implemented, the scheme will result in increased competitiveness of domestic producers, and given the reliance on exports, benefits will help India increase its market share in the global agrochemicals markets. The scheme will also help the industry become self-sufficient and will be able to integrate backwards to produce its own technical-grade ingredients instead of relying on China for supplies.

Moreover, many countries across the world are looking forward to a 'China plus one strategy' to avoid excess dependence on China. The adoption of this strategy internationally will benefit India, as the countries that import pesticides from China may now opt for India, which is the 4th largest producer and 13th largest exporter of agrochemicals globally.

While the above-mentioned factors will support the Indian pesticide industry going forward, it is worth mentioning that the Indian pesticide industry remained resilient even during the pandemic year (2021-22) as exports from the

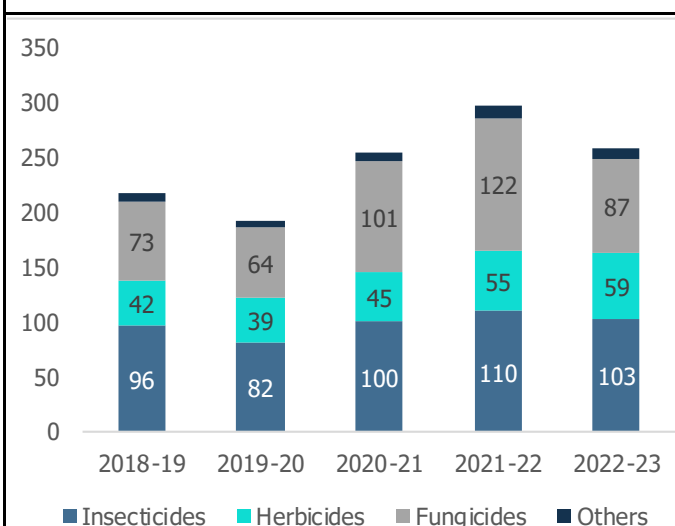
Indian pesticide industry increased by a healthy 22% to 648 thousand tonnes and grew by 37.7% to Rs.365 billion on a y-o-y basis.

In addition, India has a competitive edge in terms of low labour costs and has support towards chemical clusters, which will also aid the growth of the agrochemical industry in the coming years.

5.4 Review of Domestic Pesticide Industry and Production Capacity

The output of pesticides in India (which includes 42 technical grades) increased at a CAGR of 4.5% from 217 thousand tonnes in 2018-19 to 258 thousand tonnes in 2022-23.

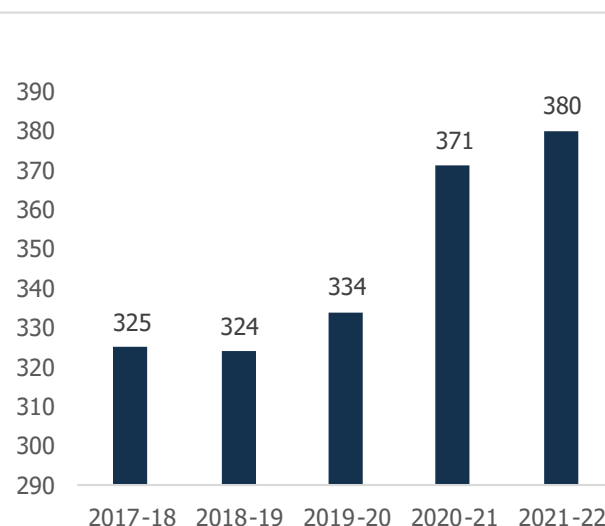
Chart 27: Trend in Production of Pesticides in India ('000 tonnes)



Source: Directorate of Plant Protection, Quarantine & Storage

Note: The production data includes quantity of technical grades only. 'Others' include plant growth regulators, fumigants, bio stimulants, rodenticides and nematocides.

Chart 28: Trend in Production Capacity of Pesticides in India ('000 tonnes)



Source: Department of Chemicals and Petrochemicals

Note: The capacity refers only to technical grade

- During 2022-23, the production of pesticides declined by 13.3% y-o-y to 258 thousand tonnes. The demand for pesticides from agriculture was also subdued globally and domestically, which is believed to be the reason for degrowth.

- The pesticide production capacity in India meets the domestic and export requirements of the nation. Over the years, the production capacity in India has increased at a CAGR of 4.0%. It has increased from 325 thousand tonnes in 2017-18 to 380 thousand tonnes in 2021-22.

- It can be seen that the pesticide production capacity has grown in each of the years for the period 2018-2022 except for 2018-19, where the capacity declined by a marginal 0.3% to 324 thousand tonnes. It is important to note that the industry's capacity utilisation on average has been around 65% in these last five years.

Outlook

The upward momentum in pesticide industry output is expected to continue going forward backed by growth in food consumption in the domestic market amid an expected increase in population, government support towards agriculture and demand from export markets, horticulture and floriculture markets, among others. The penetration of pesticides and agrochemicals in India is low and this poses an opportunity for growth for agrochemical producers.

In addition to this, the government's aim to reduce dependency on China and improve self-sufficiency is expected to support the industry's backward integration and thus its growth.

These factors are estimated to increase the pesticide industry output at a CAGR of 4.0%-5.0% by 2027-28 (Refer to table below).

Table 20: Estimates of Pesticides Production by 2027-28 for Technical Grade (Thousand Tonnes)

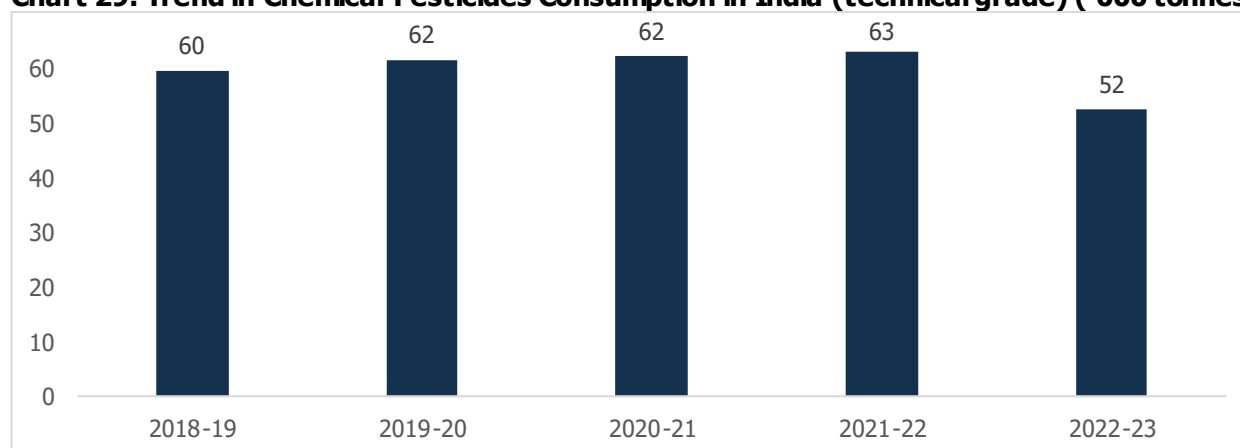
Segments	2022-23	2027-28P	CAGR
Insecticides	103	~130	4.5%-5.0%
Fungicides	87	~102	2.5%-3.5%
Herbicides	59	~80	6.0%-6.5%
Others	9	~11	5.0%-5.5%
Total	258	~323	4.0%-5.0%

Source: Directorate of Plant Protection, Quarantine & Storage, CareEdge Research estimates based on industry sources

5.5 Trend in Chemical Pesticides Consumption

The domestic consumption of chemical pesticides degrew at a CAGR of 3.2% from 60 thousand tonnes in 2018-19 to 52 thousand tonnes in 2022-23. This is an impact of new-age agrochemicals where the active ingredient or formulation is at a lower dosage per acre.

Chart 29: Trend in Chemical Pesticides Consumption in India (technical grade) ('000 tonnes)

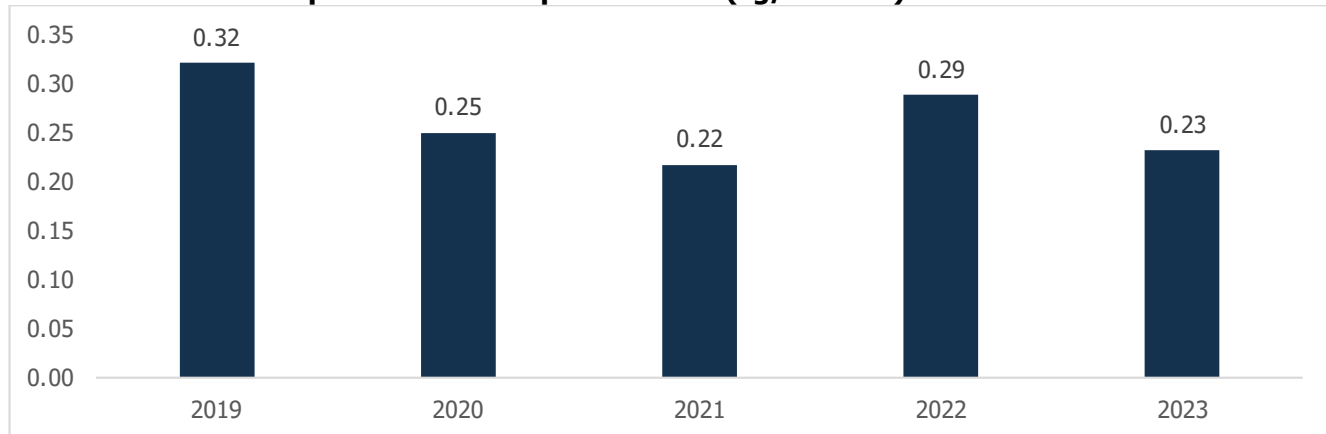


Source: Directorate of Plant Protection, Quarantine & Storage

Note: This does not include data on the states/UTs that have not reported pesticides consumption. Also, figures of 2019-20 for Haryana, Jammu and Kashmir, Tripura, Pondicherry, Goa and Nagaland have been taken from inputs provided by the States/UTs during Zonal Conference (PP) for Rabi, 2020-21 Season.

5.6 Low Per Hectare Pesticides Consumption in India

Of the total pesticides produced in India, the average per hectare chemical pesticides consumption accounted to around 0.26 kg/hectare during the period 2018-19 to 2022-23. In FY23, the per hectare pesticide consumption in India was 0.23 kg/hectare. India's share is the smallest compared to all other nations. India's per hectare consumption is even lower than the world average of 2.6 kg per hectare and that of Asia which stood at 3.7 kg per hectare.

