Assessment of the Global & Domestic Agrochemicals Market

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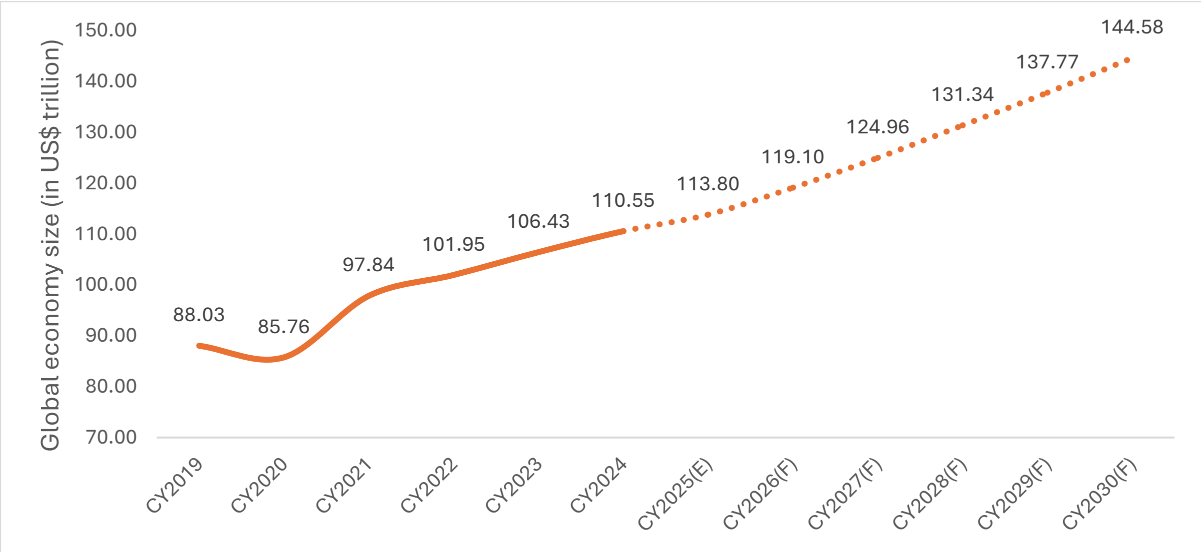
Contents

1. Global economic overview

As per the International Monetary Fund (IMF), the size of global economy was projected to reach USD 113.8 trillion in CY2025 (in nominal terms) and continue to grow to USD 144.6 trillion in CY2030 (in nominal terms) at a CAGR of ~5%. Despite multiple Global challenges, economic activity at the global level has remained broadly resilient with growth in employment and steady income levels, favourable demand and supply developments, utilization of substantial savings accumulated during the pandemic and healthy household consumption supported major economies to maintain their growth. Sectors like healthcare, technology, logistics and services have particularly supported jobs and wage growth. At present, as the inflation is approaching towards targeted levels of major advance economies, their central banks have begun to pivot towards policy easing.

Chart 1: Global economy growth and prediction till CY2030 (in US$ trillion- nominal terms)



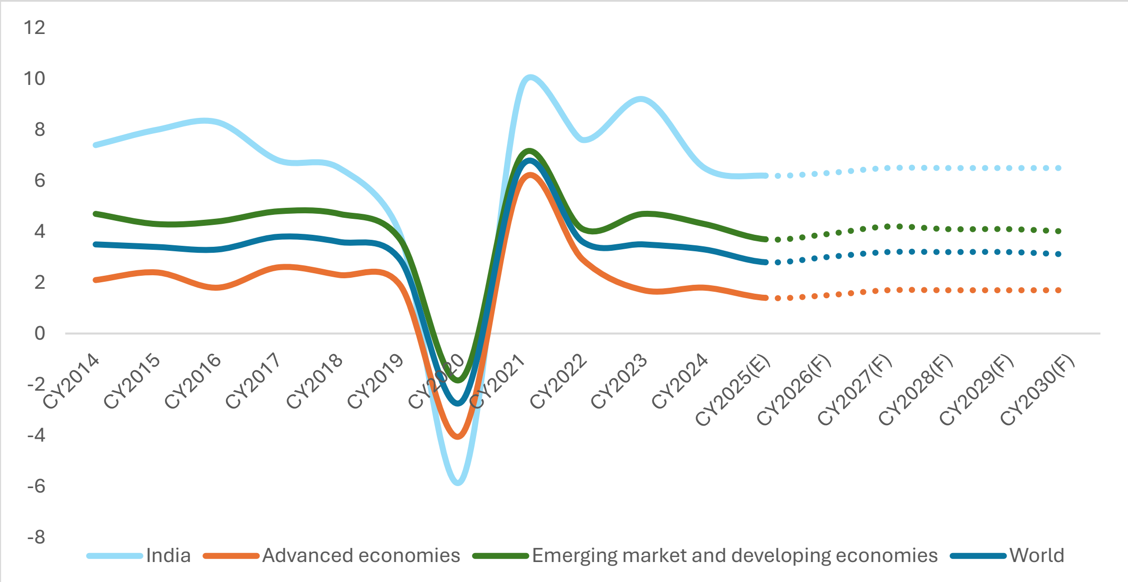
Source: IMF, ICRA Analytics
Note: F-Forecasted; data from CY2026-2030 are forecasted

As per the IMF, World Economic Outlook published in April 2025, the Global growth was anticipated to decrease from an estimated 3.3% in CY2024 to 2.8% in CY2025, subsequently rebounding to a modest 3% in CY2026 as inflation continues to ease, real incomes recover, and financial conditions gradually normalize. The reductions are widespread across nations and largely stem from the direct impacts of the recent trade policies, as well as their indirect consequences through trade linkages, increased uncertainty, and declining sentiment. Tariffs' short-term effects on economic growth vary by country, shaped by trade relationships, industry structures, policies, and trade diversification potential. Fiscal support in some cases (for example, China, euro area) offsets some negative growth impacts. The global inflation rate is predicted to decrease from an annual average of 6.6% in CY2023, 5.7% in CY2024 to 4.3% in CY2025 and further to 3.6% in CY2026. .

Tariffs and tariff-related issues influence the global agrochemicals sector by affecting both cost structures and trade flows. Many agrochemicals rely on globally dispersed supply chains for raw materials, intermediates, and finished products; hence, tariff impositions on key inputs such as technical-grade chemicals or solvents can inflate production costs and reduce competitiveness. Conversely, high import duties on finished agrochemicals in certain regions protect domestic manufacturers but restrict market access for global players, often leading to price distortions and inefficiencies. Trade disputes, non-tariff barriers, and sudden regulatory-driven tariff adjustments further create uncertainty, disrupting procurement strategies and inventory planning for agrochemical companies. Over time, persistent tariff challenges encourage shifts in sourcing, greater localization of production, and in some cases, consolidation in the industry as firms seek to mitigate cost and supply risks while maintaining market reach.

1.1 Global Economies and Growth Trend:

Chart 2: Real GDP growth rate (annual % change) of India and other economies



Source: International Monetary Fund (IMF), ICRA Analytics
Note: F-Forecasted; data from CY2025-2030 are forecasted

Table 1: India v/s Other Economies (Real GDP, Y-o-Y % change)

Real GDP growth (Annual % change)	CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CY 2024	CY 2025(E)	CY 2026(F)	CY 2027(F)	CY 2028(F)	CY 2029(F)	CY 2030(F)
India	6.5	3.9	-5.8	9.7	7.6	9.2	6.5	6.2	6.3	6.5	6.5	6.5	6.5
Advanced economies	2.3	1.9	-4	6	2.9	1.7	1.8	1.4	1.5	1.7	1.7	1.7	1.7
Emerging market and developing economies	4.7	3.7	-1.8	7	4.1	4.7	4.3	3.7	3.9	4.2	4.1	4.1	4
World	3.6	2.9	-2.7	6.6	3.6	3.5	3.3	2.8	3	3.2	3.2	3.2	3.1

Source: IMF, ICRA Analytics
Note: F- Forecasted; data from CY2025-2030 are forecasted, Advanced Economies includes United States, Germany, France, Japan, United Kingdoms, Canada and other developed countries. Emerging market and developing economies includes India, China, Saudia Arabia, Mexico, Vietnam and other developing economies

The global real GDP growth was ~3.3% in CY2024 and was anticipated to decrease to 2.8% in CY2025 and 3% in CY2026. The rapid increase in trade tensions and exceptionally high levels of policy uncertainty are anticipated to considerably affect global economic activity. The growth is projected to remain steady at around ~3.1% from thereon till CY2030, wherein growth would be driven mainly by easing of monetary policy and strong private consumption.

Growth trend in Advanced Economies

Meanwhile, the real GDP growth rate for advanced economies was ~1.8% in CY2024 and is expected at ~1.4% in CY2025. It is further expected to increase to ~1.5% in CY2026, and continue to grow at a stable rate, reaching around 1.7% in CY2030. United States of America's (USA) real GDP was ~2.8% in CY2024 and is expected to decrease at ~1.8% in CY2025 due to increased policy ambiguity, trade conflicts, and weakened demand momentum. It is further expected to decrease to ~1.7% in CY2026, and post that continue to grow at a stable rate, reaching around 2.0% in CY2027 and 2.1% from thereon till CY2030.

The European region recovered from a low GDP growth rate of 0.4% in CY2023 to 0.9% in CY2024 however is expected to grow at a slower pace at 0.8% in CY2025 and further increase to 1.2% in CY2026. Amongst the Euro region- France, Italy and Spain's GDP growth grew at the rate of 1.1%, 0.7% and 3.2% respectively and is expected to grow at ~0.6%, ~0.4% and ~2.5% respectively during CY2025. However, Germany has witnessed a degrowth during CY2024 at -0.2% while the same is expected to remain stable during CY2025.

China real GDP was 3% in CY 2022 due to Covid disruptions, regained momentum in CY 2023 to 5.2%. The momentum weakened in CY 2024 to 4.6% due to slowing exports and investments and is expected to decrease to 4.1% due to structural slowdown in CY 2025. It is further expected to decrease and stabilize at 4% till CY 2030.

Among other advanced economies, the United Kingdom witnessed a real GDP growth rate of ~0.4% in CY2023 and increased to ~1.1% in CY2024 and is expected to remain stable at ~1.1% in CY2025.

Growth trend in emerging market and developing economies

Real GDP stood at 4.3% in CY2024 and the growth in real GDP rate is projected to drop to 3.7% in CY2025 and 3.9% in CY2026 with significant downgrades for countries affected most by recent trade measures and tariff pressures has eroded export competitiveness across several Asian economies. While domestic demand remains a partial buffer, export led growth models are under pressure particularly for ASEAN economies closely tied to global value chains. Growth in emerging and developing Asian economies is expected to decline from ~5.3% in CY2024 to ~4.5% by CY2025

Coming to Sub-Saharan Africa, the GDP grew at a healthy rate of 4% during CY2024 and is expected to grow at a rate of 3.8% during CY2025, but the region's demographic advantage and rising consumption provide strong foundation for future expansion. Amongst Sub-Saharan African region, South Africa and Nigeria's the continent's two largest economies, GDP grew at a rate of 0.6% and 3.4% respectively during CY2024 and is projected to grow at the rate of ~1% and ~3% respectively during CY2025.

On the other hand, growth in emerging and developing European economies was at ~3.4% in CY2024 and projected to decrease to ~2.1% in CY2025. In Latin America and the Caribbean, the real GDP growth rate is expected to decrease from ~2.4% in CY2024 to ~2% in CY2025 before rising again to ~2.4% during in CY2026.

Growth trend in India

India is the fastest growing economy globally, witnessing a rise in real GDP growth rate from ~7.6% in CY2022 to ~9.2% in CY2023 however increased at a comparatively steady rate at 6.5% in CY2024, because pent-up demand accumulated during the pandemic has been exhausted, as the economy reconnects with its potential. The country is projected to grow by ~6.2% in CY2025 and ~6.3% in CY2026 as per IMF, supported by private consumption, particularly in rural areas and investment momentum, but is 0.3% lower on account of higher levels of trade tensions and global uncertainty. This is expected to remain steady with forecasts till CY2030 showing a continued growth of ~6.5% supported by reforms, infrastructure and demographic strength.

1.2 Shift in global manufacturing destination preference

For decades, China has been the world's dominant manufacturing centre especially since the late 1970s and 1980s due to its economic reforms that opened the country to foreign direct investments (FDIs). However, in the recent past, there has been a shift in the global landscape that led companies to revaluate their risk, supply chain strategies and explore alternative production locations outside China. Some of the factors driving the shift from China are:

- Rising labour costs
- Geopolitical tensions- the ongoing trade war between United States and China
- Intellectual property protection concerns and trade barriers

Other countries including India, Vietnam and Mexico are emerging as top manufacturing hubs as more companies are opting for supply chain diversifications. Some of the factors driving the shift towards these destinations are:

- Competitive cost structures
- Large labour pools
- Strategic locations
- Growing scale and capabilities across industries
- Favourable government incentives
- Stable political environment

India, being the fastest growing economy globally, has been able to attract significant foreign direct investments from various companies. The Indian government's Make in India" and Production Linked Incentive (PLI) schemes for various sectors provide significant fiscal incentives for setting up of manufacturing operations.

'Make in India' initiative launched in September 2014, focuses on the growth of manufacturing sector by making India an integral part of the supply chain. India has encouraged FDIs from various countries across different sectors, thereby attracting investments through ease of doing business.

Production Linked Initiative (PLI) scheme focuses on amplifying the domestic manufacturing capabilities and exports. The scheme provides a capital outlay to 14 different sectors which boosts the investments and thereby creating additional production and employments in the specific sectors.

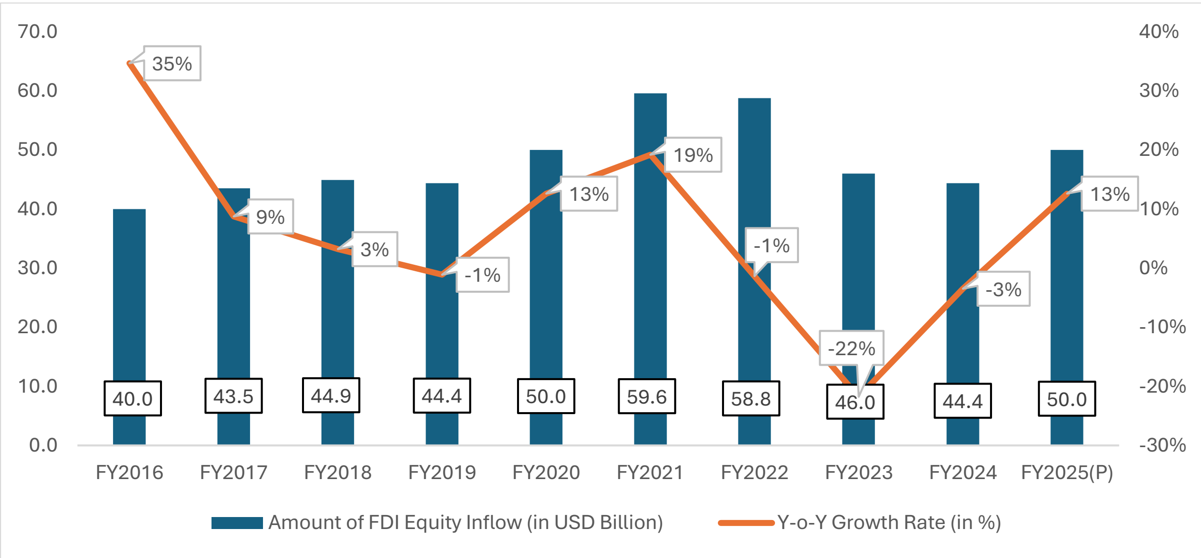
Mexico is emerging as another alternative, with strong intellectual property protections thereby mitigating technology theft risks. It also has skilled workers with extensive experience in automotive, aerospace, and electronics manufacturing.

Vietnam, on the other hand, offers lower labour costs, a strategic location, strong government support with favourable business environment and growing capacity in various industries.

Brazil has been investing in various infrastructural projects, thereby boosting its economy. This ensures improvement in transport and logistics, better productivity and strengthened competitiveness. Brazil has a lucrative consumer market of more than 200 million people thereby making it one of the largest economies in Latin America. This encourages international industries to consider and expand into the Brazilian market.

Various other South American and Southeast Asian countries are also emerging as viable options for companies looking for production locations outside of China. Countries like Philippines, Bangladesh, Brazil, Argentina, Bolivia, Indonesia, Malaysia, Thailand have their unique advantages that make them viable options in the new global manufacturing landscape.

Chart 3: Amount of FDI Equity inflow in India and y-o-y growth over the past ten years



Source: Department for Promotion of Industry and Internal Trade (DPIIT), RBI, ICRA Analytics.
Note: P-Provisional data

In the recent years, 'China+1' and 'Europe+1' strategy, has been implemented by various global manufacturing giants to diversify their risks and achieve supply chain resistance against global geopolitical disruptions. Europe is at the brink of recession driven by factors such as Germany's negative annual growth rate, rising energy prices and highest inflation recorded in 25 years, while the Chinese economy experienced a slow recovery after the pandemic. The ongoing trade war of China with United States has also created opportunities for other emerging economies to rise as viable alternatives in the global manufacturing landscape.

As per the World Bank chief, India is one of the key beneficiaries of the 'China+1' and 'Europe+1' strategy and has the opportunity to draw investments for the next 3-5 years. It has been able to attract global manufacturers for setting up production bases in the domestic market.

- Indian government is working on various infrastructure programs including projects like the Bharatmala highway programme, the Sagarmala project for port-led development and the Smart Cities Mission to transform the country's landscape and boost growth and competitiveness.
- PLI Scheme introduced by the Indian government with an initial capital outlay of Rs. 1.97 lakh crore (over $ 26 billion) across 14 sectors. It encourages production, employment,

economic growth, and exports in India. It provides incentives to the companies for promoting domestic production and thus accelerating India’s manufacturing investments.

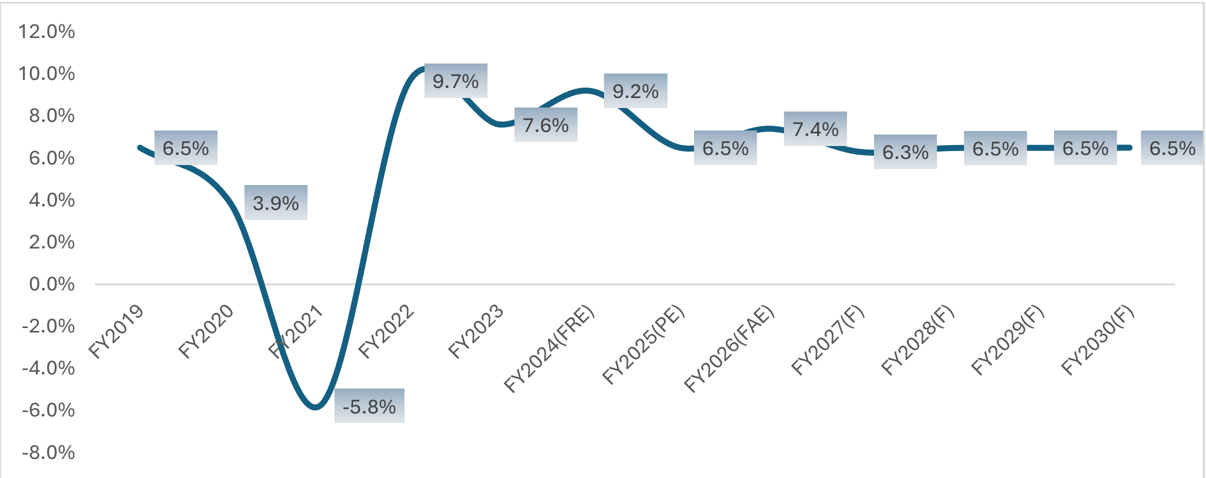
- India has low-cost labour, lower energy costs as compared to Europe, digital advantage and well-balanced economic partnership and trade agreements that give greater access to finance, technology, and new markets.
- Most importantly, India has a large domestic consumer market attracting majority investment projects in electronics, automobiles, capital goods, pharmaceuticals and defence sector. Nearly 60% of India’s GDP is driven by domestic private consumption, as compared to 40% in China. Hence the economy is protected largely against external shocks and cycles of low or high public investment.

2. Domestic Overview:

2.1 GDP Trend & outlook:

India's real Gross Domestic Product (GDP) for FY2025 has grown by 6.5%, according to the National Statistical Office (NSO), Ministry of Statistics and Programme Implementation (MoSPI) in January 2026. This represents a slight upward revision from the initial estimate of 6.4% published in January 2025. GDP to now reach a level of Rs 188 trillion (lakh crore). India’s real GDP registered 9.2% growth in FY2024 as against 7.6% in FY2023, making FY2024 the 3rd year of real GDP growth of 7.0% or above. Growth was majorly driven by robust domestic demand, vibrant demographic landscape, ongoing economic reforms, India is establishing its growing impact on global trade, investment, and innovation, coupled with Government’s focus on infrastructural and economic development supported this upward trend in the country’s growth rate. Furthermore, International Monetary Fund (IMF) expects India to continue being the fastest growing economy in the world, whereby it expects India’s output to grow by 6.5% from FY2028 to FY2031.

Chart 4: GDP growth trend in India



Source: RBI, IMF, ICRA Analytics
Note: F-Forecasted; FRE- First Revised Estimates; PE: Provisional Estimates; FAE: First Advance Estimates
Data from FY2026-2031F are forecasted from IMF
FY2024 (FRE) is the First Revised Estimates; FY2025(PE) is the Provisional Estimates and FY2026 (Fae) is the First Advance Estimates released by the National Statistical Office (NSO)

The Reserve Bank of India has projected real GDP growth at 7.4% for FY2026, reaffirming India's position as the world's fastest-growing major economy, and at 6.5% for FY2025, following a robust expansion of 9.2% in the previous year.

Agriculture remains on a positive footing, supported by healthy reservoir levels and robust crop production, which is expected to sustain rural demand. Manufacturing is showing early signs of revival amid improved business sentiment, and the services sector continues to demonstrate resilience.

On the investment side, activity is gaining pace on the back of higher capacity utilization, continued government focus on infrastructure, and strong balance sheets of banks and corporates. Easing financial conditions have also aided this recovery. While services exports are likely to remain steady, merchandise exports could face headwinds from global uncertainties and trade disruptions. Looking ahead, the RBI has projected real GDP growth at 6.7% for FY2027, suggesting continued recovery momentum.

Table 2: RBI estimates of GDP growth

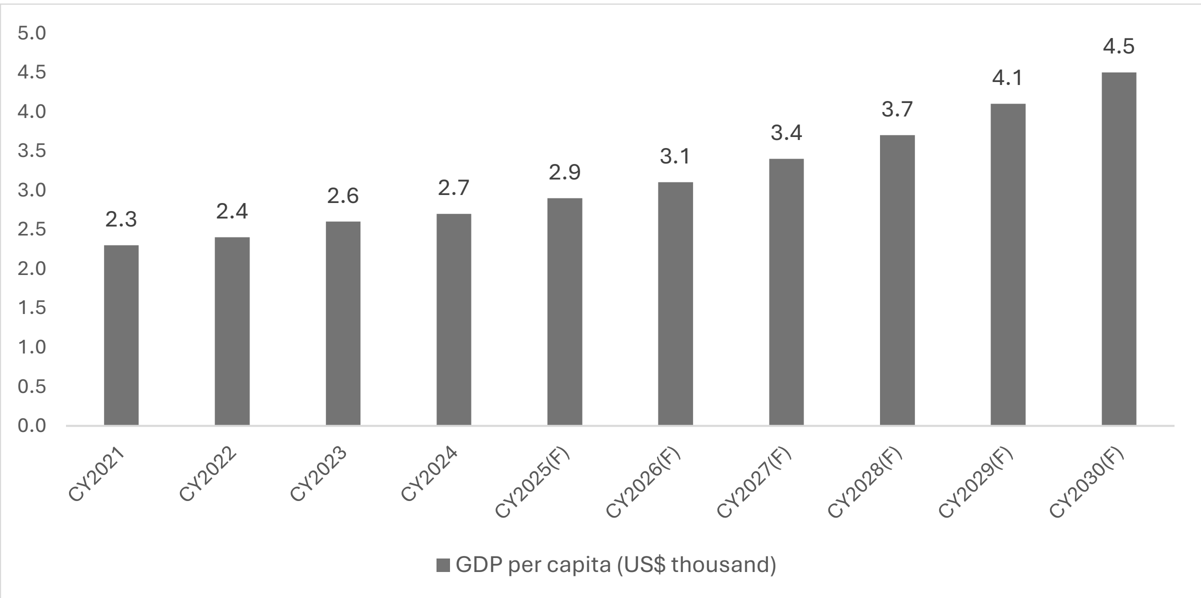
Real GDP Growth (at constant 2011-12 prices)	FY2025 E	FY2026 F			FY2027 F	
% change	(E)	Q3 (F)	Q4 (F)	(F)	Q1 (F)	Q2 (F)
GDP at market prices	6.5*	7.0	6.5	7.4	6.9	7.0

F- Forecasted; E- Estimated
Source: RBI, ICRA Analytics

2.2 Per capita GDP

India's GDP per capita has shown a steady and sustained upward trajectory. This growth reflects India's economic resilience, supported by strong domestic consumption and ongoing structural transformation. Key contributors to this progress include rapid expansion in the digital economy, technology-enabled services, and extensive government-led infrastructure development—particularly in transportation, energy, and urban sectors—which have collectively enhanced productivity and income levels.

Chart 5: Per Capita GDP trend of India (at current US$)



Source: IMF, ICRA Analytics
Note: F- Forecasted; data from CY2025-2030 are forecasted
Note: The data provided for India is for the fiscal year, mapped to the calendar year as FY(t/t+1) = CY(t). Eg: CY2021 is FY2022 for India

2.5 CPI general and Inflation trends

Retail inflation in India, as indicated by the Consumer Price Index (CPI), which represents the cost of daily goods and services, retail inflation in India has followed a steady downward path over the past three financial years, falling from 6.7% FY2023 to 5.4% during FY2024, and further to 4.6% during FY2025. This consistent moderation highlights the combined impact of the Reserve Bank of India's calibrated monetary policy and the Government of India's focused interventions to ease supply-side constraints and stabilise prices of essential commodities. The declining trend has helped ease cost-of-living pressures and fostered a more stable environment for economic growth.

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The strategic interventions implemented by the government have helped in controlling price increases, using measures such as the enhancement of buffer stocks for essential food items and their periodic release into open markets, in addition to subsidized retail sales of staples such as rice, wheat flour, pulses, and onions.

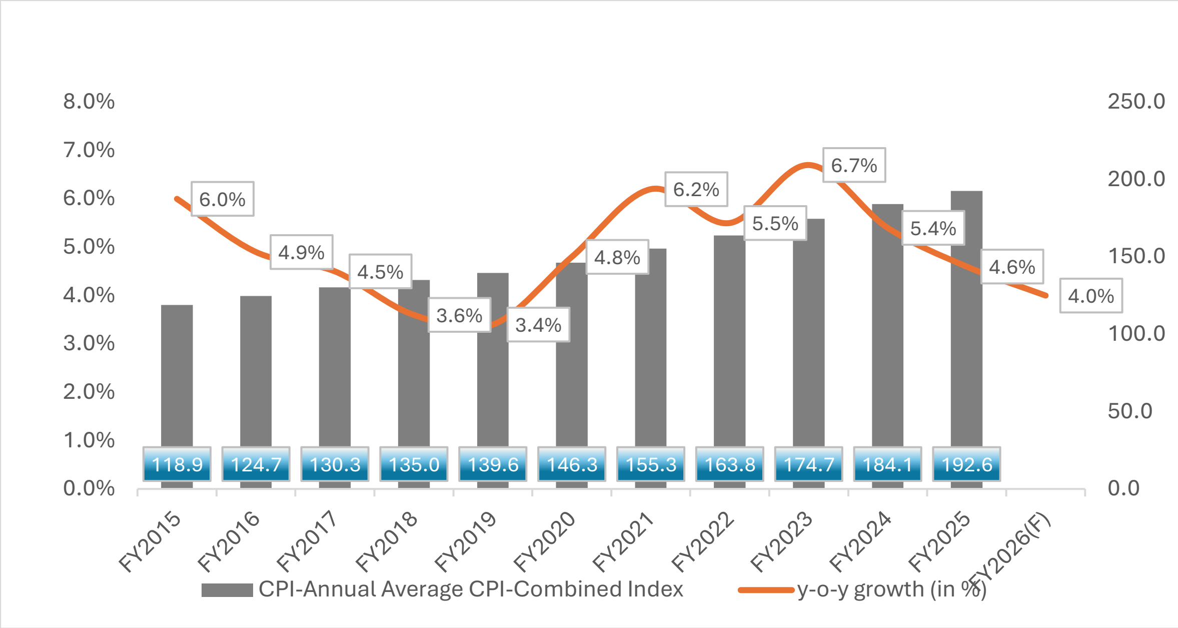
Moreover, the simplification of import duties on vital food items, the enforcement of stricter stock limits to deter hoarding, and the reduction of GST rates on essentials have contributed to alleviating price pressures. Targeted subsidies, including LPG support through the Pradhan Mantri Ujjwala Yojana and the Pradhan Mantri Garib Kalyan Anna Yojana, have shielded vulnerable households from the escalating costs of food grains, ensuring that the advantages of reduced inflation are accessible to those who require it the most.