Chart 30: Per hectare pesticide consumption in India (kg/hectare)

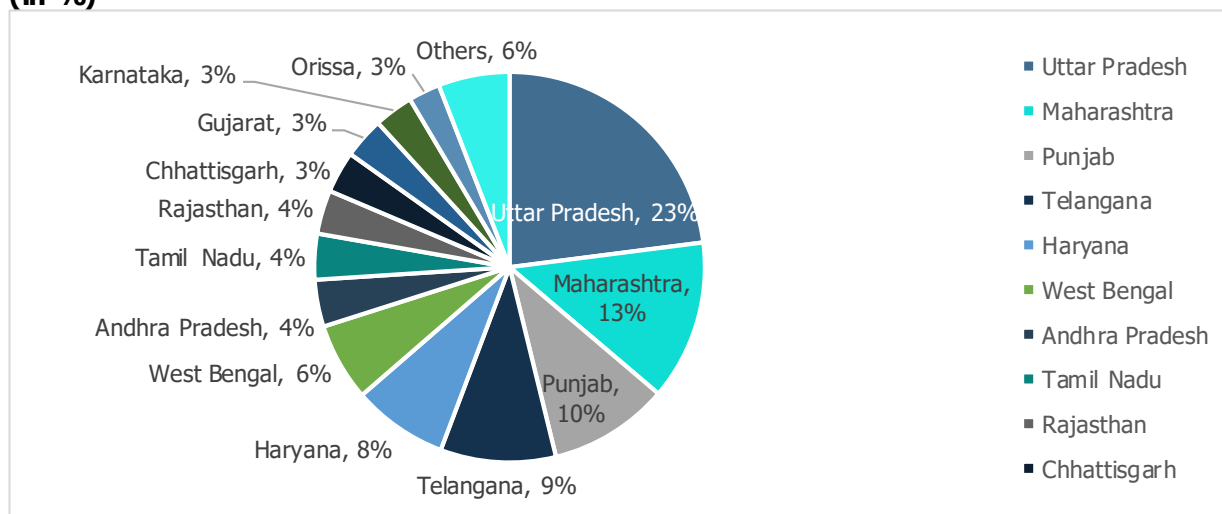
Source: Directorate of Plant Protection, Quarantine & Storage

India's per hectare consumption is even lower than the world average of 2.6 kg per hectare and that of Asia which stood at 3.7 kg per hectare. The per hectare consumption of pesticides in India is minimal 0.2 kg compared to the per hectare consumption of 13 kg and 12 kg in China and Japan, respectively. The low consumption at home has made India the net exporter of pesticides and India has emerged as the 13th largest exporter of pesticides globally which is discussed later in the report.²

5.7 State-Wise Consumption of Chemical Pesticides In India

The top ten states and UTs that reported chemical pesticide consumption accounted for around 83% of the total chemical pesticide domestic consumption in India during 2022-23.

Of the total, Uttar Pradesh and Maharashtra contributed to a significant share of 23% and 13%, respectively. Telangana accounted for around 9% of overall chemical pesticide consumption. Following this, Haryana, West Bengal, Rajasthan, Andhra Pradesh, Karnataka, Tamil Nadu, and Gujarat contributed in the range of around 3%-8%. Others (which include remaining states and UTs) accounted for 6% of the total chemical pesticide consumption during 2022-23.

Chart 31: State-Wise Consumption of Chemical Pesticides in India during 2022-23 (technical grade) (in %)

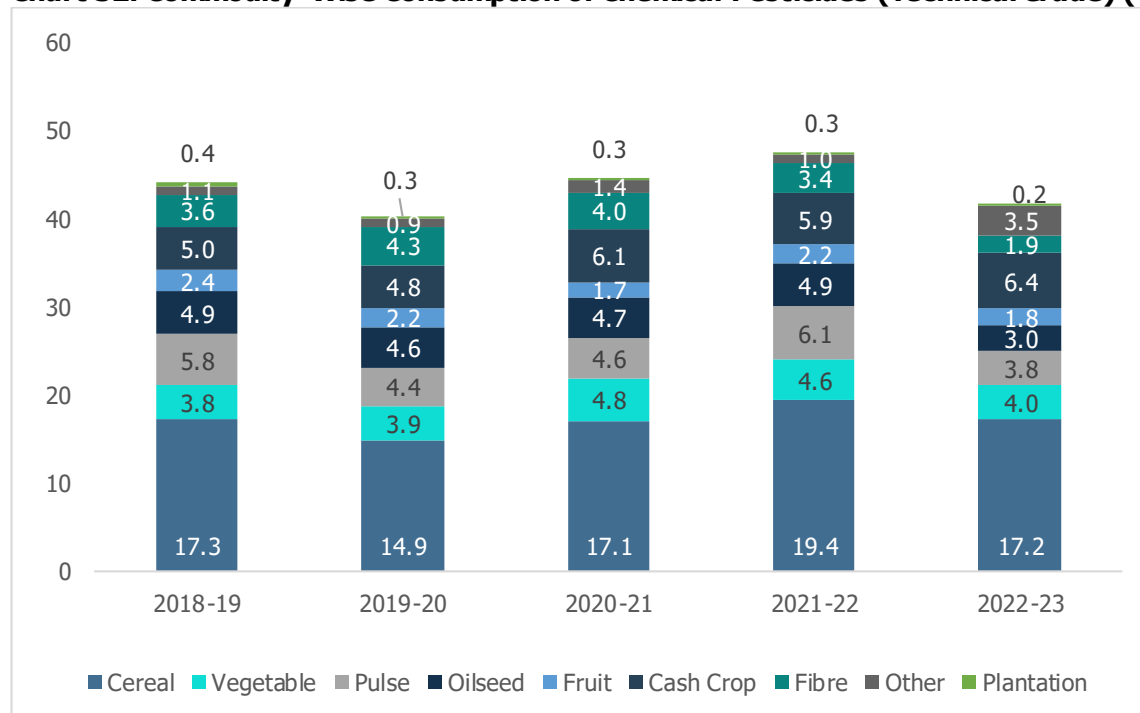
Source: Directorate of Plant Protection, Quarantine & Storage

² The data is taken from FICCI – Overview of Agrochemicals Report 2021.

5.8 Commodity-Wise Consumption of Chemical Pesticides

Pesticides are used and applied across a variety of commodities which includes cereals, vegetables, pulses, oilseeds, fruits, plantation, cash crops, fibre, and others.

Chart 32: Commodity-Wise Consumption of Chemical Pesticides (Technical Grade) ('000 tonnes)



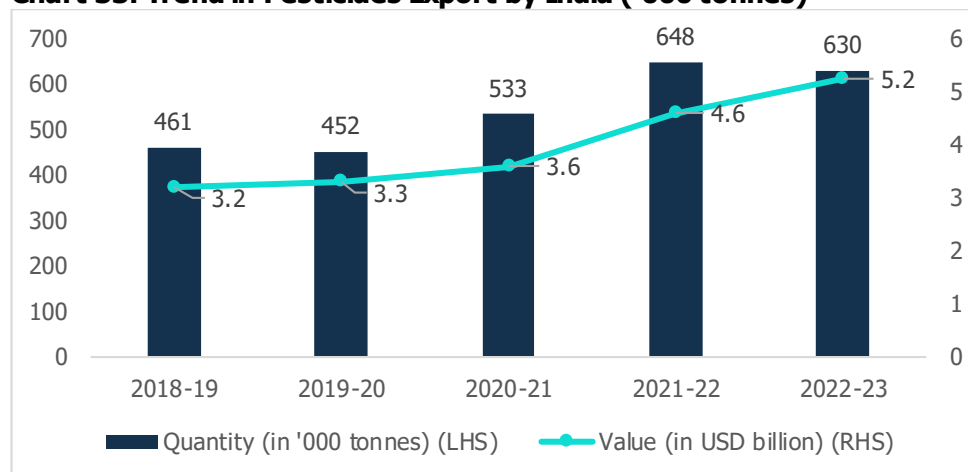
Source: Directorate of Plant Protection, Quarantine & Storage

Of the total commodities covered by pesticides, cereals account for the majority of the share contributing around 39% on average during the five-year period 2018-19 to 2022-23. Following this, pulses, cash crops, oilseeds, vegetables, and fibres contributed in the range of about 10%-12% on average. The other commodities that have a small share include fruits (4%), plantations (0.73%), and others (3%).

5.9 Pesticides Exports

Trend in Pesticides Exports by India

India is net exporter of pesticides and the outbound shipments account for a significant share of the total market size of the Indian agrochemicals industry. Exports of pesticides (technical and formulations both) grew at a CAGR of 8.1% from 461 thousand tonnes in 2018-19 to 630 thousand tonnes in 2022-23. It is to be noted that export CAGR increased at a faster pace compared to that of production, which grew at a CAGR of 4.5%. Moreover, the export value of pesticides grew at a relative higher CAGR of 22% from USD 3.2 billion (Rs.225 billion) in 2018-19 to USD 5.2 billion (Rs.431 billion) in 2022-23.

Chart 33: Trend in Pesticides Export by India ('000 tonnes)

Source: Directorate of Plant Protection, Quarantine & Storage

Note: This includes data on both technical and formulations

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Table 21: Volume-Wise Top 10 Export-Destinations of Pesticides for India 2022-23

Country	Share	Country	Share
Brazil	19.82%	France	1.65%
USA	16.13%	Indonesia	2.61%
Bangladesh	6.87%	China	2.20%
Vietnam	5.46%	Argentina	1.74%
Australia	3.17%	Colombia	1.75%

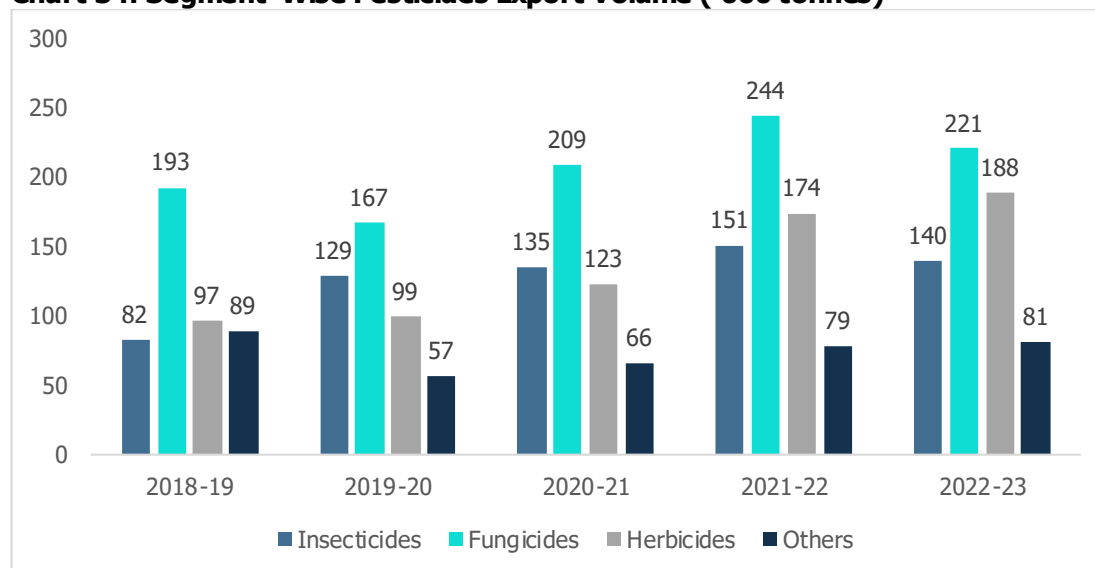
Source: CMIE

Trend in Segment-Wise Exports Volume

• Segment-Wise Export Volume

Of all the pesticide segments, fungicides accounted for the largest share of about 35% on average over the five-year period 2018-19 to 2022-23 in terms of volume. This was followed by herbicides, insecticides, and others that contributed 30%, 22% and 13%, respectively, towards total pesticide exports.