As of July 2025, the Reserve Bank of India (RBI) has revised its Consumer Price Index (CPI) inflation forecast for the fiscal year 2025–26 (FY26) downward to 3.7%, from an earlier projection of 4.0%. This adjustment reflects a sustained decline in food inflation, robust agricultural output, and favourable monsoon conditions.

Notably, it has pared the CPI inflation projection for Q1 FY2026 (+2.9% in June 2025 vs. +3.6% in April 2025) and Q2 FY2026 (+3.4% vs.+3.9%) by a sizeable 50-70 bps. While the projection for Q3 FY2026 (+3.9% vs. +3.8%) was revised upwards slightly, that for Q4 FY2026 was kept unchanged at 4.4%. This implies a linear upward trajectory in inflation through the fiscal.

ICRA projects Consumer Price Index (CPI) inflation to moderate to 3.5% in FY2026, down from 4.6% in FY2025, which is below the Monetary Policy Committee's (MPC) updated estimate of 3.7%. While the inflation readings for the first half of the fiscal are largely in line with their expectations, it is anticipated that those for the latter half may fall slightly below the MPC's projections. In their assessment, the return to a neutral policy stance sends a clear indication of a pause, particularly when viewed alongside the unanticipated Cash Reserve Ratio (CRR) reduction.

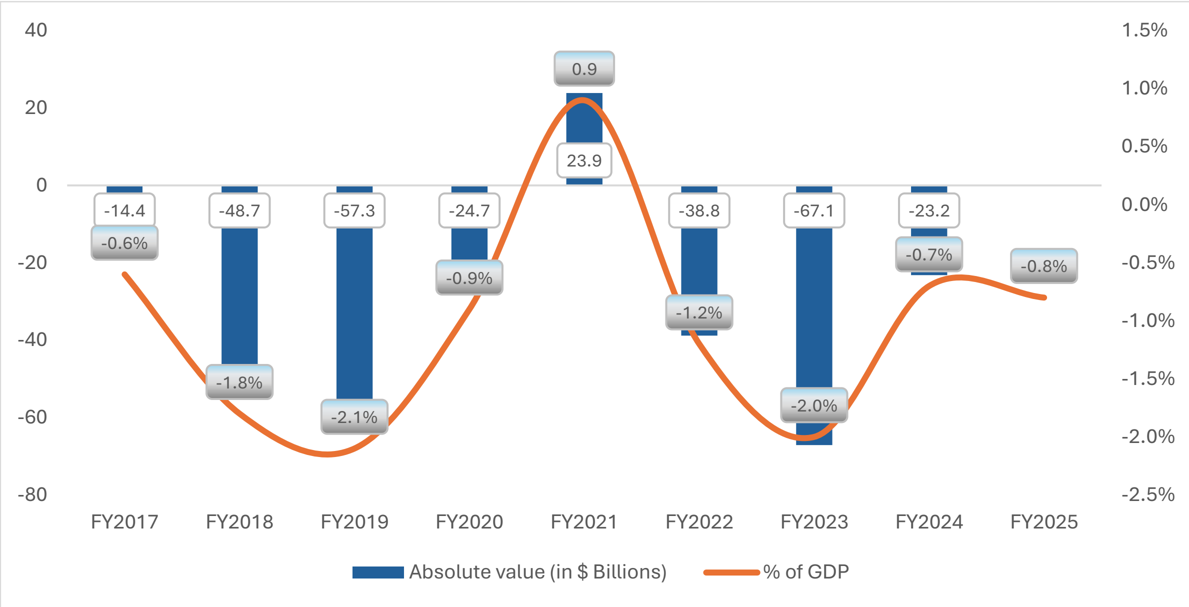
Chart 8: Inflation and CPI trend over past ten years



Source: RBI, MOSPI, ICRA Analytics

2.6 Current Account Deficit in India

Chart 9: Current Account Deficit (Absolute and % of GDP)



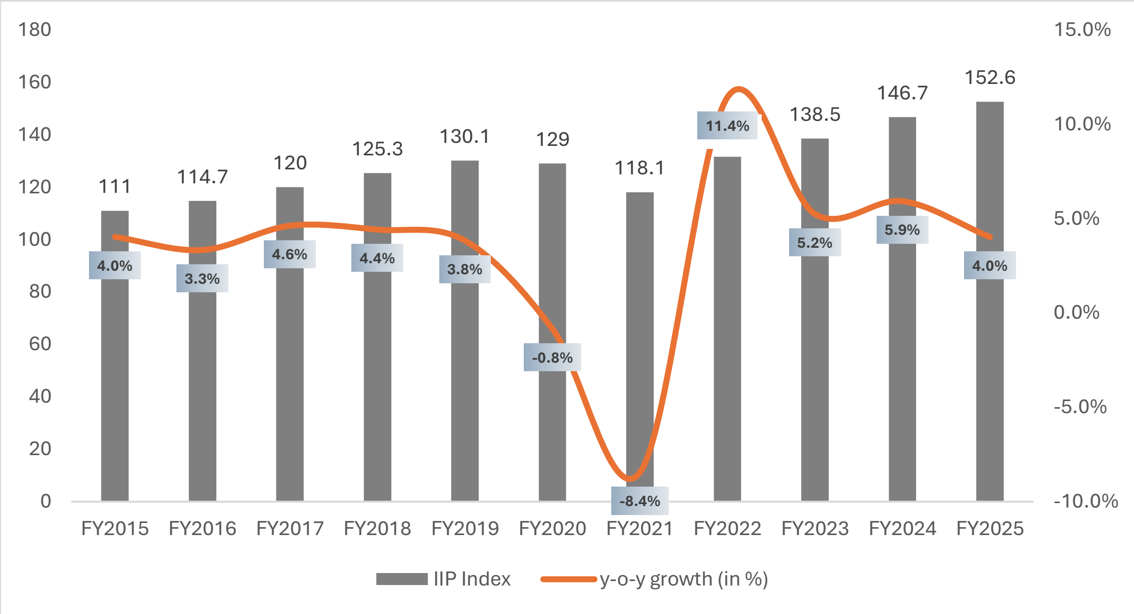
Source: RBI-Database on Indian Economy, IMF, ICRA Analytics

India's current account deficit has exhibited considerable fluctuations, influenced by both global economic conditions and domestic demand dynamics. Beginning with a modest deficit of -0.6% of GDP in FY2017, the gap widened to -2.1% by FY2019 due to rising crude oil prices and increased import demand. A partial correction occurred in FY2020, followed by a brief surplus of 0.9% in FY2021, driven primarily by a sharp decline in imports during the COVID-19 pandemic and steady inflows from services exports and remittances. However, the deficit re-emerged in FY2022 and peaked again at -2.0% in FY2023, reflecting a strong post-pandemic recovery in domestic consumption and elevated global commodity prices. In the subsequent years (FY2024 & FY2025), the current account deficit has gradually narrowed, stabilizing below ~1.0% of GDP, aided by softening oil prices and resilient export performance.

2.7 Industrial Activity Growth

Aided by strong corporate profits on the back of reduced input cost pressures and government support in promotion of manufacturing in India through various schemes such as Make in India, Startup India, Digital India, etc, led to healthy growth in Index of Industrial Production (IIP). Industrial output reported expansion of 4.0% in FY2025 as compared to 5.9% in the preceding year (i.e. FY2024). Led by electrical equipment, transport equipment, furniture and basic metals, 17 of 23 industry groups recorded y-o-y expansion in the manufacturing space. Moreover, while considering user-based classification all categories reported year over year growth. Going forward, India's manufacturing sector is expected to reach US$ 1 trillion by FY2025-26, mainly led by investments in automobile, textiles and electronics industries.

Chart 10: Industrial activity growth over past ten years



Source: MOSPI, ICRA Analytics

2.8 Tailwinds for growth in manufacturing in India

Manufacturing sector is constantly evolving, and India is offering both scale and growth. A strong logistic framework with heavy investments planned for the upcoming years is expected to transform it to a manufacturing hub globally.

To achieve the vision of *'Viksit Bharat'* and *'Atmanirbhar'*, the GoI has put in place policy reforms and initiatives like enabling Production Linked Incentive (PLI) schemes, Make-In-India initiatives, improving export-linked initiatives, providing tax incentives and subsidies to start-ups and entrepreneurs, liberalising FDI and foreign trade regimes, developing national networks and infrastructure to meet global standards along with introduction of Government schemes like PM Gati Shakti, Industrial corridors and dedicated freight corridors (DFCs), National Infrastructure Pipeline (FY2019–25) etc. The state governments are also working in tandem with central government, by offering fiscal benefits and incentives namely capital subsidies, turnover subsidies, tax reimbursements, liberalising labour laws, customized incentive packages as per scale of investments, implementing sectoral and region-specific incentives to name a few.

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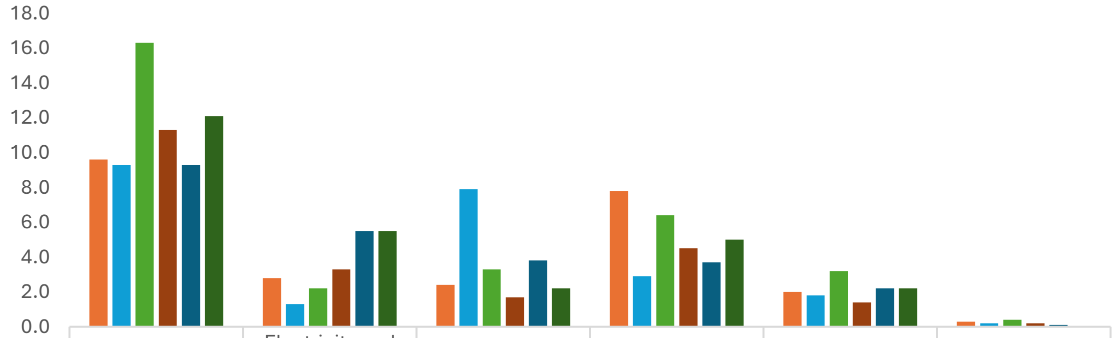
In order to attain self-reliance, reduce import dependence and enhance supply chain resilience in the critical import dependent bulk drugs - Key Starting Materials (KSMs)/ Drug Intermediates and Active Pharmaceutical Ingredients (APIs) in the country, the Department of Pharmaceuticals had launched a Production Linked Incentive (PLI) Scheme for promotion of their domestic manufacturing by setting up greenfield plants in four different Target Segments, i.e. Target segments 1 and 2 are fermentation based and Target segments 3 and 4 are chemical synthesis based. The scheme envisages manufacturing of 41 bulk drugs with a total outlay of Rs. 6,940 crore during the tenure of the scheme i.e. FY2021 to FY2030. The scheme envisages incentive at the rate of 20% for first four years, 15% for fifth year and 5% for sixth year on eligible sales of fermentation based bulk drugs. In respect of chemical synthesis based bulk drugs, incentive is to be given at the rate of 10% for six years on the eligible sales. The PLI scheme for bulk drugs will lead to reduced import dependence and better supply chain resilience.

The Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR) set up at Paradip, Odisha has attracted investments worth Rs 73,518 crore resulting in employment of about 40,000 people. A PCPIR is a combination of production units, public utilities, logistics, environmental protection mechanisms, residential areas and administrative services. Each PCPIR would have a refinery/ petrochemical feedstock company as an anchor tenant. Additional support, in terms of fiscal incentives, such as tax breaks and special incentives through PCPIRs or SEZs to encourage downstream units will enhance production and development of the chemicals industry. The dedicated integrated manufacturing hubs under the PCPIR policy are likely to attract an investment of Rs. 20 lakh crores by FY2035.

India has attracted significant FDI over US$ 667.4 billion between FY2014 and FY2024, some of the key sectors being IT hardware, telecom, pharmaceutical and chemical sectors. Another key reason for rapid development can be attributed to sunrise sectors (like IT, Telecom, consumer electronics, mobiles and wearables, automotive, aerospace and defence) which are widely enabling the growth of new investments in India. Ease of doing business (EoDB) in India has also drastically improved, moving from 142nd place in FY2014 to being in 63rd place in FY2019, witnessing a jump of 79 positions within a span of 5 years. India offers a strong business ecosystem, well developed networks and infrastructure along will skilled labour force. It is on the path to becoming a global manufacturing hub as planned by the government reforms and policies and driven by the robust demand.

Chart 11: FDI inflow across different sectors over FY2020-FY2024 (in US$ Billion)



	Manufacturing	Electricity and Other Energy Generation, Distribution & Transmission	Transport	Communication Services	Construction	Mining
FY2020	9.6	2.8	2.4	7.8	2.0	0.3
FY2021	9.3	1.3	7.9	2.9	1.8	0.2
FY2022	16.3	2.2	3.3	6.4	3.2	0.4
FY2023	11.3	3.3	1.7	4.5	1.4	0.2
FY2024	9.3	5.5	3.8	3.7	2.2	0.1
FY2025(P)	12.1	5.5	2.2	5.0	2.2	0.0

Source: RBI, ICRA Analytics
Note: P- Provisional data

2.9 Key takeaways from Union Budget

- Higher Allocation and Rising Fiscal Support: Finance Minister Nirmala Sitharaman allocated ₹1,62,671 crore to the agriculture sector in the Union Budget 2026–27, a 7% increase over the revised estimate of ₹1,51,853 crore for 2025–26. This continues the long-term upward trend in fiscal support, with the Department of Agriculture and Farmers' Welfare outlay rising from about ₹21,933.50 crore in 2013–14 to approximately ₹1,51,853 crore in 2025–26, underscoring sustained emphasis on farmer welfare, food security, and rural livelihoods.

- Launch of Bharat Vistar AI Platform: The Union Budget announces the launch of 'Bharat Vistar', a multilingual AI tool integrating AgriStack portals and ICAR's agricultural practices to provide customised advisory support, enhance farm productivity, reduce risks, and improve farmers' on-ground decision-making. Focus on High-Value Crop Diversification, Allied Sector Support and Targeted Schemes: The budget promotes diversification into high-value crops—coconut, cashew, cocoa, sandalwood, agarwood (North East), and nuts—along with orchard rejuvenation, high-density cultivation, and youth-led value addition; introduces a Coconut Promotion Scheme, cashew-cocoa initiatives, fisheries development of 500 reservoirs, and credit-linked animal husbandry subsidies to modernise livestock value chains and generate rural/peri-urban employment.

- Public capex push: Public capital expenditure for FY2026-27 is budgeted at ₹12.2 lakh crore, alongside multiple infra initiatives (e.g., new Dedicated Freight Corridors, new National Waterways, Coastal Cargo Promotion Scheme, Seaplane VGF Scheme, and "Purvodaya" East Coast Industrial Corridor).

- Fiscal consolidation path: Fiscal deficit is estimated at 4.3% of GDP in BE FY2026-27, with a stated medium-term goal of reaching a debt-to-GDP ratio of 50±1% by 2030.
- Tax/ease-of-living measures: Key proposals include reducing TCS to 2% on overseas tour packages and on LRS remittances for education/medical, extending the time for revising returns up to 31 March (with a nominal fee), and a one-time 6-month foreign asset disclosure scheme for small taxpayers.
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2.10 Factors turning India into preferred manufacturing destination

Manufacturing sector is a significant contributor in India's GDP and has the potential to transform the economy into a developed economy by FY2047, as targeted in "*Viksit Bharat"* initiative of GoI. This transformative era is supported by advancement in technology IoT (Internet of Things), AI (Artificial intelligence), robotics, and big data analytics, Cyber-physical systems (CPS). India is embracing the concept of smart manufacturing and integration of advanced technologies.

Indian government is taking various initiatives to promote smart manufacturing such as "Make in India", "Digital India", "National policy on Advanced Manufacturing", "Atal Innovation Mission (AIM)", manufacturing zones and smart cities. One of the initiatives called 'SAMARTH Udyog Bharat 4.0' is aimed at driving Industry 4.0 adoption across Indian manufacturing under the Ministry of Heavy Industries' Capital Goods Competitiveness Scheme. It has established four Smart Advanced Manufacturing and Rapid Transformation Hubs (SAMARTH Centres) — in Pune (C4i4 Lab), IIT Delhi (AIA Foundation), and two in Bengaluru (IISc and CMTI) — to help MSMEs and industries conduct digital maturity assessments, identify use cases, develop smart manufacturing technologies and tools, host demonstration model factories, train digital champions, and provide IoT/data analytics incubation support, without offering direct financial subsidies. Moreover, the Centre for the Fourth Industrial Revolution, established in FY2018, serves as a hub for developing and implementing these technologies. This technological shift ensures increased efficiency, cost reduction, quality improvement, flexibility, waste reduction, further contributing to environmental sustainability and enhanced competitiveness for the Indian manufactures.

With these technological advancements, global corporations are considering India as an attractive manufacturing destination. Many global players have already started to diversify their supply chain into the Indian manufacturing landscape.

- BASF expanded its e-coating manufacturing division in India due to its increased demand from the global and Indian automotive manufactures.
- Lubrizol Corporation, a leader in specialty chemicals, has acquired 120 acres in Aurangabad for its largest-ever facility in India. This new plant—projected at $200 million—will be its second largest globally and focuses on transportation and industrial fluids for India and regional export markets.
- Apple has rapidly scaled up iPhone assembly and exports in India. In FY2025, Apple exported approximately ₹1.5 lakh crore (~$12–13 billion) worth of iPhones from India, and in Q1 alone reached ₹20,000 crore in March. In April 2025, India shipped 3.3 million iPhones to the U.S., surpassing China's exports, and iPhone 17 series assembly has

reportedly begun locally. Apple aims to manufacture most U.S.-bound iPhones in India by end-2026. Though China still produces over 75% of global iPhones, India now contributes about 18% and is expected to rise to 20% in 2025.

- Boeing continues to deepen its footprint in India, sourcing approximately $1.25 billion annually from over 300 suppliers and employing around 7,000 people. They recently marked delivery of the 300th AH-64 Apache fuselage via the Tata-Boeing joint venture in Hyderabad, which produces over 90% of components locally. Although Boeing has indicated that more regional aircraft orders will be needed before considering a final civil aircraft assembly plant in India, the partnership aligns closely with the "Make in India" and "Atmanirbhar Bharat" initiatives.

- Nokia has invested over Rs. 1000 crore in India. Nokia's Chennai factory has been manufacturing telecom products (5G/4G equipment) with over 50% as exports. It was the first Indian factory to start the 5G New Radio production (FY2018), thereby aligning with the "Make in India" program. Nokia is willing to localise more of its operations, identifying the need to move up the value chain in India. It is prioritizing to design telecom network infrastructure equipment in Chennai's facility, thereby shifting a large part of its global design capacity to India.

Few other factors that help India become an attractive destination for global manufacturing investments are:

- Sectoral policies and reforms: Indian government offers attractive industrial policies and measures such as Make in India, PLI scheme, export linked initiatives, enhanced investment in infrastructure, digitalization of economy, adoption of cleaner routes such as renewable energy, green hydrogen etc. and liberal FDI and foreign trade regimes, to name a few.

- Enhanced ease of doing business: As per World Bank's Doing Business Report (DBR), FY2020, India ranked 63rd in Ease of Doing Business (EoDB). India's rank improved from 142nd in FY2014 to 63rd in FY2019, registering a jump of 79 ranks in a span of 5 years. This was driven by improvements in infrastructure, digitization and simplification of procedures. Indian government's progressive policies like PM Gati Shakti, National Logistics Policy, Unified Logistics Interface Platform, reduction in corporate taxes for different business units, Business Reforms Action Plan (BRAP) and special courts for resolving disputes faster thereby helping to increase economic growth.

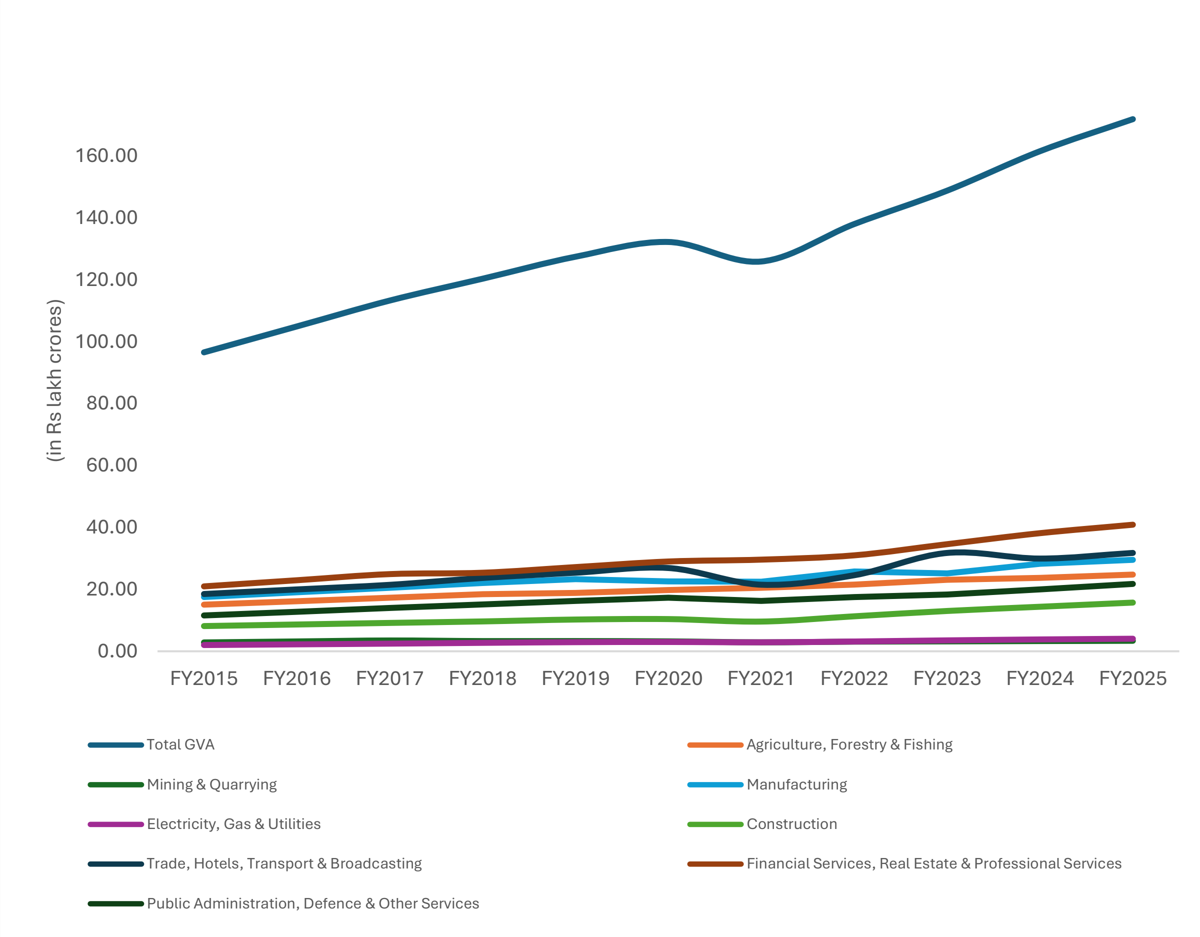
- Cheap labour and material cost makes India's manufacturing sector more attractive. Additionally, India also has a growing working population with a median age of around 28 years, which is around 11 years lower than China.

- India has good partnerships with different countries across the world. India-Australia Economic Cooperation and Trade agreement, India–UAE Comprehensive Economic Partnership Agreement (CEPA) are some of the recent Free Trade Agreements (FTAs) boosting international trade.

- India's infrastructure push—covering roads, urban development, railways, power, and irrigation—supported by programs like NIP, PM Gati Shakti, port expansion, and energy grid rollout.

2.11 Sectoral growth trend:

Chart 12: Gross Value Added at Constant Basic Prices: By Economic Activity: Base Year 2011-12



Source: MOPSI, ICRA Analytics

In FY2024–25, India's Gross Value Added (GVA) at constant prices stood at around ₹171.87 lakh crore, marking a 6.4% growth over ₹161.51 lakh crore in FY2023–24. Gross Value Added (GVA) at constant prices for the services sector is Rs. 86.7 lakh crore in FY2024. the rising significance of India's services sector, noting its contribution to Gross Value Added (GVA) at current prices has increased from 50.6% in FY14 to around 55% in FY25. This steady rise reflects the sector's resilience and its pivotal role in driving economic growth, even during periods when manufacturing faced global trade headwinds. The survey refers to the services sector as the "Old War Horse" of the economy, underscoring its ability to consistently support GDP expansion.

Over the past decade, the services sector has maintained an annual growth rate of over 6% in real GVA, except during FY21 when the pandemic disrupted economic activity. Before the pandemic, the average annual growth rate stood at 8%, and in the post-pandemic recovery period from FY23 to FY25, this has further strengthened to 8.3%. The sector's robustness has been instrumental in sustaining GDP momentum, with services exports also playing a critical role in improving India's external balance.

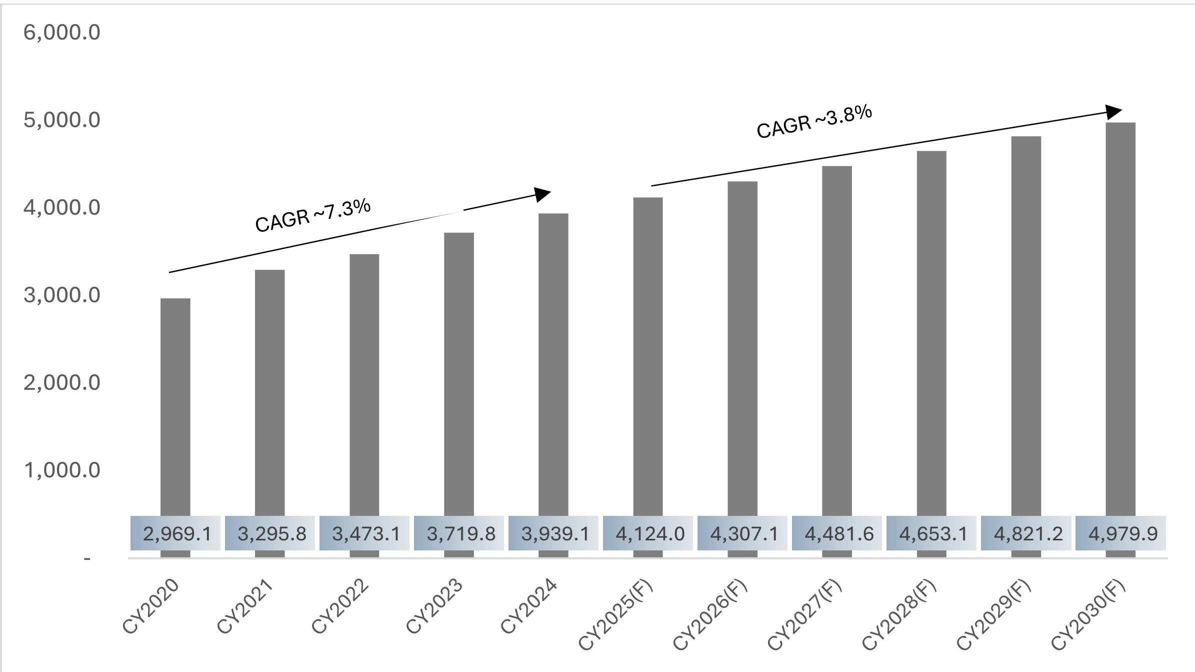
3. Global Agriculture Market:

The establishment of healthy, sustainable, and inclusive food systems is essential for realizing global development objectives. Agriculture development serves as a potent mechanism to eradicate poverty, enhance shared prosperity, and provide sustenance for an anticipated population of 10 billion by the year 2050. The growth of the agriculture sector is two to four times more effective in increasing incomes for the poorest populations compared to growth in other sectors.