In terms of CAGR, the largest segment – fungicides, increased at a CAGR of 3.4%, which was slower than the CAGR of herbicides (18.1%) and insecticides (14.1%) segments. The remaining segment, others, however, declined at a CAGR of 2.4% during the five-year period.

Chart 34: Segment-Wise Pesticides Export Volume ('000 tonnes)

Source: Directorate of Plant Protection, Quarantine & Storage

Note: This includes data on both technical and formulations

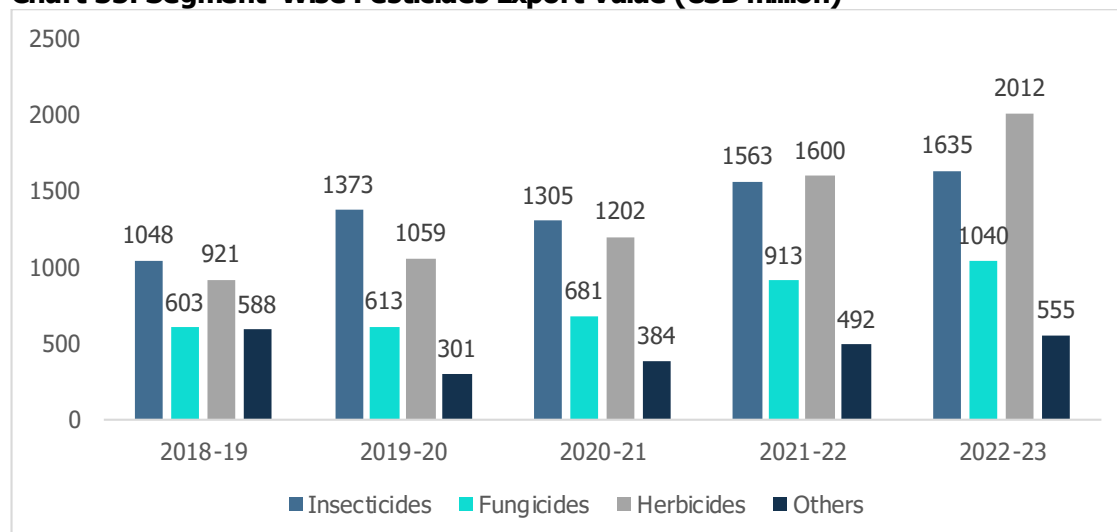
Outlook

An increase in Indian pesticide exports is expected to continue going forward backed by demand from the international market. The pesticide export volumes are estimated to grow at a CAGR of 6%-7% by 2027-28 (~845 thousand tonnes) with the fastest pace of rise likely to be witnessed by the insecticides segment (10%-11%) followed by herbicides (7.5%-8.5%) and fungicides (4%-5%).

• Segment-Wise Export Value

The scenario of segments in terms of contribution towards pesticides export value however is different with the insecticides segment accounting for the highest share of 35% on an average during 2018-19 to 2022-23. This was followed by the herbicides segment, which contributed 34% of total pesticide export value. The fungicides segment that had the largest share in terms of volume accounted for a smaller share of 19% in outbound shipments. The remaining segment, others, contributed 12% on average during the five years.

Further, in terms of CAGR, the herbicides segment reported the fastest CAGR of 21.6% during 2018-19 to 2022-23 followed by fungicides and insecticides which increased at a CAGR of 14.6% and 11.8%, respectively. The other segment, on the other hand, decreased at a CAGR of 1.4% during the five-year period.

Chart 35: Segment-Wise Pesticides Export Value (USD million)

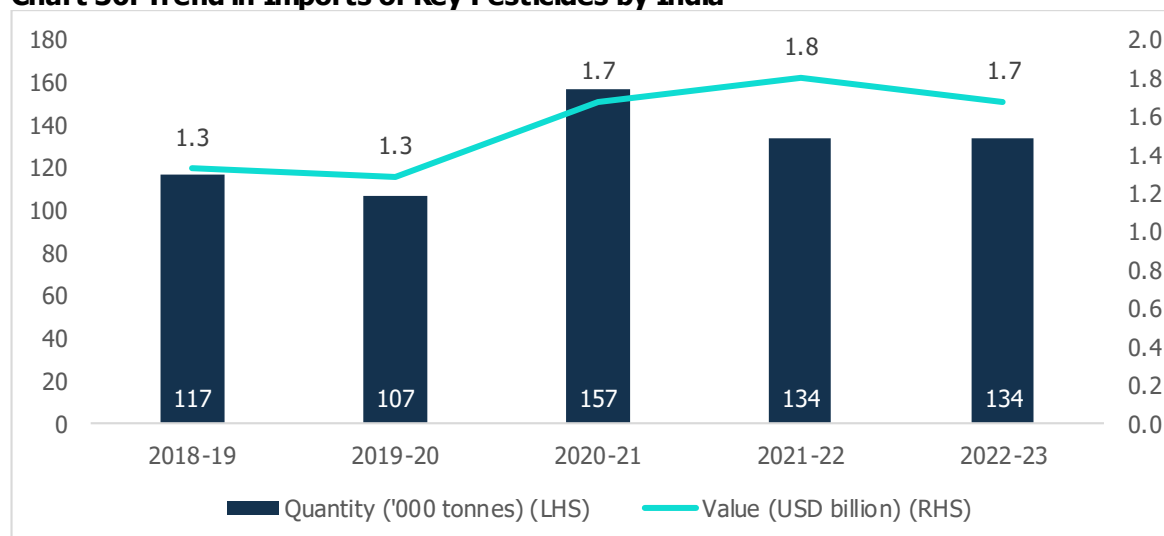
Source: Directorate of Plant Protection, Quarantine & Storage

Note: This includes data on both technical and formulations

5.10 Pesticides Imports

Trend in Pesticides Imports by India

The quantity of pesticides imported by India is quite less compared to that of the pesticide exports. However, the quantity of pesticides imported by India has increased at a CAGR of 3.5%. The imports increased to 134 thousand tonnes in 2022-23 from 117 thousand tonnes in 2018-19. The value of imports grew at a higher CAGR of 6.0% from USD 1.3 billion (Rs.89 billion) in 2018-19 to USD 1.7 billion (Rs.140 billion) in 2022-23.

Chart 36: Trend in Imports of Key Pesticides by India

Source: Directorate of Plant Protection, Quarantine & Storage

Note: This includes data on both technical and formulations

China is the major source of pesticide imports and accounted for more than half of India's total imports with a share of 51.97% during 2022-23. This was followed by the USA, Israel, and Taiwan, contributing 10.24%, 7.69%, and 6.91%, respectively. Other countries from which pesticides were imported included Thailand (a share of around 4%), while Singapore, Japan, and Belgium each accounted for 2-3% of the total pesticide imports by India.

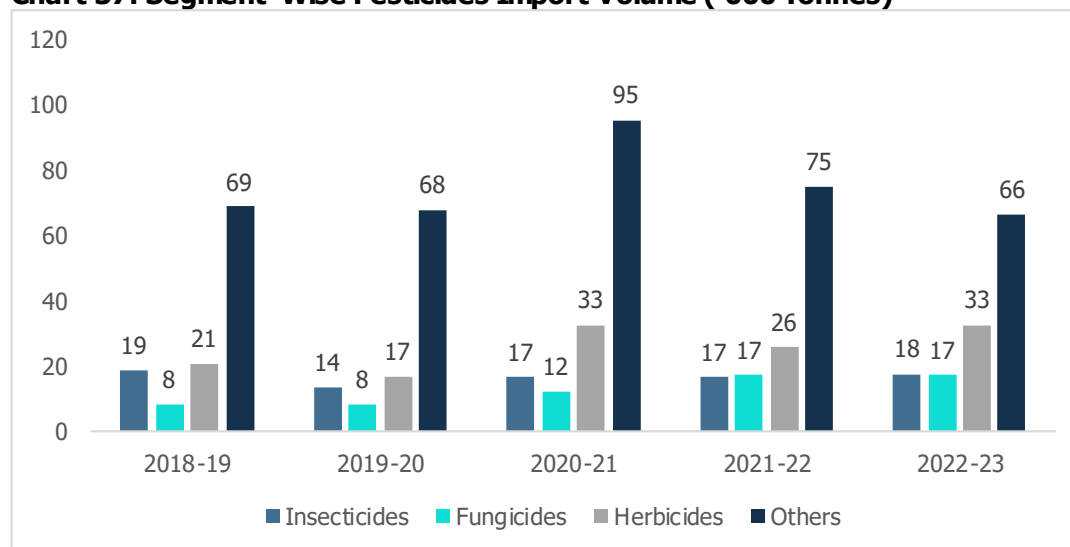
Table 22: Volume-Wise Top Source of Pesticides Imports for India 2022-23

Country	Share
China	51.97%
USA	10.24%
Israel	7.69%
Taiwan	6.91%

Source: CMIE

Trend in Segment-Wise Imports**• Segment-Wise Import Volume**

Of all the pesticides segment imported by India, herbicides accounted for 19.8% followed by insecticides and fungicides with a share of 12.8% and 9.7%, respectively, on an average during 2018-19 to 2022-23. In terms of CAGR, while herbicides and fungicides grew in the range of around 10%-20%, the quantity of insecticides imported decreased at a CAGR of 1.5% during 2018-19 to 2022-23.