Furthermore, agriculture plays a vital role in economic advancement, contributing 4% to the global gross domestic product (GDP), and in certain least developed nations, it may represent over 25% of GDP.

The global agriculture market reached a production value of $ 3,939.1 billion in 2024, representing a CAGR of 7.3% during CY2020-CY2024. Going forward, global agriculture market is expected to reach a production value of $ 4,979.9 billion by CY2030, growing at a CAGR of 3.8% during CY2025-CY2030.

Chart13: Production Value of the Agriculture Market (in $ Billion)

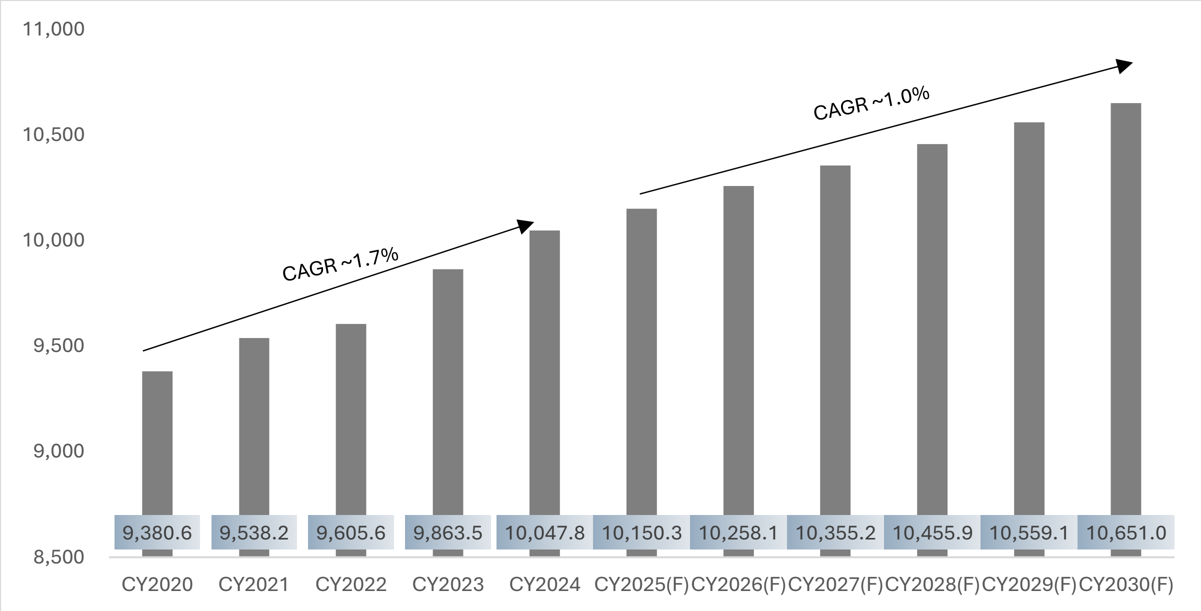


Source: FAO, IMARC Group, ICRA Analytics
Note: F-Forecasted; data from CY2025-2030 are forecasted

In terms of volume growth, the global agriculture market grew at a CAGR of 1.7% during CY2020-CY2024 to 10,047.8 million tonnes in CY2024. Going forward, the market is expected to reach a production volume of 10,651.0 million tonnes by CY2030, exhibiting a CAGR of ~1.0% during CY2025-CY2030.

Price realizations are rising with the volume growing at 0.97% and value at 3.8%. Key drivers include higher production costs (energy, labor, fertilizers), increased demand for premium products, and supply chain disruptions due to weather and geopolitical factors. These pressures result in higher prices despite limited volume growth. In addition, we used a time series forecasting methodology to project the market.

Chart14: Production Volume of the Agriculture Market (in Million Tonnes)



Source: FAO, IMARC Group, ICRA Analytics
Note: F-Forecasted; data from CY2025-2030 are forecasted

3.1 Market drivers in the global agriculture market-

- **Global emphasis on food security:** The global emphasis on food security is driving growth in agriculture, with significant investments in sustainable and efficient food production methods to meet the needs of a projected ~10 billion plus people by 2050.
- **Organic farming:** The shift towards organic farming is significantly driving agriculture growth due to rising consumer demand for healthier and environmentally friendly products. The Organic Trade Association reported a 5.2% increase in organic products sales in the U.S. in 2024 compared to 2023. European countries like Germany and France are also experiencing growth in organic agriculture, supported by government policies and consumer demand for sustainable food options.
- **Technological advancements:** Technological advancements like IoT and AI in precision farming are revolutionizing agriculture, exemplified by AGCO Corporation's "FUSE" technology, which optimizes crop management and machinery operations. These innovations are transforming traditional farming practices, increasing productivity while reducing environmental impacts.
- **Government policies:** Government policies and subsidies play a crucial role in advancing agriculture development. The Common Agricultural Policy (CAP) of the European Union delivers essential financial assistance to farmers, enhancing both productivity and sustainability. Similarly, the U.S. Farm Bill provides crop insurance, conservation initiatives, and commodity support, which contribute to the financial security of farmers and encourage sustainable agriculture methods. Such policies are essential for sustaining a stable and productive agriculture industry.
- **Adapting to climate change:** Climate change adaptation is a key driver of agriculture innovation, focusing on resilient practices and technologies like drought-resistant crops and climate-smart agriculture. For eg, The International Rice Research Institute (IRRI) developed flood-tolerant rice varieties in Asia to help farmers maintain yields despite

adverse climatic conditions. These adaptive measures are crucial for sustaining agriculture productivity in the face of climate challenges.

- **Rise of entrepreneurship in agriculture:** The rise of agribusinesses and agri-entrepreneurship, leveraging innovative technologies, is fuelling market growth and enhancing productivity. Companies in the U.S. are pioneering vertical farming, providing locally grown produce with minimal environmental impact. The adoption of sustainable practices, such as regenerative agriculture promoted by the "European Green Deal," aims to improve soil health and agriculture resilience. Additionally, advancements in agriculture biotechnology is one of the key driver. Genetic engineering is enabling the development of crops with enhanced traits, with better crop yields and disease resistance, driving modern agriculture forward.

Looking ahead, breakthroughs in gene editing technologies like CRISPR and blockchain integration for supply chain transparency are expected to drive the global agriculture market. Autonomous farming equipment, including driverless tractors and drones for crop monitoring, will revolutionize agriculture practices by enhancing efficiency and precision. Collectively, these advancements are steering the global agriculture market towards a more productive, sustainable, and resilient future.

3.2 Threats and challenges for the global agriculture sector:

The global agriculture market encounters numerous challenges that impede its development.

- **Climate change:** One of the primary concerns is climate change, which results in extreme weather phenomena and altered climatic patterns that significantly affect crop production. For example, recurrent droughts and floods can damage crops and affect overall productivity. Farmers in areas such as Sub-Saharan Africa face specific difficulties due to erratic rainfall, making it challenging to plan planting and harvesting activities. Likewise, in Australia, extended periods of drought have led to considerable losses in crop yields and decreased livestock production, underscoring the widespread impact of climate variability. These climate-induced disruptions can contribute to rising food prices and diminished food security, further complicating the dynamics of the global agriculture sector.
- **Cost concerns:** The high cost of advanced agriculture technologies is a significant barrier for smallholder farmers in developing regions like India and Vietnam. Precision farming equipment, such as sensors and data analytics, are expensive and limit productivity. Geopolitical tensions and trade restrictions disrupt international supply chains, increasing costs for producers and consumers. Trade disputes, particularly between major agriculture exporters and importers, can result in tariffs and trade barriers, further complicating the dynamics of global trade.
- **Degradation of natural resources:** The degradation of natural resources including soil erosion, nutrient depletion, and water scarcity, poses significant threats to sustainable agriculture. Intensive farming practices, such as monoculture and excessive use of chemical fertilizers, deteriorate soil health and fertility. In regions like California, overuse of groundwater for irrigation has drastically reduced water availability. Addressing these challenges requires investment in sustainable practices and resource management. While regenerative agriculture and conservation are essential, they face significant hurdles, impacting the global agriculture market and highlighting the need for strategic, long-term solutions.

3.3 Success factors in the global agriculture market:

- **Rapid advancements in technology:** These are reshaping agriculture methodologies. Innovations such as precision agriculture, intelligent irrigation systems, and sophisticated data analytics have transformed the way farmers utilize their resources, resulting in higher crop yields and improved efficiency. The introduction of agri-tech innovations, including drone surveillance and autonomous machinery, has further streamlined operations, lowering labour expenses and boosting productivity. Progress in genetic modification and CRISPR gene editing has facilitated the creation of crops that are more resistant to pests, diseases, and environmental challenges. Adding to this, investing in biotechnological research can enable companies to address critical agriculture issues and secure a competitive edge.
- **Sustainability:** This presents another significant opportunity, marked by a growing focus on environmentally friendly agriculture practices. Both consumers and regulatory authorities are advocating for sustainable approaches, including organic farming, regenerative agriculture, and integrated pest management. This transition not only addresses pressing environmental issues but also creates new market opportunities for sustainable goods. Enterprises that commit to these practices can appeal to environmentally conscious consumers while complying with rigorous regulatory requirements. The rapid increase in population and urbanization in areas such as Asia-Pacific, Latin America, and Africa is leading to a heightened demand for food and agriculture products. As these regions advanced their agriculture methodologies, there are promising prospects for investment and collaboration that can result in considerable returns.
- **Government policies and incentives**: These are crucial in promoting innovation and growth within the agriculture sector. Numerous governments are implementing programs that offer financial incentives, subsidies, and research grants aimed at supporting sustainable agriculture practices and the development of infrastructure. Organizations that collaborate with policymakers and utilize these incentives can more adeptly navigate regulatory environments and seize available opportunities. The critical issues surrounding global food security are prompting investments in technologies and practices that improve productivity and resilience. This scenario presents businesses with the chance to create solutions that tackle these challenges, including enhancements in storage and transportation systems, increases in crop yields, and reductions in food waste.

3.4 Global: Market breakup by country (size and % share for CY2024)

Table 4: Market size (production, in value terms) and percentage of top 5 countries in the agriculture sector

Country	CY2024 (in $ Billion)	CY2024 (%)
China	1,520	38.6%
United States of America (USA)	288	7.3%
Brazil	186	4.7%
India	152	3.9%
Others	1,792	45.5%
Total	3,939	100%

Source: FAO, IMARC, ICRA Analytics

The total market size of the global agriculture market stands at $3,939 billion. In terms of market size (in value terms) in the global agriculture market, China dominates the market with ~38.6% share followed by USA at ~7.3%, Brazil at ~4.7% and India taking the fourth position at ~3.9%.

3.5 Global export breakup by country (value & % share for CY2024)

Table 5: Export share of top 5 countries in the agriculture sector

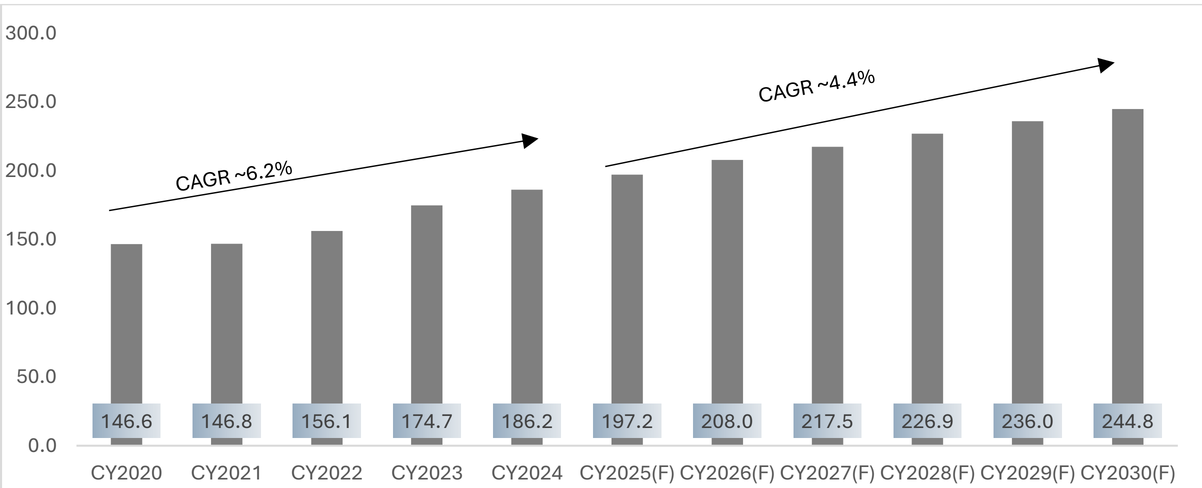
Country	CY2024 (in $ Billion)	CY2024 (%)
United States of America (USA)	79,201	14.1%
Brazil	76,954	13.7%
China	39,882	7.1%
Canada	25,277	4.5%
Australia	20,783	3.7%

Source: FAO, USDA, IMARC, ICRA Analytics

USA and Brazil together contribute about 27.8% to the global agriculture exports with relatively lower consuming population compared to China, which remains at third position with 7.1% share despite its dominant share in world agriculture production.

3.6 Brazil agriculture market

Chart 15: Production value of Brazil's agriculture market (in $ Billion)

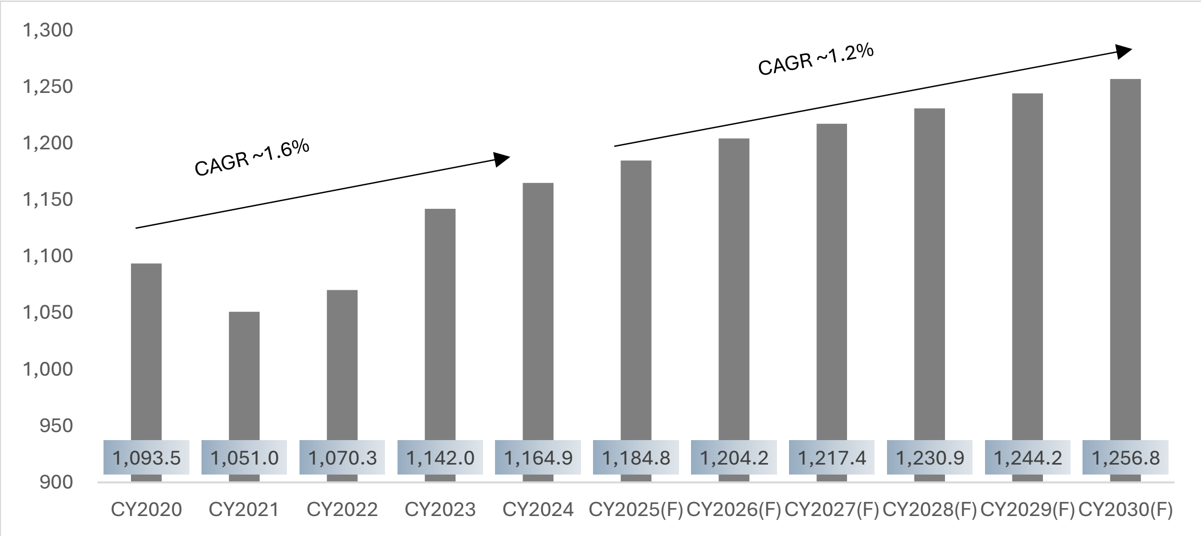


Source: FAO, IMARC, ICRA Analytics

Note: F-Forecasted; data from CY2025-2030 are forecasted

During CY2024, the agriculture market for Brazil reached a production value of $ 186.2 billion representing a CAGR of 6.2% during CY2020-CY2024. Going ahead, the agriculture market for Brazil is expected to reach a production value of $ 244.8 billion by CY2030, exhibiting a CAGR of 4.4% during CY2025-CY2030.

Chart 16: Production volume of Brazil's agriculture market (in Million Tonnes)



Source: FAO, IMARC, ICRA Analytics
Note: F-Forecasted; data from CY2025-2030 are forecasted

In terms of volume, the agriculture market for Brazil reached a production volume of 1,164.9 million tonnes in CY2024, exhibiting a CAGR of 1.6% during CY2020-CY2024. Going forward, the agriculture market for Brazil is expected to reach a production volume of 1,256.8 million tonnes by CY2030 exhibiting a CAGR of 1.3% during CY2025-CY2030.

3.6.1 Market drivers:

- Brazil's agriculture output market benefits from extensive fertile land and a favorable climate, enabling the efficient cultivation of high-yield crops like soybeans, corn, sugarcane, and coffee, supporting both domestic consumption and a strong export market.
- The adoption of advanced agriculture technologies, such as precision farming tools, GPS systems, drones, and biotechnology, boosts productivity and reduces costs.
- Government initiatives, including subsidies, favorable loans, and research by entities like Embrapa, further drive agriculture growth.
- Brazil's position as a major ethanol producer aligns with the global shift toward renewable energy, enhancing its competitive edge and promoting sustainable practices.

3.6.2 Technological advancement in Brazil's agriculture sector:

The Brazilian agriculture sector is witnessing significant progress due to the integration of various advanced technologies mentioned as follows:

- The use of agriculture drones and remote sensing technologies is increasingly popular in Brazil, providing farmers with advanced tools for crop monitoring and management. Drones equipped with high-resolution sensors offer real-time insights into crop health, growth patterns, and potential problem areas. This technology supports timely, targeted interventions, reducing crop losses and enhancing overall productivity. Additionally, integrating drone technology with data analytics platforms further refines management practices, increasing the precision and effectiveness of agriculture operations.
- Precision agriculture is transforming Brazilian farming by utilizing advanced technologies to optimize crop management and resource use. This technique involves tools like GPS-guided machinery, drones, and remote sensing to collect detailed data on soil conditions, crop health, and environmental factors. For example, Solinftec, a Brazilian company, uses an advanced precision agriculture system with autonomous tractors, drones, and data analytics platforms. Their technology offers high-resolution data on soil moisture, nutrient levels, and crop health, enabling precise fertilizer and pesticide applications. This approach improves input efficiency, significantly increases crop yields, and reduces operational costs. Additionally, it supports sustainable farming practices by minimizing resource waste and environmental impact.
- Biotechnology is crucial in Brazil's agriculture progress, particularly through developing genetically modified (GM) crops. Brazilian research institutions and biotech firms are at the forefront of creating crops resistant to pests, diseases, and harsh environmental conditions. A notable example is the extensive use of Bt cotton, a genetically engineered variety that reduces the need for chemical insecticides. This innovation has led to higher crop yields and lower production costs.
- Data analytics and farm management software are becoming integral to Brazilian agriculture, aiding farmers in making informed decisions and enhancing operational efficiency. Technologies like Agrotools and FieldView analyze data from weather conditions, soil metrics, and crop performance to provide actionable insights. These platforms streamline agriculture processes, improve resource management, and increase crop yields. The integration of data analytics with farm management systems fosters sophisticated, data-driven approaches to agriculture, driving continuous improvements in farm productivity.
- Smart irrigation systems in Brazil are advancing rapidly due to recent technological innovations. The SWAMP (Smart Water Management Platform) project, a collaboration between Brazilian institutions and the European Union, exemplifies these developments. This initiative uses IoT-based sensors and data analytics to optimize water usage in agriculture.

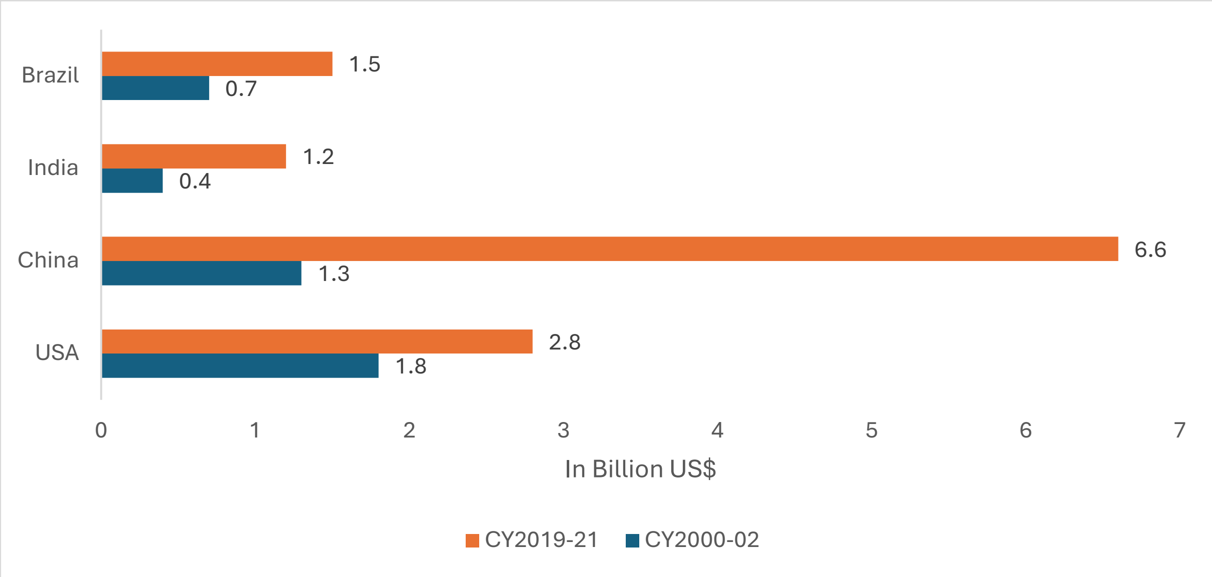
3.6.3 Climate Factors impacting Agriculture

- Climate change is the driving force behind more frequent and extreme weather events, including severe droughts, floods, and chronic heatwaves, which disrupt crop production and agriculture schedules. These severe weather patterns impact the crop yield negatively and can lead to reduced yields or even crop failure. India’s Ministry of Agriculture & Farmers Welfare predicts a reduction in wheat yields by ~19.3% and ~40% by FY2050 and FY2080 respectively as a result of climate factors with significant spatial and temporal variations. Another example is the Australian bush fires which were intensified by prolonged drought and elevated temperatures in CY2019-20. This devastated around 24.3 million hectares of farmland and severely affected crop yields and livestock. France’s winter drought resulted in 32 consecutive days without rainfall in early 2023. All these highlight the impact of extreme weather on agriculture productivity and food security globally.

- Global water scarcity is a major challenge for the agriculture sector. Changes in weather patterns and erratic monsoons have increased the challenges faced due to water stress. This water stress impacts irrigation practices, which in turn results in lower crop yield while increasing operational costs. A prime example of this is the Colorado River Basin in the USA which is seeing lower yields and higher operational costs by way of expensive water-saving technologies and cutting back on yield areas, as the area faces prolonged droughts. As per United Nation’s (UN) estimates, by CY2025 around 1.8 billion people will be settled in locations experiencing absolute water scarcity, thus intensifying this global challenge and putting increased pressure on the global agriculture production.
- The rise in global temperatures have led to growth in agriculture pests and diseases. This poses as a significant risk to crop health, yield and productivity. As per the Food and Agriculture Organization, invasive pests cost around $70 billion annually to the global economy, due to crop loss, lesser yields and increased use of pesticides. For example, pests like Fall Armyworm have resulted in up to 60% yield losses in parts of Africa. All these highlight the growing need to safeguard crops and ensure sustainability in the agriculture sector to ensure food security globally.
- Climate change has various effects, one of them being soil degradation. Due to the process of erosion, nutrient depletion and salinization, soil degradation can lead to lower soil fertility and agriculture productivity. For example, increased rainfall coupled with deforestation has resulted in severe soil erosion in Ethiopia, potentially reducing yields in certain regions by up to 50% from rain-fed agriculture. The Food and Agriculture Organization (FAO) estimates ~33% of global agriculture land to be already degraded and further projects ~90% to face degradation by CY2050. Effective soil conservation practices and sustainable land management is required to combat these challenges.
- Rising temperatures and shifting weather patterns have resulted in altered suitability of agriculture zones. This requires significant adjustments in agriculture practices and infrastructure in the crop zones. For example, coffee plantations needed to be relocated to higher altitudes due to increasing temperatures in tropical zones such as Brazil. These shifts reflect the broader impact of climate change on crop viability, affecting local economies and food security negatively.
- A major by-product of climate change is the rise in sea level, which is increasingly encroaching on coastal regions. This has major ecological implications and can also jeopardize agriculture global processes. Saltwater intrusion into arable lands in coastal areas leads to the soil yielding less crops or even turning infertile. Bangladesh’s rice and shrimp farming has been negatively affected significantly due to saltwater intrusion, resulting in loss of local livelihoods and risk food security. If current emission trends continue, the global sea levels can witness a rise by up to 1.1 meters by CY2100, as per The Intergovernmental Panel on Climate Change’s (IPCC) Sixth Assessment Report forecasts. Vietnam’s coastal regions are facing reduced agriculture yield due to saltwater intrusion, showcasing the consequences farming communities face in low lying areas.

3.7 Spendings by different regions on Agriculture Research and Development (R&D)

Chart 17: Agriculture Knowledge and Innovation Systems spendings (In $ Billion)



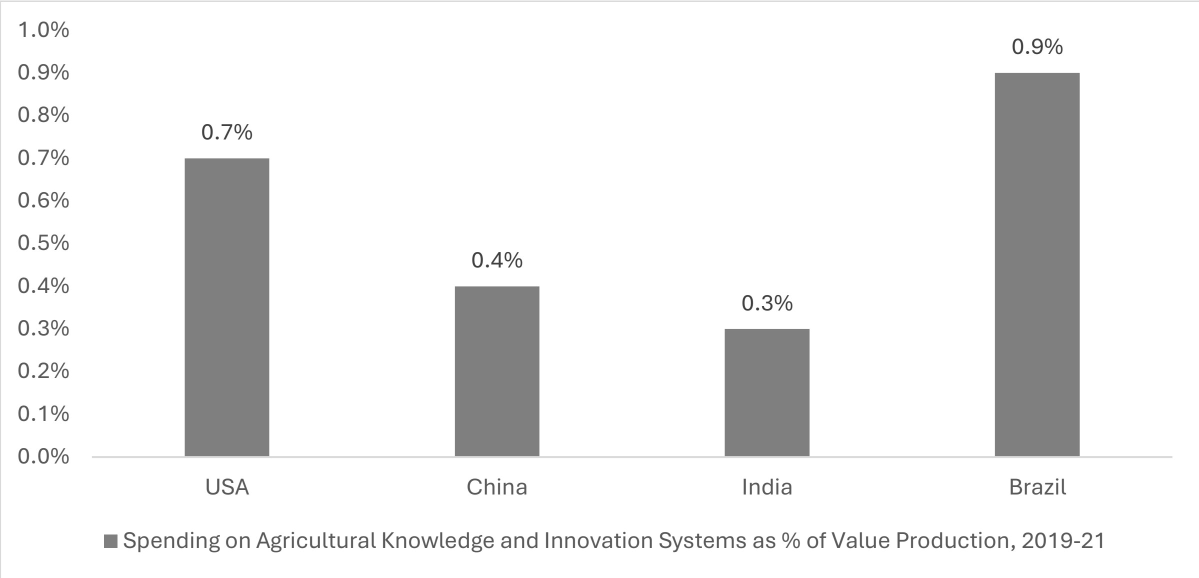
Source: OECD (2022)

Over the last two decades, USA witnessed an increase in spending on agriculture R&D from $1.8 billion to $2.8 billion per year, while India saw a rise from $400 million to $1.2 billion. Brazil's spending rose from $700 million to $1.5 billion. Meanwhile China saw the biggest impact, increasing almost five times from $1.3 billion to $6.6 billion annually, which is more than the cumulative spending of USA, India and Brazil.

As per data from the OECD, between CY2000-CY2002 and CY2019-CY2021, annual average spending on Agriculture Knowledge and Innovation Systems (the term used by OECD for R&D) increased by approximately $1 billion in USA, India, and Brazil (measured in nominal dollars). These investments include a wide range of activities like budgetary financing for R&D of agriculture and data dissemination, irrespective of public or private institutions or the nature and purpose of research. It also covers agriculture vocational schools, high-level education programs, training for farmers, data collection networks and information dissemination related to agriculture production and marketing.

3.8 Public R&D Spending and Agriculture Production

Chart 18: Spending on Agriculture Knowledge and Innovation Systems as % of Value Production, CY2019-CY2021



Source: OECD (2022), IMARC group, ICRA Analytics

Public R&D Spending and Agriculture Production as a % of agriculture production value were highest for Brazil at 0.9%, followed by 0.7% for USA, 0.4% in China and lastly 0.3% for India. Countries which showcase higher R&D spending have shown significant advancements in crop yields, pest control and sustainable farming practices. Such increased public investment can also help in development of new technologies, enhanced resilience against climate change and better resource management, while ensuring food security, economic growth and farmer's welfare.