Chart 37: Segment-Wise Pesticides Import Volume ('000 Tonnes)

Source: Directorate of Plant Protection, Quarantine & Storage

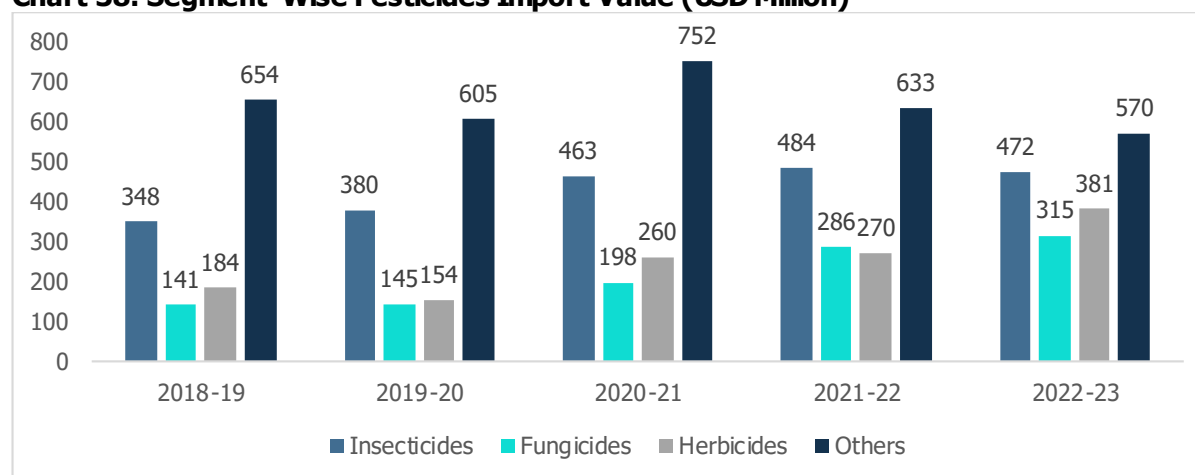
Note: Others include fumigants, plant growth regulators and miscellaneous (where miscellaneous comprises disinfectants, paper impregnated, repellent for insect, weedicides and weed killing agents, etc.)

Apart from this, imports also include fumigants, plant growth regulators, and miscellaneous (where miscellaneous includes disinfectants, paper impregnated, repellent for insects, weedicides, weed killing agents, etc.) covered under the other segment. The component others accounted for the remaining share of 57.6% on an average during the period 2018-19 to 2022-23. It largely remained flat at 66 thousand tonnes in FY23 vs 69 thousand tonnes in FY19.

• Segment-Wise Import Value

During the five-year period 2018-19 to 2022-23, insecticides, herbicides, and fungicides contributed about 29.2%, 13.3%, and 12.0%, respectively, in the overall import value of pesticides. The component others as described above accounted for the remaining share of 45.3% on average in terms of import value.

Whereas on the import front, the pesticides import of all four components grew in double-digit in the range of 8%-16% during these years.

Chart 38: Segment-Wise Pesticides Import Value (USD Million)

Source: Directorate of Plant Protection, Quarantine & Storage

Note: Others include fumigants, plant growth regulators and miscellaneous (where miscellaneous comprises disinfectants, paper impregnated, repellent for insect, weedicides and weed killing agents etc.)

5.11 Generic and Premium Pesticides

The Indian pesticides market is primarily dominated by generics that account for almost 75%-80% of the total market with speciality or premium pesticides accounting for the remaining share. The generic pesticides are sold at a cheaper price compared to speciality pesticides that offer higher effectiveness.

Further, generic pesticides are manufactured with the availability of molecules that go off-patent since this enables the commercial development of generic pesticides. A patent is an exclusive right granted by the government for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem.

In addition, a patent confers on its owner the legal right to exclude others from making, using, offering for sale, or importing a patented product or product obtained from a patented process without his/her consent for a period of 20 years. The period of 20 years commences from the date of the filing of the relevant patent application. The patent protection period of 20 long years gives the patentee ample opportunity to recoup the money spent on initial research and subsequent commercial introduction. The patent rights are territorial and limited to the country where they have been granted.

5.12 Industry Growth Drivers

• Agriculture

Agriculture is the primary source of livelihood for about 58% of India's population. As a result, the share of agriculture and allied sectors to the total economy's Gross Value Added (GVA) has been significant and has increased over the years as shown in the table.

Percentage share of GVA of Agriculture and Allied Sectors to Total Economy

Year	% share
2018-19	17.6
2019-20	18.4
2020-21	20.2
2021-22*	15.6
2022-23#	15.1

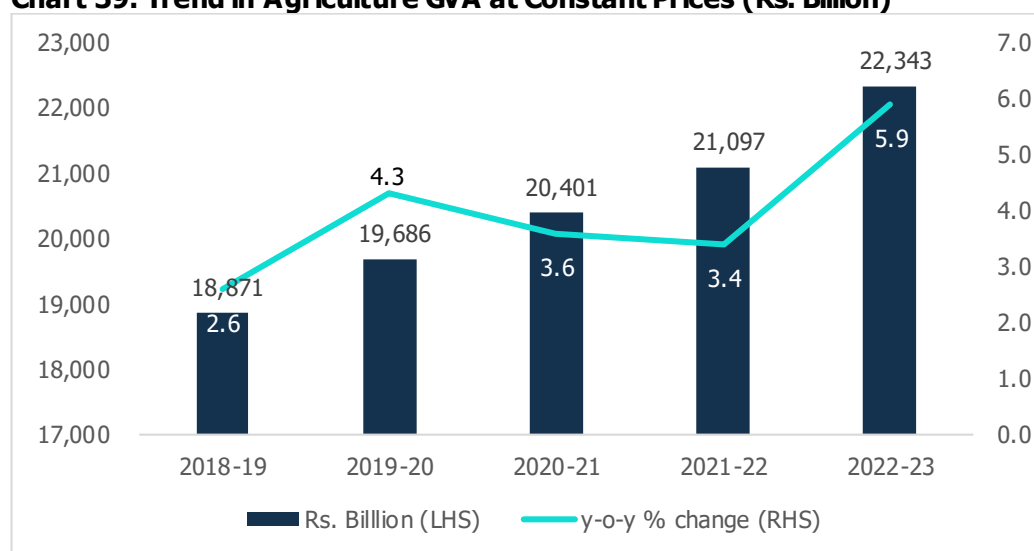
Source: PIB Release and Economic Survey 2021-22, MOSPI

Note: * denotes 1st Revised Estimates and # denotes Provisional Estimates

As on 2022-23, the sector is the largest employer of workforce and accounted for a sizeable 15.1% in Gross Value Added (GVA) of the country. Growth in allied sectors including livestock, dairying and fisheries has also been the major drivers of overall growth in the sector.

The expansion in share of agriculture and allied sector's GVA is backed by an upward trend in the GVA of agriculture activities. During the five-year period 2018-19 to 2022-23, the GVA for agriculture increased at a CAGR of 4.3% from Rs.18,871 billion in 2018-19 to Rs.22,343 billion in 2022-23.

Chart 39: Trend in Agriculture GVA at Constant Prices (Rs. Billion)



Source: CMIE

The growth in agriculture GVA has been supported by various measures on credit, market reforms, and food processing. Moreover, in addition to several measures aimed at increasing productivity and improving the marketing of agricultural produce, the government also carries out a large food management programme with significant financial implications in terms of food subsidies.

The growth in the agriculture sector is expected to result in more demand for agrochemicals in India thus aiding its overall production and consumption.

• Government Support:

The government provides aid to the rural economy through various budget announcements that aim at reviving rural areas and raising farmers' income. In addition, growth in credit facilities to farmers through institutional credit mechanisms and low-interest rate farm loans are likely to motivate farmers towards usage of pesticides that help increase the productivity and yields of crops. Besides, the increased minimum support price (MSP) of crops also may contribute to pesticide usage. Moreover, in the recent Union Budget 2022-23, the government promoted the concept of natural and organic farming, thereby encouraging the usage of environment-friendly agrochemicals.

• Growth in Food Demand:

With the expected increase in population, the demand for food grain in India is likely to rise. Accordingly, the growing consumption needs are to be met with almost the same arable land. Thus, raising farm productivity becomes important and this can be done with optimal usage of products like agrochemicals. It is to be noted that per hectare consumption of pesticides in India is one of the lowest in the world.

• Increasing Demand for Horticulture and Floriculture:

Fruits and vegetables have a significant share of around 90% of the Indian horticulture output. With increased consumption of healthy and nutritive foods, the demand for fruits and vegetables is likely to increase. This, in turn, is expected to support higher consumption of fungicides, which helps in contracting post-harvest losses in fruits and vegetables.

- **Growing Awareness of Bio-Pesticides:**

The rising awareness with respect to the environment-friendly usage of agrochemicals and the use of integrated pest management (IPM) mechanisms are expected to encourage the application of biopesticides. The biopesticides market in India constitutes a small proportion, offering growth opportunities for the segment.

- **Off-Patent Molecules:**

Any pesticide that goes off-patent provides an opportunity for the Indian industry to develop generic molecules. Such an event thus opens up opportunities for Indian manufacturers to increase their exports. An opportunity amounting to around USD 5 billion is estimated to go off-patent by FY27. This is likely to support pesticide exports from India going forward.

- **Export Markets:**

The outbound shipments account for a major share of the Indian agrochemicals market and have grown at a CAGR of around 8.8% over the five-year period 2016-17 to 2020-21, thus driving the overall agrochemicals industry. These exports have not just supported the agrochemicals industry but also the overall chemical exports from India as the contribution of pesticides has been significant. Pesticide exports accounted for about 45% of the chemical export value during 2019-20. To support the ambition of making India a USD 5 trillion economy by 2025, the Indian agrochemical industry is estimated to make outbound shipments of around Rs.385 billion by 2025. This target is also likely to encourage agrochemical/pesticide exports from India.

5.13 Challenges faced by the Industry

- **Research & Development (R&D) Costs:**

The companies are required to invest in R&D to develop new molecules, which usually involves high costs. Also, developing a new molecule takes around 9 years on average. While R&D is important to introduce innovation, the investment and time it demands restricts the development of R&D.

- **Distribution Systems:**

The weak distribution system hinders the reach of agrochemicals to each and every remote area of the country. This, in turn, restricts its availability to the users that are spread at the remotest location in India. The industry requires efficient distribution through retailers to enhance its availability.