3.9 Cropping cycles and classification of crops

India's two major cropping seasons are Kharif and Rabi.

Kharif crops are sown at the onset of the monsoons and harvested at the end of the rainy season, aligning with the Indian subcontinent's southwest monsoon. The word is derived from the Arabic word meaning "Autumn", due to their harvesting time coinciding with the season (around September or October). These crops are also known as monsoon crops as they thrive in the rainy season with abundance of water, in hot and humid climates. These crops are heavily reliant on the monsoons. The amount and timing of rain often becomes crucial in the successful growth of the crops. The Kharif cropping cycle varies in different regions, as per the arrival of the monsoon winds. Some common kharif crops are rice, bajra, groundnut, cotton, pulses, maize, and various oilseeds.

Rabi crops on the other hand are sown in winter and harvested in spring. These types of crops depend on the residual moisture in the soil left after the monsoons and the cooler winter climate. These are also known as winter crops. Rabi crops require less water supply and can typically be grown with irrigation process. Examples of Rabi crops are wheat, mustard, barley, green peas, sunflower, coriander, and cumin.

Table 6: Classification of Crops

Parameters	Kharif Crops	Rabi Crops
Season	Sowing period is from early summer to mid-summer, usually from mid-May aligning with the onset of monsoons	Sowing period is in winter, typically from October to December when the temperatures are comparatively cooler
Temperature	Grown in warm temperatures	Grown in cool temperatures
Water Requirements	Requires high levels of water, often needs to be submerged for optimal growth	Do not require much water supply as water requirements are low
Crops Duration	Harvesting duration is short, allowing potential for two harvests per year	Longer crop growth cycle resulting in usually one harvest per year
Examples	Maize, Cotton, Rice, Jowar, Groundnut	Barley, Peas, Wheat, Oilseeds, Gram

4. Domestic Agriculture Market Overview:

India’s agriculture market output plays a key role in the county’s economy, providing food security while also contributing significantly to India’s GDP (approximately ~18% in overall GVA at current prices during FY2025). Recent developments in agriculture practices, improved technology, rise in investments coupled with favourable government policies have led to robust growth in the sector. Crops like rice, wheat, sugarcane, and cotton dominate the agriculture landscape forming the cornerstone of India's agriculture output.

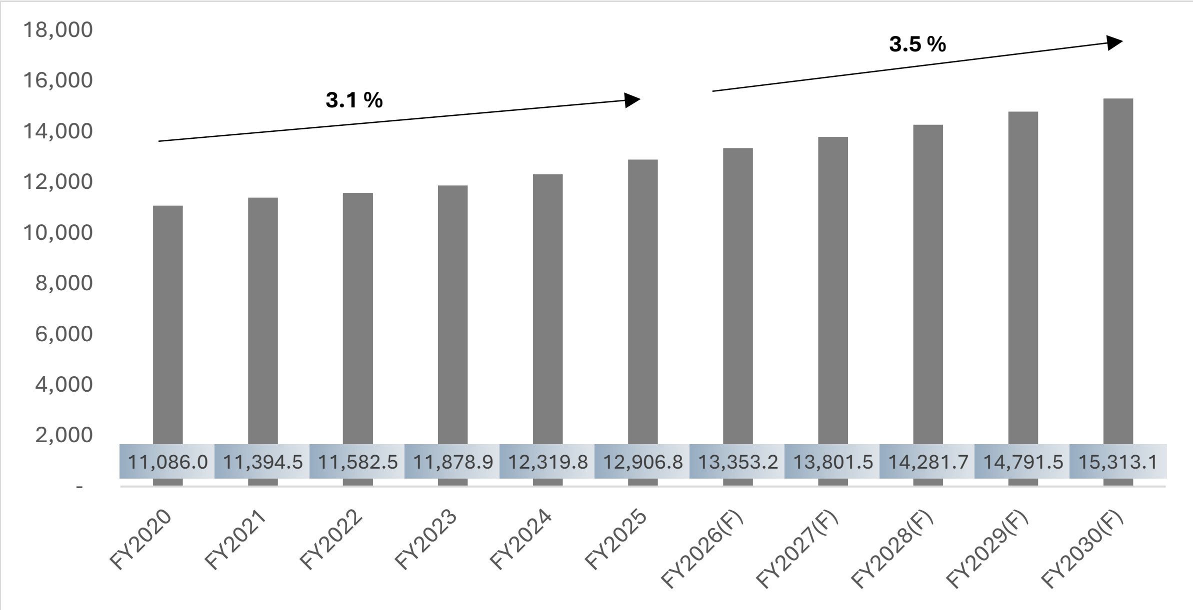
High yielding crop varieties, modern irrigation techniques, and mechanization of farming process have contributed to increased productivity. This has helped stabilize agriculture output and food production. It has also contributed to development and welfare of millions of farmers all over the country. The government has implemented various schemes like the Pradhan Mantri Fasal Bima Yojana, offering crop insurance, electronic National Agriculture Market (e-NAM) which provides a unified online market to the farmers, Pradhan Mantri Krishi Sinchayee Yojana (PMKSY) which helps in physical access of water to farm and increase cultivable land to name a few. But despite these tailwinds, the agriculture sector faces various challenges. Climate change is one of the biggest hurdles resulting in changes in weather patterns and erratic monsoon rains. These disruptions and adverse climatic conditions result in lower crop yield or in extreme cases, crop failure. Water scarcity remains another major challenge for India, especially for regions which are reliant on the monsoons for irrigation and farming. Fragmented land holdings too hinder economies of scale and mechanization of the farming process.

To combat these challenges, there is an emphasis on sustainable agriculture production, along with integration of digital technology into farming. Precision farming, using real time data and utilizing data and technology for optimum crop yield is slowing changing the traditional agriculture landscape, as they help farmers make informed decisions, enhancing productivity and resilience.

4.1 Market Performance of the Indian agriculture market:

The Indian agriculture market has reached an estimated value of Rs. 12,906.8 billion in FY2025, in terms of gross value added (GVA). Indian agriculture market includes GVA for food grains, sugarcane, nine oilseeds, cotton, and jute. The growth is recorded at a CAGR of 3.1% during FY 2020-FY2025. The Indian agriculture market is projected to reach a value of Rs. 15,313.1 billion by FY2030 in terms of GVA, growing at expected CAGR of 3.5% during FY2026-FY2030.

Chart 19: India: Agriculture Market: Value (Rs. In Billion) FY2020-FY2030

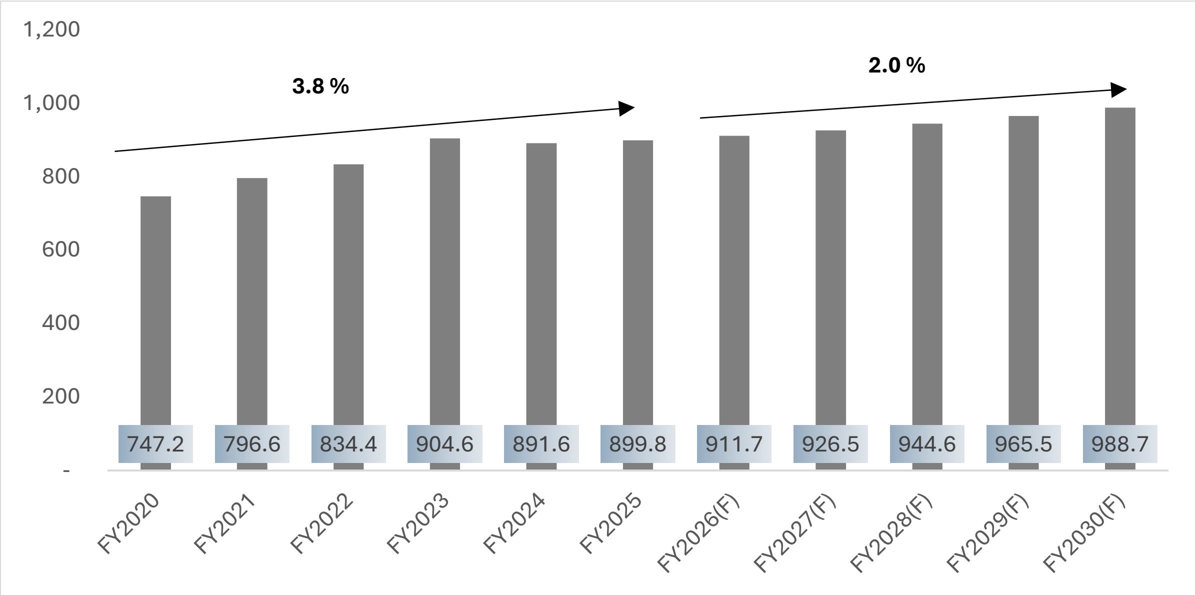


Source: Department of Agriculture and Farmers Welfare, IMARC, ICRA Analytics

The Indian agriculture market has reached an estimated production volume of 899.8 million tons in FY2025, growing at CAGR of 3.8% during FY2020-FY2025. The projected volume is expected at 988.7 million tons by FY2030, growing at CAGR of 2.0% during FY2026-FY2030.

Price escalation includes extreme weather events, which disrupt growing seasons and reduce yields, as well as lower reservoir levels that impact water availability for irrigation. Additionally, damaged crops from unpredictable weather patterns have adversely affected farm output, leading to higher food prices. These challenges increase production costs and create supply constraints, thereby impacting the overall market value within the sector.

Chart 20: India: Agriculture Market: Production volume (in Million Tons) FY2020-FY2025



Source: Department of Agriculture and Farmers Welfare, IMARC, ICRA Analytics

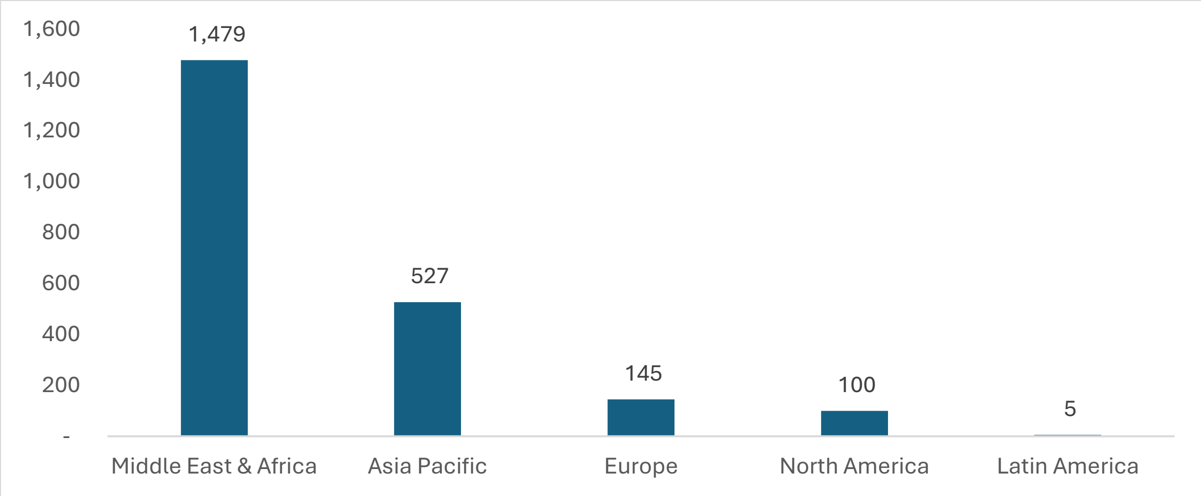
The market drivers boosting value and volume of growth in the agriculture sector include:

- **Increase in consumer demand-** Increasing population of India along with rising incomes have resulted in growing demand for diverse and quality food products, thus boosting production and adoption of advanced technologies.
- **Employment generation-** As per the Periodic Labour Force Survey (PLFS) conducted by Ministry of Statistics and Programme Implementation (MoSPI), ~46% of the total workforce of India was engaged in agriculture and allied sector during FY2023. This highlights the role of the sector in employment generation in India.
- **Economic contribution-** Share of GVA from agriculture and allied sectors is ~ 18% of the total economy at current prices, reflecting the significant role the segment plays in the economy.
- **Impact on supply chain-** The agriculture sector supports various key industries like consumer-packaged goods (CPG), retail, agrochemicals to name a dew.
- **Development of rural regions-** Creation of employment and development of infrastructure adds to rural development. Agriculture development also leads to improved roads, schools, and healthcare facilities.
- **Export and trade-** India is a significant global exporter of rice, spices, and tea, which positively affects the foreign exchange earnings and improves the balance of trade of the nation.

4.2 India's export Market analysis:

In FY2025, the largest market for exported agriculture was Middle East & Africa. This accounted for 65.6% of the total exported agriculture output in terms of value. It was followed by Asia Pacific at 23.4%, followed by Europe at 6.4%, North America at 4.4% and lastly Latin America at 0.2%. The total agriculture exports stood at Rs 2,257 billion during FY2025.

Chart 21: India's Agriculture Export Market breakup by Region for FY2025 in Rs. billion (in value terms)



Source: UN Comtrade, IMARC Group, ICRA Analytics

4.3 Drivers, restraints and opportunities of the domestic agriculture:

4.3.1 Drivers:

- **Increase in Food demand-** The Indian food market is witnessing a radical shift in demand, due to urbanisation, shifts in gender composition in workforce, increasing consumption rate, demand for higher quality products etc. The rising population has increased the gap between demand and supply, driving the need for effective agriculture solutions. Furthermore, significant crop losses because of inadequate use of crop protection products are a major challenge. Agrochemicals play a key role in improving crop yield and prevention against pests and diseases. With the food demand projected to reach $1.2 trillion by FY2026, agrochemicals are essential in addressing food security challenges and driving growth in the sector.
- **Growing agriculture land-** India's total geographical area amounts to 328.7 million hectares(ha), with net sown area amounting to 139.3 million ha and gross cropped area being 197.3 million ha, reflecting a cropping intensity of 141.6%. Net sown area constitutes around 42% of the total geographical area. Furthermore, net irrigated area stands at 71.6 million ha, indicating that a significant portion of land has access to irrigation. This highlights the extent of cultivable land and the scope for further enhancement of productivity by way of improved land use and irrigation practices in India.
- **Diversification of crops-** Crop diversification has boosted India's crop production by enhancing production efficiency, increasing market resilience and overall broadening the range of crops produced in the country. This helps farmers to mitigate risks related to environmental uncertainties and market fluctuations. Various government initiatives (like Technology Mission on Oilseeds) have incentivized profitable crops to reduce reliance on imports and boost domestic production. Additionally, the diversification process also enables better climate and soil management, increases export opportunities, stabilizes agriculture production and ultimately helps drive the profitability of the agriculture sector.
- **Large workforce-** As per the PLFS conducted by MoSPI, ~ 46% of the total Indian workforce was engaged in agriculture and allied sectors in FY2023. It highlights the

impact the sectors have on job creation and stabilization in India. To further develop the sectors, GoI has set up 10,000 Farmer Producer Organizations (FPOs) to boost farmer incomes and set up *713* Krishi Vigyan Kendra and 684 agriculture technology Management Agencies for training and propagation of modern technologies to farmers. These schemes and initiatives are expected to boost development and workforce strength in the agriculture segment.