- **Spurious Products:**

The unavailability of pesticides at different locations gives an opportunity for spurious products to make their way. The usage of these counterfeit products, in turn, may also affect the crops, thus harming the honour of the agrochemicals industry and its sales. Besides, the unawareness among farmers contributes towards the growth of such products.

- **Lack of Awareness:**

There is a lack of awareness among farmers with respect to the optimum and proper application of pesticides, which is affecting the growth of the agrochemicals industry. The companies, however, have been working toward increasing awareness about the usage of pesticides by farmers. Also, companies have been educating the farmers about the benefits of agrochemicals and their safe usage. This is further expected to increase the demand for pesticides.

Also, companies are educating farmers on aspects such as the right quantity, right use, and right application method for the usage of pesticides. Besides, farmers are trained with respect to appropriate chemicals that are to be used for identified pest problems.

- **Genetically Modified (GM) Seeds:**

GM seeds have the potential to decrease the application of pesticides. These seeds introduce pest avoidance qualities in high-yielding crops. GM seeds, thus, have immunity developed in them, which tends to prevent them from the vagaries of nature. Accordingly, this quality of GM seeds has the potential to affect the demand for agrochemicals.

- **Organic Farming:**

With growing health consciousness among people, there has been an increase in demand for organic food, and thus, organic farming. Thus, there is a need for the agrochemicals industry to consider and work toward these concerns to prevent their impact on industry growth.

5.14 Industry Regulations and Government Initiatives

Regulation of Pesticides Awaiting to undergo Modifications

The Government of India regulates the manufacture, sale, transport, export/import etc. of pesticides under the guidelines of the Insecticides Act, 1968. The Insecticide Act, 1968 is administered through Ministry of Agriculture, Department of Agriculture and Cooperation (DAC). Central Insecticides Board and the Registration Committee are the agencies under the Department to regulate the manufacture, distribution, export, import, ban and usage of pesticides. Insecticide Act is enforced by the State Governments.

As per this act, no pesticide is allowed for production/import without registration. Compulsory registration is needed for the product at the central level and licenses for manufacture, formulation and sale at the state level. This creates hinderance as various state governments have different set of rules. Also, the government has proposed a steep hike in registration fees of pesticides. Price hike proposed is from Rs. 5000 to Rs. 4,50,000.

The government is in the process of replacing the old legislation with the proposed Pesticides Management Bill, 2020.

Registration of Insecticides under the Insecticides Act, 1968

1. Any person desiring to import or manufacture any insecticide may apply to the Registration Committee for the registration of such insecticide and there shall be separate application for each such insecticide.

Provided that any person engaged in the business of import or manufacture of any insecticide immediately before the commencement of this section shall make an application to the Registration Committee within a period of 17 months from the date of such commencement for the registration of any insecticide which he has been importing or manufacturing before that date: Provided further that where any person referred to in the preceding proviso fails to make an application under that proviso within the period specified therein, he may make such application at any time thereafter on payment of a penalty of one hundred rupees for every month or part thereof after the expiry of such period for the registration of each such insecticide.

2. Every application under sub-section (1) shall be made in such form and contain such particulars as may be prescribed.

3. On receipt of any such application the registration of an insecticide, the Committee may, after such inquiry as it deems fit and after satisfying itself that the insecticide to which the application relates conforms to the claims made by the importer or by the manufacturer, as the case may be, as regards [on such conditions as may be specified by it and on payment of such fee as may be prescribed, the insecticide, allot a registration number thereto and issue a certificate of registration in token thereof within a period of twelve months from the date of receipt of the application.

Provided that the Committee may, if it is unable within the said period to arrive at a decision on the basis of the materials placed before it, extend the period by a further period not exceeding six months.

Provided further that if the Committee is of opinion that the precaution claimed by the application as being sufficient to ensure safety to human beings or animals are not such as can be easily observed or that notwithstanding the observance of such precautions the use of the insecticides involves serious risk to human beings or animals, it may refuse to register the insecticide.

3A: In the case of applications received by it prior to the 31st March, 1975 notwithstanding the expiry of the period specified in sub-section (3) for the disposal of such applications, it shall be lawful and shall be deemed always to have been lawful for the Registration Committee to dispose of such applications at any time after such expiry but within a period of one year from the commencement of the Insecticides (Amendment) Act, 1977 (24 of 1977):

Provided that nothing contained in this sub-section shall be deemed to make any contravention before the commencement of the Insecticides (Amendment) Act, 1977 (24 of 1977), of a condition of a certificate of registration granted before commencement, an offence punishable under this Act.

3B: Where the Registration Committee is of opinion that the Insecticide is being introduced for the first time in India, it may, pending any inquiry, register it provisionally for a period of two years on such conditions as may be specified by it.

3C: The registration Committee may, having regard to the efficacy of the insecticide and its safety to human beings and animals, vary the conditions subject to which a certificate of registration has been granted and may for that purpose require the certificate-holder by notice in writing to deliver up the certificate to it within such time as may be specified in the notice.

4. Notwithstanding anything containing in the section, where an insecticide has been registered on the application of any person, any other person desiring to import or manufacture the insecticide or engaged in the business of, import or manufacture thereof, shall on application and on payment of prescribed fee be allotted a registration number and granted a certificate of registration in respect thereof on the same conditions on which the insecticide was originally registered.

Registration of Insecticides under the Insecticides Rules, 1971

1. An application for registration of an insecticide under the Act shall be made in Form I and the said Form including the verification portion, shall be signed in case of an individual by the individual himself or a person duly authorised by him ; in case of Hindu Undivided Family, by the Karta or any person duly authorised by him ; in case of partnership firm by the managing partner ; in case of a company, by any person duly authorised in that behalf by the Board of Directors ; and in any other case by the person in-charge or responsible for the conduct of the business. Any change in members of Hindu Undivided Family or partners or the Board of Directors or the person in charge, as the case may be shall be forthwith intimated to the secretary, Central Insecticides Board and Registration Committee and the Licensing Officer.

2. The Registration Committee may, if necessary, direct inspection of the 'testing facility' for establishing the authenticity of the data.

3. An application form duly filled together with a bank draft of Rs.100 only, drawn in favour of the Accounts Officer, Directorate of Plant Protection, Quarantine & Storage, payable at Faridabad towards registration fee shall be sent to the Secretary, Registration Committee, Directorate of Plant Protection, Quarantine & Storage, NH-IV, Faridabad-121001, Haryana. One Self-addressed stamped envelope and one stamped envelope must be enclosed along with the application.

4. The registration fee payable shall be paid by a demand draft drawn on the State Bank of India, Faridabad, in favour of the Accounts Officer, Directorate of Plant Protection, Quarantine and Storage, Faridabad, Haryana.

5. The certificate of registration shall be in Form II or Form II-A, as the case may be and shall be subject to such conditions as specified therein.

There is a total of 802 pesticide formulations registered as on 01-07-2022.

The Pesticide Management Bill 2020

The Insecticides Act, 1968 (the Act) was enacted to regulate the import, manufacture, sale, transport, distribution and use of insecticides with a view to prevent risk to human beings or animals. In the said Act, there is a lack of sufficient deterrence against violations and there is no stricter penalty to safeguard the farmers interest. There is also no mechanism to regulate pricing and disposal in an environmentally sound manner. Further, the Act is more

than fifty years old and its provisions are inadequate to meet the multi-dimensional management and administration of pesticides in present times. It is also important to align India's obligations with various International forums.

In view of the above, stricter penalties are required for safeguarding the interest of farmers, which is jeopardised by the rampant availability of the pesticides which are of dubious and deceptive identity, composition and source. Representation of farmers and greater participation of States in formulation of technical standards for holistic management of pesticides is required. It is also pertinent to strike a balance amongst all stakeholder's aspirations.

In this background, a need was felt to bring a new legislation providing for better management of pesticides. With this in view, it is proposed to replace the Insecticides Act, 1968 by a new legislation, namely, the Pesticide Management Bill, 2020.

The proposed Bill, inter alia, provides for the following, namely:

- (i) to ensure transparency and effective implementation of the provisions of the proposed legislation and also to enable the Central Government to make rules relating to the manner in which the powers and functions of the Registration Committee would be exercised;
- (ii) provision has been made for encouraging indigenous manufacturing;
- (iii) provision has also been made for promoting pesticides that are biological and based on traditional knowledge;
- (iv) while registering a pesticide, the Registration Committee apart from evaluating its safety and efficacy, would also be guided by factors like necessity, end use, risk involved and availability of safer alternatives;
- (v) fixation of maximum residue limits for pesticides have been made mandatory;
- (vi) provision has been made for review, suspension and cancellation of registration and ban on pesticides;
- (vii) the State Governments may prescribe qualifications for Licencing Officer, Pesticide Inspector and Pesticide Analyst to be appointed by them;
- (viii) provision has been made to constitute an authority to exercise such powers and perform such functions relating to regulating the price of pesticides;
- (ix) provision has been made for deemed revocation of licences in case of cancellation of registration of a pesticide;
- (x) the Central Government may, by notification, specify ordinary use pesticides in respect of which a licence to sell or stock will not be required;
- (xi) empowering the Central Government and the State Governments to accredit private laboratories to carry out any or all functions of a Pesticide Testing Laboratory on compliance of prescribed standards;
- (xii) offences have been categorised separately in terms of the degree of severity like 'punishment for obstruction', 'punishment on violations of conditions of registration and licensing', 'punishment for activities related to import and export of pesticides', 'punishment for activities involving unregistered and unlicensed pesticides', 'punishment for activities involving falsified pesticides', 'punishment for activities involving banned pesticides', 'punishment for causing hurt, grievous hurt or death', etc.;
- (xiii) to deter the subsequent offences, a provision has been made for imposing a fine of not less than twice the fine that was imposed at the time of the first conviction, in case of subsequent offences, irrespective of the maximum fine provided for such offence;
- (xiv) it has also been provided that if a person is convicted for third time or more for violations of conditions of registration and licencing, he shall be liable to imprisonment for a term extending up to one year;
- (xv) provision has been made to empower the Central Government to constitute a fund, inter alia, for making ex gratia payments to persons or their legal heirs, as the case may be, who have suffered hurt, grievous hurt or have died in the course of poisoning due to occupational exposure to pesticide;
- (xvi) to enable the Central Government to give directions to a State Government, the Central Pesticide Board and in case of exigency, to the Registration Committee for carrying out all or any of the provisions of the proposed legislation or rules made thereunder.

The Bill seeks to achieve the above objectives.

The Pesticide Management Bill 2020 was under assessment by the Parliamentary Standing Committee on Agriculture. The government had asked for public inputs. The Committee has recently submitted its report in December 2021

where it suggested several measures to further strengthen the Pesticide Management Bill, 2020 and to inculcate sufficient safety provisions for farmers and introduce a system of checks and balances against possible misuse of power by pesticide inspectors. Also, the Committee rejected the pesticides industry's demand on three key issues – price control, criminalization and data protection.

The bill was presented in Rajya Sabha in 2008 with an aim to upgrade the act of 1968. In 2017, the act was upgraded and presented as a draft. The bill was introduced by the Agriculture Minister in the Rajya Sabha in 2020.

The bill is expected to protect farmers from spurious brands and will promote pesticides that are biological in nature.

Central Insecticides Board and Registration Committee

All the provisions of the Insecticides Act were brought into force with effect from 1st August, 1971. In the Act and the Rules framed there under, there is compulsory registration of the pesticides at the central level and license for their manufacture, formulation and sale are dealt with at the state level. With the enforcement of the Insecticides Act in the country pesticides of very high quality are made available to the farmers and general public for household use, for protecting the agricultural crops from the ravages of their pests, humans from diseases and nuisance caused by public health pests and the health hazards involved in their use have been minimized to a great extent. For the effective enforcement of the Insecticides Act, the two bodies have been constituted at the Central level viz. Central Insecticides Board and Registration Committee.

Central Insecticides Board - established Under Section 4 of the Insecticides Act, 1968

Objectives

- a. The Central Insecticides Board advises the Central Government and State Governments on technical matters arising out of the administration of this Act and to carry out the other functions assigned to the Board by or under this Act.
- b. The matters on which the Board may advise includes:
 - the risk to human being or animals involved in the use of insecticides and the safety measures necessary to prevent such risk;
 - the manufacture, sale, storage, transport and distribution of insecticides with a view to ensure safety to human beings or animals.

Functions

- a. Advise the Central Government on the manufacture of insecticides under the Industries (Development and Regulation) Act, 1951 (65 of 1951).
- b. Specify the uses of the classification of insecticides on the basis of their toxicity as well as their being suitable for aerial application.
- c. Advise tolerance limits for insecticides residues and establishment of minimum intervals between the application of insecticides and harvest in respect of various commodities.
- d. Specify the shelf-life of insecticides.
- e. Suggest colorization, including coloring matter which may be mixed with concentrates of insecticides, particularly those of highly toxic nature.
- f. Carry out such other functions as are supplemental, incidental or consequential to any of the functions conferred by the Act or the Rules.

By laws have been framed for Central Insecticides Board. The by laws require Central Insecticides Board to meet at least once in 6 months.

Registration Committee - established under Section 5 of the Insecticides Act, 1968

Objectives

- a. To register insecticide after scrutinizing their formulae and verifying claims made by the importer or the manufacturer, as the case may be, as regards their efficacy and safety to human being and animals; and
- b. To perform such other functions as are assigned to it by or under this Act.

Functions

The Registration Committee shall, in addition to the functions assigned to it by the Act, perform the following functions, namely

- a. Specify the precautions to be taken against poisoning through the use or handling of insecticides
- b. Carry out such other incidental or consequential matters necessary for carrying out the functions assigned to it under the Act or these rules.

Registration Committee meets normally once in a month to transact its business. It meets fortnightly exclusively for registration for export, if required.

Proposal to ban Some Pesticides

The government considering the demands of nations that imports from India have banned certain pesticides to avoid the loss of exports from India. For example, pesticide residue problems affected the exports of Basmati rice to the European Union (EU) following strict rules imposed by the EU on usage of chemicals. Similarly, Saudi Arabia also insisted on tightening norms on the minimum residue levels of pesticides on Basmati rice imported from India. Punjab, which accounts for close to half of the exported rice from India, then announced a ban on the usage of 9 chemicals during the kharif season 2020.

The Union government also reviewed 66 contentious pesticides for their toxicity. While 18 of these were banned in 2018, the government, in January 2021, had appointed an expert panel to review the agrochemicals industry's objections to the proposed ban on 27 widely used pesticides.

The list of 18 pesticides that were banned in 2018 and the list of 27 pesticides for proposed ban is given below.

List of 18 Pesticides

S.No.	Pesticides	S.No.	Pesticides	S.No.	Pesticides
1	Alachlor	7	Fenthion	13	Sodium Cyanide
2	Benomyl	8	Linuron	14	Thiometon
3	Carbaryl	9	Methoxy Ethyl Mercury Chloride	15	Triazophos
4	Diazinon	10	Methyl Parathion	16	Tridemorph
5	Dichlorovos	11	Phorate	17	Trichlorfon
6	Fenarimol	12	Phosphamidon	18	Trifluralin

Source: Government notifications and releases

List of 27 Pesticides

S.No.	Pesticides	S.No.	Pesticides	S.No.	Pesticides
1	Acephate	10	Deltamethrin	19	Oxyfluorfen
2	Atrazine	11	Dicofol	20	Pendimethalin

S.No.	Pesticides	S.No.	Pesticides	S.No.	Pesticides
3	Benfuracarb	12	Dimethoate	21	Quinalphos
4	Butachlor	13	Dinocap	22	Sulfosulfuron
5	Captan	14	Diuron	23	Thiodicarb
6	Carbendazim	15	Malathion	24	Thiophanat emethyl
7	Carbofuran	16	Mancozeb	25	Thiram
8	Chlorpyrifos	17	Methomyl	26	Zineb
9	2,4-D	18	Monocrotophos	27	Ziram

Source: Government notifications and releases

5.15 Government Initiatives

Agriculture being a state subject, the State Government is primarily responsible for the growth and development of agriculture sector and developing perspective plans for their respective states and ensuring effective implementation of the programmes/schemes. However, Government of India supplements the efforts of the State Governments through various schemes / programmes. The details of various schemes, reforms and policies are given below:

- a) Unprecedented enhancement in budget allocation
- b) Fixing of MSP at one-and-a half times the cost of production
- c) Increase in procurement from farmers
- d) Income support to farmers through PM KISAN
- e) Pradhan Mantri Fasal BimaYojana (PMFBY)
- f) Institutional credit for agriculture sector
- g) Providing Soil Health Cards to farmers
- h) Promotion of organic farming in the country
- i) Neem Coating of Urea
- j) Agri Infrastructure Fund
- k) Promotion of FPOs Scheme
- l) National Bee and Honey Mission (NBHM)
- m) Pradhan Mantri Krishi Sinchai Yojana (PMKSY)
- n) Micro Irrigation Fund
- o) Agricultural Mechanization
- p) Changes in Disaster Relief Standards
- q) Setting up of E-NAM extension Platform
- r) Improvement in farm produce logistics, Introduction of Kisan Rail
- s) Creation of a Start-up Eco system in agriculture and allied sector

Government has taken several steps for increasing investment in agriculture sector such as enhanced institutional credit to farmers; promotion of scientific warehousing infrastructure for increasing shelf life of agricultural produce; setting up of Agri-tech Infrastructure Fund for making farming competitive and profitable; developing commercial organic farming etc.

Government is implementing various schemes for supply of farm inputs, like seeds, fertilizers, agricultural machinery and equipments, irrigation facilities, institutional credit, etc., at subsidized rates to the farmers in the country. Government has recently taken several steps for increasing investment and growth in agriculture sector which include creation of Long-Term Irrigation Fund (LTIF), Micro Irrigation Fund for water use efficiency, promotion of commercial organic farming, etc. The details of such major schemes /steps are given below.

Government of India has launched the Central Sector Scheme of financing facility under Agriculture Infrastructure Fund (AIF) to boost Agriculture Infrastructure relating to post harvest management and community farming assets. Under this scheme entities such as farmers, agri entrepreneurs, starts up, Central/ State agency or local body sponsored public private partnership projects etc. can take benefit for setting up eligible infrastructure projects.

Some of the schemes are:

- Rashtriya Krishi Vikas Yojana (RKVY)
- Mission for Integrated Development of Horticulture (MIDH)
- Pradhan Mantri Kisan Samman Nidhi (PM-KISAN) Scheme

5.16 Overview of Bio-Pesticides Industry

The biopesticides sector comprises products based on microorganisms, biochemicals extracted from biological sources, macrobials (largely invertebrates) used for pest control. It is usually applied in a manner similar to chemical pesticides, but achieve pest management in an environment friendly way.

Bio-pesticides cover a wide spectrum of potential products and they can be classified as follows:

- Microbial pesticides and other entomopathogens:

These are pesticides that contain microorganisms like bacteria, fungi or virus which attacks specific pest species. Although most of these agents attack insect species (called entomopathogens; products referred to as bioinsecticides), there are also microorganisms (i.e. fungi) that controls weeds (bioherbicides).

- Plant-incorporated protectants:

These include pesticidal substances that are produced in genetically modified plants or organisms i.e. through the genetic material that has been incorporated into the plant.

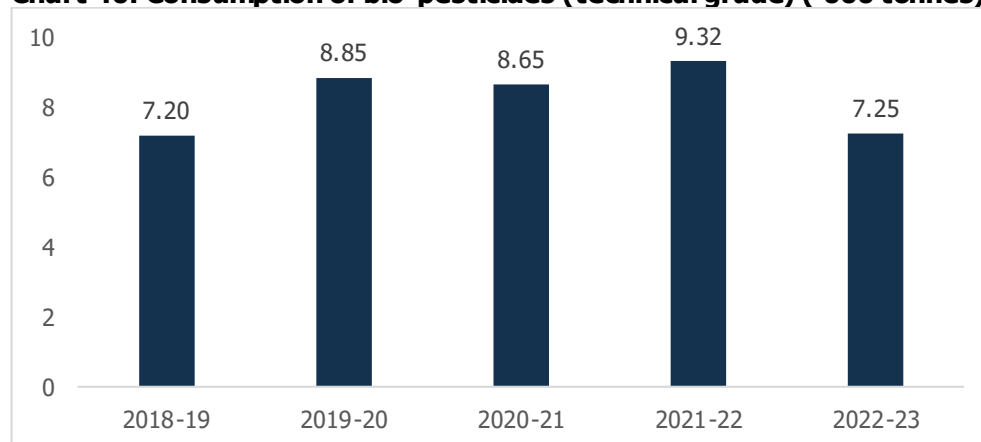
- Biochemical pesticides:

These pesticides work in contrast to chemical pesticides that contain synthetic molecules which directly kill the pest. Biochemical pesticides are based on naturally occurring substances that control pests by non-toxic mechanism. They fall into different biologically functional classes including plant extracts and natural insect growth regulators.

Increasing the adoption rate of organic cultivation in India is a major driving factor for the biopesticide industry in India. Along with this, increasing food safety awareness among the households, coupled with rising environmental issues, the Government of India has banned certain chemical ingredients used in pesticides which has further augmented the growth of biopesticides.

Over the five-year period 2018-19 to 2022-23, the domestic consumption of bio-pesticides grew marginally from 7.2 thousand tonnes in 2018-19 to 7.25 thousand tonnes in 2022-23, driven by increasing adoption of organic way of farming.

Chart 40: Consumption of bio-pesticides (technical grade) ('000 tonnes)



Source: Directorate of Plant Protection, Quarantine & Storage

Some of the advantages of bio-pesticides are:

- Biopesticides are made of organic products, they don't possess fatal properties and are easily degradable thus do not affect the plant adversely.
- They're pest specific and kill only one or two species of pest at a time.
- It is pocket friendly and a little amount of biopesticide is enough for application of large fields.
- Biopesticide is a better option as all the components are natural and plant digestible. Even the plants benefit from the nutrients of pesticides.

Some of the disadvantages of bio-pesticides are:

- Compared to conventional pesticides, biopesticides have a slower rate of control and often a lower efficacy and shorter persistence.
- Bio-pesticides also have a greater susceptibility to adverse environmental conditions.
- Biopesticides are not as robust as conventional pesticides and they also require a greater level of knowledge to use them effectively.

6 Competitive Landscape

Nova Agri Tech Limited

Nova Agritech Limited is an agri-input manufacturing company established in 2007 which offers soil health management, crop nutrition and crop protection products focused on tech-based farmer driven solution approach, wherein mainly offer ecologically sustainable and nutritionally balanced products based on extensive R&D.

The company has a dealer network comprising of approximately 11,722 dealers out of which approximately 6,769 dealers are active to whom Nova has distributed and sold its products during the current financial year. Nova's dealer network is currently spread across 16 states of India and 02 dealers in Nepal. Nova has also entered into marketing, distribution and supply agreements with certain third parties in Bangladesh, Sri Lanka and Vietnam and is currently awaiting the necessary permission to start business in these jurisdictions.

They also do bulk sales to various companies as a part of institutional business. They manufacture a wide range of product categories consisting of soil health management products such as organic fertilizers, bio fertilizers and soil conditioners; crop nutrition products such as micronutrient fertilizers, beneficial element fertilizers, straight nitrogen fertilizers, straight potash fertilizers and 100% water soluble NPK fertilizer; and crop protection products such as insecticides, fungicides, herbicides and plant growth regulator.

As on November 2023, the company has received a total of 720 product registrations comprising of 7 registrations in the soil health management category, 176 registrations in the crop nutrition category, 4 registrations in bio pesticide category, 7 products under technical indigenous manufacture and 526 registrations in the crop protection category. All of the 526 registrations in the crop protection category are in the name of Nova Agrisciences Pvt Limited.

The company has won several awards for technical innovation and outstanding performance in the Agri Inputs industry and has many firsts in the field of bio stimulants, micronutrients and organic inputs. Nova Agritech Limited has obtained 36 trademarks registrations for its products in India while NASPL has obtained 118 trademarks.

The company has a dedicated in-house Research and Development ("R&D") facility and a Quality Control / Quality Assurance facility at its manufacturing facilities to support technology transfer for new products and on-site process improvement.

Nova has been recognized as 'Best Emerging Novel Nutrient Company' towards its passion in development and offering of unique specialty grades of organic fertilizers (OM-K), biofertilizers (UNISTRICKER), beneficial elements fertilizers and customized grades of 100% water soluble NPK mixtures (NOVA GOOGLEY), etc.

Nova has entered into a MOU with Io Tech World Avigation Private Limited for the purpose of manufacturing and supply of Agribot drones. This is a Directorate General of Civil Aviation (DGCA)-approved agricultural drone and it is also QCI (Quality Council of India) certified. This drone technology is developed to cater to the farmers and reduce their burden. Drones can help farmers to optimize the use of inputs (seed, fertilizers, water), to react more quickly to threats (weeds, pests, fungi), to save time crop scouting (validate treatment/actions taken), to improve variable-rate prescriptions in real time and estimate yield from a field. The Group also has a lightweight soil fertility testing device (Bhu-Parikshak).

One of the initiatives taken by the company is development of the Nova Kisan Seva Kendram (NKSK). It started in 2010, named as Nova Rythu Seva Kendram in 2011 and established as Nova Kisan Seva Kendra in 2018. NKSK took shape for proper dissemination of agricultural information from 'source' to 'utility' point effectively.

The aim of NKSK is to create a bridge between point of research to farmer fields to attain its objective of generating revenue by adding more satisfied loyal customers by providing need-based solutions with production, technologies and usage skills.

- NKSK structure consists of 24 NKSK Co-ordinators, 96 Kisan Mithras and 142 Kisan Sevaks and the hierarchy of the system is as follows:



- NKS Co-ordinators are trained agri graduates and their role is to provide information about product, help in identifying the problem, support kisan sevak and kisan mithr, work with technical team and content writers for solutions and recommendations and lastly share the data with kisan mitra and on social media.
- The NKS coordinators are mostly females who have a degree in agriculture. Kisan Mithras are agriculture graduates who have an understanding about crop deficiencies and products, whereas kisan sevaks work closely with the farmers in providing solutions.
- The kisan sevak meets the farmer, understands the problem and feeds it into the system. The problem is then identified and worked upon to provide a solution. After the solution is provided, it is checked if there is any scope for improvement. Lastly, feedback is taken for the solution provided and if the problem is still persistent, the issue is addressed again.
- The network reach of NKS is as follows:
 - Total countries covered: 2
 - Total states covered: 16
 - Total districts covered: 224
 - Total crops covered: 129
- The company has a dedicated Facebook and Instagram page and also operate a dedicated YouTube channel, NOVA AGRI TECH, wherein it showcases videos regarding its products. It currently has approximately 10,000 subscribers for YouTube channel.
- NKS has got more than 19.25 lakh farmer's database and contacts around 100 to 150 farmers on daily basis.
- As of March 2023, number of new product trainings provided are 34, number of crop training provided to dealers and farmers are 18 and 596 respectively. And as on November 2023, the company has 283 employees working with them.
- As of H1FY24, Nova group's net worth is Rs. 7,423 lakhs.

Nova Agri Tech Limited (Consolidated)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	16,058	18,556	21,056	10,322
y-o-y % change	26.9	15.6	13.5	NA
Operating margin (PBIDTM) (in %)	11.3	14.9	18.6	18.8
Net margin (in %)	3.9	7.3	9.7	10.1
Total debt (Rs. lakh)	5,110	6,427	7,096	6,852
Return on Capital Employed ¹ (ROCE) (in %)	38.0	20.3	48.7	22.4
Interest coverage (in times)	2.5	3.9	4.6	4.5
Net Worth (Rs. lakh)	2942.0	4319.0	6,387.9	7,423.2
Return on Equity ² (in %)	24.0	37.7	32.1	14.0

Source: CareEdge Research

Note: FY indicates financial year which is April to March

Key Players

1. Aries Agro Limited

Aries Agro Ltd was founded by Dr. T. B. Mirchandani and Mrs. Bala Mirchandani in 1969. The business of the company is manufacturing of micronutrients and other customized nutritional products for plants and animals. They started the business by manufacturing a small range of mineral feed additives for animals & birds and then diversified into mineral additives for the agriculture use.

In 1975, they diversified into nutrients for plants. They had in-house expertise in the area of mineral nutrition and hence conducted research on compounds that could deliver mineral nutrients to plants more efficiently. This research identified "Metal Chelates".

Through in-house R&D efforts, the Company branched out into Agrochemicals in 1975 with the introduction of Chelated Micronutrients. They pioneered the concept of Chelates in India with the introduction of "Agromin", a micronutrient fertilizer in the year 1975.

The company's plants are presently located at Bangalore, Mumbai, Hyderabad, Kolkata, Chattral and Lucknow, Raipur, Fujairah, UAE (Associate company). The company has a total installed capacity of 95,400 MT in India and the total capacity utilization stood at 71.43%.

¹ Return on Capital Employed (ROCE) formula: Operating profit (PBIDT)/ Capital Employed

² Return on Equity (ROE) formula: Net Profit/ Net Worth

Aries Agro Limited (Consolidated)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	47,451	43,237	47,223	33,970
y-o-y % change	27.7	-8.9	9.2	NA
Operating margin (PBIDTM) (in %)	12.0	11.7	12.0	12.4
Net margin (in %)	4.8	3.0	3.4	5.0
Total debt (Rs. lakh)	13,460	10,590	9,554	15,255
Return on Capital Employed (ROCE) (in %)	25.6	20.9	21.4	14.8
Interest coverage (in times)	2.2	1.0	2.4	3.2
Net Worth (Rs. lakh)	19,052	22,424	24,285	25,944
Return on Equity (in %)	11.9	5.8	6.6	6.5

Source: CareEdge Research

2. Aimco Pesticides Limited

AIMCO – An abbreviation for 'All India Medical Corporation', is a Global Entity which has its roots in the agrochemicals industry. The company is in the field of agrochemical manufacturing, formulations and marketing. The company is into the business of herbicides like triclopyr, atrazine, insecticides like fipronil, chlorpyrifos, imidacloprid, emamectin benzoate, fungicides like hexaconazole, difenoconazole among others. It also operates in business of combinations, rodenticides and fumigant, plant growth regulators.

The company has presence across 42 plus countries and exports accounted for around 58% of the sales during FY21. The company has manufacturing facility located at Lote Parshuram. In FY23, the company significantly elevated its technical-grade manufacturing capacity from 4,500 TPA to 6,000 TPA.

Aimco Pesticides Limited				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	17,569	31,199	20,619	12,639
y-o-y % change	-5.2	77.6	-33.9	NA
Operating margin (PBIDTM) (in %)	5.6	6.0	1.6	7.8
Net margin (in %)	1.2	3.4	-1.1	-3.6
Total debt (Rs. lakh)	1,037	1.3	1,262	1,863
Return on Capital Employed (ROCE) (in %)	22.8	37.1	7.0	23.0
Interest coverage (in times)	2.2	12.7	1.3	6.2
Net Worth (Rs. lakh)	4080.4	5048.9	4,628.3	4,046.6
Return on Equity (in %)	5.1	21.1	-4.7	-11.3

Source: CareEdge Research

3. Basant Agrotech Limited

Basant Agrotech Limited is a part of 130-year-old 'Bhartia Group' of Akola, Maharashtra. They have a multi-product portfolio which involves various grades of fertilizers, seeds, agriculture plastics, organic products and they have also recently ventured into chemicals.

They are a leading supplier of SSP in Maharashtra and are one of the largest seed processors in India. The major types of fertilizers manufactured by them are NPK granulated mixed fertilizers and Single Super Phosphate. They have 6 manufacturing plants of fertilizers namely in Akola, Sangli, Jalgaon, Hospet, Neemuch, Madhya Pradesh, Karnataka.

Basant Agrotech Limited (Standalone)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	32,298	44,815	54,926	23,248
y-o-y % change	13.0	38.8	22.6	NA
Operating margin (PBIDTM) (in %)	5.7	6.8	6.7	5.4
Net margin (in %)	2.7	4.2	3.3	-0.7
Total debt (Rs. lakh)	3,267	7,209	12,388	14,871
Return on Capital Employed (ROCE) (in %)	12.2	17.7	18.4	6.3
Interest coverage (in times)	4.6	5.1	3.5	1.7
Return on Equity (ROE) (in %)	6.5	12.4	10.8	-1.0
Net Worth (Rs. lakh)	13,484	15,328	17,094	16,921

Source: CareEdge Research

4. Best Agrolife Limited

Incorporated in 1992, Best Agrolife Ltd. has been servicing the agrochemical industry of India and international markets, with its niche product offerings. The company has a wide range of product offerings starting from technicals, intermediates & novel formulations in the form of insecticides, herbicides, fungicides, plant-growth regulators, and public health products. The company's products are accessible in 30 plus countries across the globe and pan-India.

The company manufactures fungicides like azoxystrobin TC, picoxystrobin TC, validamycin TC, insecticides like diflubenzuron TC, ethion TC, herbicides like pinoxaden TC, metribuzin TC, plant growth regulators like forchlorfenuron (CPPU) TC, paclobutrazol TC. The company's manufacturing units are located at Gajraula in Uttar Pradesh and Jammu in Jammu & Kashmir. They have about 7,000 MTPA technical manufacturing capacity and 30,000 MTPA formulations manufacturing capacity. The company has a formulation, research & development centre at Greater Noida.

Best Agrolife Limited (Standalone)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	90,544	1,13,427	1,49,996	1,34,628
y-o-y % change	31.2	25.3	32.2	NA
Operating margin (PBIDTM) (in %)	6.5	11.5	6.4	6.2
Net margin (in %)	4.1	7.7	3.1	3.4
Total debt (Rs. lakh)	2,663	13,121	27,900	32,655
Return on Capital Employed (ROCE) (in %)	44.1	41.6	26.1	20.6
Interest coverage (in times)	12.3	12.3	4.0	4.5
Return on Equity (ROE) (in %)	28.6	27.9	13.1	11.6
Net Worth (Rs. lakh)	12,966	31,230	35,949	39,855

Source: CareEdge Research

5. Bhagiradha Chemicals & Industries Ltd

Bhagiradha Chemicals & Industries Limited (BCIL) is a professionally organized public limited company based at Hyderabad, India and dedicated to the manufacture of high-quality pesticides that includes various technical grade of insecticides, herbicides and fungicides. The company is also capable of manufacturing liquid and powder formulations using their technical grade pesticides conforming to international standards. Also, the company manufactures specialty intermediates.

The company is one of the leading manufacturers of azoxystrobin (fungicide) and fipronil (insecticide) and is engaged in the manufacturing of products such as chlorpyrifos, triclopyr, imidacloprid, diafenthiuron and

others. BCIL's manufacturing unit is located near the eastern coastal town of Ongole with three production blocks, 300 kms north of Chennai. They have a production capacity of 3,250 MT. They have also commenced the construction of subsidiary's plant at Kadechur, Karnataka. Exports account for about 50% of the company's sales in general.

Bhagiradha Chemicals & Industries Ltd (Consolidated)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net sales (Rs. lakhs)	31,789	43,566	50,209	22,202
y-o-y % change	29.4	37.0	15.2	NA
Operating margin (PBIDTM) (in %)	15.0	15.9	15.9	9.8
Net margin (in %)	7.4	8.2	9.0	3.8
Total debt (Rs. lakhs)	6,224	8,054	4,997	8,042
Return on Capital Employed (ROCE) (in %)	27.2	34.6	24.0	6.4
Interest coverage (in times)	4.8	6.6	15.9	5.4
Return on Equity (ROE) (in %)	15.1	18.9	14.4	2.7
Net Worth (Rs. lakhs)	15,583	18,987	31,325	31,803

Source: CareEdge Research

6. Heranba Industries Limited

Heranba Industries Ltd offers a wide range of technicals, intermediates, formulations and public health products. The segments covered by the company includes insecticides, herbicides, fungicides, plant growth which offers deltamethrin, profenophos, temephos, metribuzin, hexaconazole etc. The company has four independent manufacturing facilities located at Vapi in Gujarat. Two of these units are involved in production of various technicals and intermediates, while the third plant is purely a formulation and packing facility. They have aggregate capacity of 16,224 MTPA across plants. Exports accounted around 48% of the company's revenues in the past three years.

Heranba Industries Ltd. (Standalone)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net sales (Rs. lakh)	1,21,865	1,45,037	1,32,438	71,175
y-o-y % change	28.1	19.0	-8.7	NA
Operating margin (PBIDTM) (in %)	18.7	19.2	13.2	8.7
Net margin (in %)	12.7	13.0	8.3	4.8
Total debt (Rs. lakh)	5,028	5,233	8,901	8,384
Return on Capital Employed (ROCE) (in %)	43.2	39.1	21.4	7.3
Interest coverage (in times)	42.3	68.4	22.0	14.1
Return on Equity (ROE) (in %)	29.2	26.5	13.5	4.0
Net Worth (Rs. lakhs)	52,813	71,445	81,611	84,523

Source: CareEdge Research

7. India Pesticides Limited

India Pesticides have diversified into manufacturing herbicide and fungicide technical and Active Pharmaceutical Ingredients (API). It offers technical/APIs such as thiocarbamate, folpet, cymoxanil, captan etc. The company has two complexes at Industrial area of Uttar Pradesh State Industrial Development Corporation (UPSIDC) on outskirts of Lucknow city. The sites are equipped with facilities to manufacture both technical and formulations such as WDG, EC, WP, SL, SC etc. for domestic as well as international markets in small and bulk packing. The company has manufacturing capabilities of 30,900 KLPA and 1,21,320 MTPA which consists of granules, powder

and active ingredient and bulk. The company had earned about 57% of the revenues from export market during FY21.

India Pesticides Ltd. (Standalone)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net sales (Rs. lakh)	64,895	71,614	88,493	40,341
Net sales (y-o-y % change)	35.3	10.4	23.6	NA
Operating margin (PBIDTM) (in %)	29.2	31.7	23.8	14.3
Net margin (in %)	20.7	22.1	16.2	8.9
Total debt (Rs. lakh)	3,030	1,435	359	755
Return on Capital Employed (ROCE) (in %)	47.7	35.4	27.1	7.2
Interest coverage (in times)	55.2	34.8	29.4	29.8
Return on Equity (ROE) (in %)	34.5	24.8	18.5	4.5
Net Worth (Rs. lakhs)	38,949	63,837	77,501	80,229

Source: CareEdge Research

8. Madras Fertilizers Limited

Madras Fertilizers Limited was incorporated on December 8, 1996 and is a joint venture between Government of India and AMOCO in accordance with the Fertilizer Formation Agreement and the equity contributions are 51% and 49% respectively.

The company is engaged in manufacture of ammonia, urea, complex fertilizers and biofertilizers. They have their plant facilities and headquarters located across 329 acres of freehold land in Manali, about 20km north of Chennai city. The capacity utilisation of plants is at 106.8% and 2.7% for urea and NPK plants respectively.

Madras Fertilizers Limited (Standalone)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	1,53,279	2,30,216	3,44,709	91,389
y-o-y % change	18.6	50.2	49.7	NA
Operating margin (PBIDTM) (in %)	9.1	11.7	9.8	7.6
Net margin (in %)	0.2	7.0	5.4	-3.4
Total debt (Rs. lakh)	1,37,578	1,73,490	1,49,407	1,40,252
Return on Capital Employed (ROCE) (in %)	-20.1	-53.2	-117.2	-30.4
Interest coverage (in times)	1.3	2.7	4.3	2.1
Return on Equity (ROE) (in %)	-0.4	-32.1	-64.6	13.6
Net Worth (Rs. lakhs)	-69,523	-50,539	-28,707	-22,814

Source: CareEdge Research

9. Dharmaj Crop Guard Limited

Dharmaj Crop Guard offers a full-suite range of products that includes a wide array of agrochemicals like insecticides, herbicides, fumigants, fungicides, plant growth regulators, rodenticides, and others. The products offered involves fipronil 40% + imidacloprid 40% WG, hexaconazole 5% SC, pendimethalin 38.7% CS, amino acid liquid, boron 20% among others. The company business verticals include (a) Domestic Institutional sales of agro chemicals: (b) Exports: (c) Branded Products and (d) Public Health.

Manufacturing Plant of the company is located in Gujarat which have received quality control certifications ISO 9001:2015, ISO 14001:2015 and ISO 45001:2018 for development and manufacturing of agrochemical formulations. Company is having their Laboratory accredited from National Accreditation Board for Testing and Calibration Laboratories ("NABL") and in-house R&D facility. The company is rapidly growing its sales network across India as well as in overseas market and is continuously investing in expanding its manufacturing capability.

Dharmaj Crop Guard Limited (Standalone)				
Financial indicators	FY21	FY22	FY23	H1FY24
Net Sales (Rs. lakh)	29,800	38,800	52,700	41,500
y-o-y % change	54.4	30.2	35.8	NA
Operating margin (PBITM) (in %)	10.7	12.1	9.7	12.8
Net margin (in %)	7.0	7.5	6.3	9.2
Total debt (Rs. lakh)	2,692	3,693	5,240	7,190
Return on Capital Employed (ROCE) (in %)	42.6	42.6	14.4	13.0
Interest coverage (in times)	32.0	15.7	25.5	48.1
Return on Equity (ROE) (in %)	37.3	34.2	10.3	10.6
Net Worth (Rs. lakhs)	5,635	8,492	32,143	35,897

Source: CareEdge Research

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