- **Increased government initiatives-** Government's focus on the agriculture sector has enabled it to develop significantly in recent years. Various schemes and policies have been introduced like PMFBY, Minimum Support Price (MSP) which ensures fair pricing for farmers and a stable income for them, Pradhan Mantri Kisan Samman Nidhi (PM-KISAN), which provide direct income support to farmers, PMKSY etc. These initiatives and policies have been designed to enhance productivity, support the farmers and boost overall sectoral performance.

4.3.2 Threats and Challenges:

- **Fragmented land holdings-** Fragmented land holdings act as a major barrier to agriculture efficiency and modernization. As per the 10th Agriculture Census data, the average size of operational holdings has witnessed a steady decline from 2.28 ha in FY1971 to 1.84 hectares in FY1981, to further decrease to 1.41 ha in FY1996 to ultimately reaching 1.08 ha in FY2016. This trend of steady fragmentation hinders the use of modern farming practices and reduces overall productivity and is projected to further increase in near future due to increased population and rise in food production demands.
- **Inefficient marketing and storage facilities-** Farmers in India face difficulties in agriculture marketing because of high transportation costs, price fluctuations, inadequate market infrastructure and exploitation by local traders and middlemen. Lack of proper storage areas in rural regions further aggravates the problem, resulting in substantial post-harvest losses.
- **Improper access to crop insurance-** Indian farmers face challenges like lack of awareness, inadequate coverage, and delays in claim settlements with respect to crop insurance schemes available to them. These issues they face often undermines the effectiveness of the policies meant to protect them from crop losses and financial instability.
- **Climate change-** One major impact of climate change is change in weather patterns and severe natural disasters like extreme droughts, floods, storms etc, leading to decreased soil fertility, crop yields, and livestock production. Rise in heat stress on crops, water scarcity and stress and increased cost for pest and disease management can further reduce productivity and income.
- **Lack of proper training and extension facilities-** The extension facilities in the agriculture sector are unevenly distributed, leading to many farmers not being able to access training and up-to-date farming practices. This leads to lower crop yields, higher risk of pests and diseases, lack of knowledge regarding financial assistance, ultimately reducing their productivity and income.

4.3.3 Opportunities:

- **Infrastructural investments-** India has significant potential for investments in rural infrastructure like irrigation facilities, improved storage and warehousing, transportation networks etc. These are in place to reduce post-harvest losses and improve efficiency.

- **Technological advancement-** Agriculture technology's rapid advancement can be partly attributed to the symbiotic ecosystem comprising of digital technologies, innovative start-ups and contributions from large technology companies. Core players in the value chain are adopting digital tools to enhance their services and reach.
  - Farmer supplies providers are increasingly leveraging modern technology to establish direct-to-farmer sales channels. These helps circumvent traditional middlemen and retailers.
  - Both bank and non-bank financial institutions are leveraging technology to customize their offerings to farmers' specific needs while also mitigating loan risks. State Bank of India (SBI) has developed the YONO Krishi app addressing farmers' finance, input, and advisory needs.
  - In farm equipment segment, companies like Mahindra are innovating by providing mechanization as a service like tractor rentals. This makes advanced machinery more accessible to farmers.
  - Companies which are involved in procurement, processing, and selling agriculture products have started integrating backward into the supply chain, thus creating better market linkages for farmers. Through its e-Choupal network, ITC has helped expand its direct-from-farm procurement.
  - MoooFarm, a Gurugram-based start-up, along with Microsoft helped tackle mastitis using machine learning (ML) and help farmers save US$500 million per year. Agritech players' collaboration with large companies help develop innovative solutions for farming while favouring market growth.
- **Development of agriculture in underdeveloped areas-** Rising demand for agriculture has expanded the scope for agriculture activities in regions historically considered agriculturally underdeveloped. In places where irrigation and resources are scarce, dryland farming techniques have been implemented to improve yields and productivity. Other allied activities like horticulture, floriculture, animal husbandry, and fisheries have also seen a boost in these regions, creating new economic opportunities and enhancing local livelihoods. Additionally, introduction of modern agriculture technologies and practices in these regions have slowly transformed them into more productive and economically viable regions.
- **Market linkages and export promotion-** GoI has implemented various polices to improve market linkages and export, allowing better access to both domestic and international markets. This comprises of enhancing reach of the Agriculture Produce Market Committees (APMCs) and also increasing exports of high-value crops. The Agriculture Export Policy (AEP), 2018 was introduced, with the vision to harness export potential and position India as a global leader in agriculture.

4.4 Government Initiatives to Boost Agriculture in India:

The GoI has introduced several schemes to develop the agriculture sector. Some of the most notable ones are as follows:

- **PM-KISAN-** PM-KISAN, launched on 24th February 2019, is a central government scheme that provides income support to the farmers. Financial benefit of Rs. 6000/- is provided in 3 equal instalments in a year (every 4 months), under the scheme, directly into the farmers or their family's accounts through the Direct Benefit Transfer (DBT) mode.

- **Pradhan Mantri Kisan Maan Dhan Yojana (PM-KMY)-** PM-KMY, launched on 12th September 2019, is a central government scheme, which aims to provide security to vulnerable farmer families. It is a contributary scheme where the farmers can opt to be a part of the scheme by paying a small contribution to a pension fund, which is matched by the central government.
- **PMFBY-** PMFBY, launched in FY2017, is aimed at providing an affordable crop insurance product which provides comprehensive risk cover to farmers against all non-preventable natural risks (pre-sowing to post-harvest). It also provides adequate claim amounts to the farmers. The scheme is available to all farmers and since FY2017, a total of 5549 lakh farmer applications have been insured and Rs 150589 crore paid as a claim under this scheme.
- **Formation & Promotion of new 10,000 FPOs-** The Central Sector Scheme (CSS) was launched in FY2021by the GoI for "Formation and Promotion of 10,000 FPOs", with a total budgetary outlay of Rs.6865 crore. Formation and promotion of FPOs is to be done through Implementing Agencies (IAs) which further engage Cluster Based Business Organizations (CBBOs). These aim to provide professional handholding support to the FPOs for 5 years.
- **Agriculture Infrastructure Fund (AIF)-** The AIF was launched under the Aatmanirbhar Bharat Package to bridge the existing infrastructure gaps and to mobilize investment in agriculture infrastructure. It is a medium to long term debt financing facility, used for investment in viable projects for community farming assets and post-harvest management infrastructure.
- **Rashtriya Krishi Vikas Yojana (RKVY)-** RKVY, launched as a flagship scheme of the Department of Agriculture & Farmers' Welfare (DA&FW) in FY2008, aims to incentivize States to innovate comprehensive agriculture development plans, while keeping factors like agroclimatic conditions, natural resources and technology in mind. The main focus is to ensure more inclusive and integrated development of agriculture and allied sectors. The scheme was restricted in FY2023 into the RKVY Cafeteria Scheme, integrating several existing schemes into its ambit, combining elements from:
    - Soil Health Card (SHC)
    - Rainfed Area Development (RAD)
    - Per Drop More Crop (PDMC)
    - Micro Irrigation Fund (MIF)
    - Paramparagat Krishi Vikas Yojana (PKVY)
    - Sub-Mission on Agriculture Mechanization (SMAM)
    - Crop Residue Management
    - Rashtriya Krishi Vikas Yojana - Detailed Project Report Based Schemes (RKVY-DPR)
    - Agro-Forestry
- **Krishonnati Yojana:** The Krishonnati Yojana comprises 11 Schemes/Missions, which aim to develop the agriculture and allied sectors, to improve farmer incomes and enhance productivity and crop yields.
    - National Food Security Mission (NFSM)
    - Sub-Mission on Seed and Planting Material (SMSP)
    - National Mission on Edible Oils (NMEO)-Oil Palm

- Mission for Integrated Development of Horticulture (MIDH)
- Integrated Scheme for Agriculture Marketing (ISAM)
- Mission Organic Value Chain Development for North Eastern Region
- Sub-Mission on Agriculture Extension (SMAE)
- Digital Agriculture

4.5 Government Initiatives to Boost Agriculture in India

The central government significantly influences the agriculture sector by implementing regulatory frameworks and diverse support mechanisms. In recent times, in addition to enhancing farm productivity, the government has prioritized the improvement of farmers' incomes. Recent reforms introduced for the agriculture sector encompass:

- **Amendments to the Essential Commodities Act (ECA)-**
    - Produce stock limits can only be imposed under exceptional circumstances such as national calamities or a famine.
    - Stock limit would not be applicable to other value-chain participants and processors.
    - Encouraging private investments in agriculture infrastructure and mitigate risk in agri-infrastructure.
    - ~146 million farmers can sell their produce to any person/organization anywhere in the country with a PAN card, as per new reforms.
    - Removal of state-wise restrictions for farmers where they could only sell their crops within the state mandis regulated by the APMCs previously.
- **The Farmers (Empowerment and Protection) Agreement on Price Assurance and Farm Services Ordinance, 2020-**
    - Provides farmers a legal basis to enter into contract farming practice.
    - Allows farmers to enter into written agreements with buyers, which might specify terms and conditions of quality, grade, time of supply price and extension service, for 1-5 year periods.
    - The produce's price should be a part of the agreement. The prevailing price in APMC shall be the benchmark in case of any additional amount over the agreed price.

4.6 Regulatory Framework for Domestic Agriculture Market:

- **Agricultural Produce Market Committee (APMC) Acts-** Agriculture markets are largely regulated under the state-specific APMC Act 2003 in India. The act designates specific geographical areas as market zones (which are supervised by state appointed Market Committees), where markets permitted by the government are allowed to carry out wholesale activities, creating a monopoly and restricting competition.
- **The Indian Contract Act, 1872-** Contract farming in India was initially regulated under the Indian Contract Act, 1872, which was later enhanced with the Model APMC Act 2003. This introduced specific provisions for contract farming like mandatory registration of sponsors and dispute resolution mechanisms. But despite its benefits, state governments were slow to promote contract farming due to resistance from commission agents. The Ministry of Agriculture introduced a draft Model Contract Farming Act, 2018, in February 2018, which provided a template for states to develop their own contract farming policies. In some states contract farming needs registration with the APMC, which records contractual agreements and handles disputes.

- **Essential Commodities Act, 1955-** The act regulates production, supply, and distribution of essential commodities to prevent hoarding and black marketing. This includes foodgrains, edible oilseeds and oils to name a few. The act was later modified by the Essential Commodities (Amendment) Act, 2020. The act is extremely significant in maintaining food safety and availability across the nation.
- **The Seed Act, 1966-** The act extends across India and aims to maintain and improve the quality of seeds sold and their production and supply to farmers. By amending the Seed Act, 1966 and Seed Rules, 1968, the bill seeks to enhance competition in the segment. Proposals like registration of seed varieties have been proposed under the act by the GoI, for which the seed industry has submitted observations and recommendations to the government, owing to certain drawbacks and aiming to amend the same.

4.7 Impact of Climate Change and Other Factors on Agriculture

- **Altered Rainfall Patterns:** Climate change has led to considerable changes in precipitation patterns, which have significantly affected agriculture in India, where farming is largely reliant on monsoon rains. The unpredictability of rainfall disrupts established cropping schedules, complicating the planning of sowing and harvesting for farmers. Alterations in rainfall patterns and rising temperatures may shorten the growth cycles of crops, thereby diminishing the yields of essential staples such as wheat and rice. Furthermore, variations in precipitation contribute to issues such as soil erosion, waterlogging, and increased soil salinity, which further undermine agriculture productivity. These disruptions raise serious concerns regarding food security, as a decline in agriculture output can lead to price volatility and potential food shortages, particularly in regions that are already vulnerable.
- **Severe Weather Conditions:** Events such as thunderstorms, cyclones, floods, cold waves, and heat waves present significant threats to agriculture. Thunderstorms and hail can directly damage crops, while cyclones and floods may cause waterlogging and soil erosion, severely compromising crop yields. Cold waves can hinder plant growth and lower yields, whereas heat waves can induce heat stress, adversely affecting both the quality and quantity of harvests. Research has indicated that fluctuations in rainfall and temperature resulting from these extreme weather events lead to considerable negative impacts on crop productivity.
- **Increasing Atmospheric Temperatures:** The phenomenon of climate change, primarily driven by global warming, results in a rise in average atmospheric temperatures, which in turn causes considerable alterations in the global climate system. Research in agronomy has shown that global warming adversely impacts agriculture productivity. The escalation of temperatures associated with global warming is anticipated to diminish the yields of conventional rainfed and irrigated cash crops, including jowar, bajra, pulses, sugarcane, onion, and maize.
- **Rise in sea level:** The phenomenon of rising sea levels poses considerable challenges to agriculture and food security, especially in coastal areas. The increase in salinity and the occurrence of flooding associated with elevated sea levels can result in the deterioration of arable land, thereby diminishing crop yields and jeopardizing the supply of freshwater necessary for irrigation. This situation not only endangers food production but also threatens the livelihoods of individuals reliant on agriculture activities. Furthermore, the rise in sea levels intensifies coastal erosion, leading to the loss of valuable farmland and

endangering coastal communities. As sea levels continue to rise, saline water may infiltrate freshwater sources, including rivers and groundwater aquifers, compromising the quality and accessibility of these essential resources. This intrusion has repercussions not only for agriculture practices but also for drinking water availability and local ecosystems.

4.8 Importance of having a strong R&D set up in agriculture industry for key domestic players

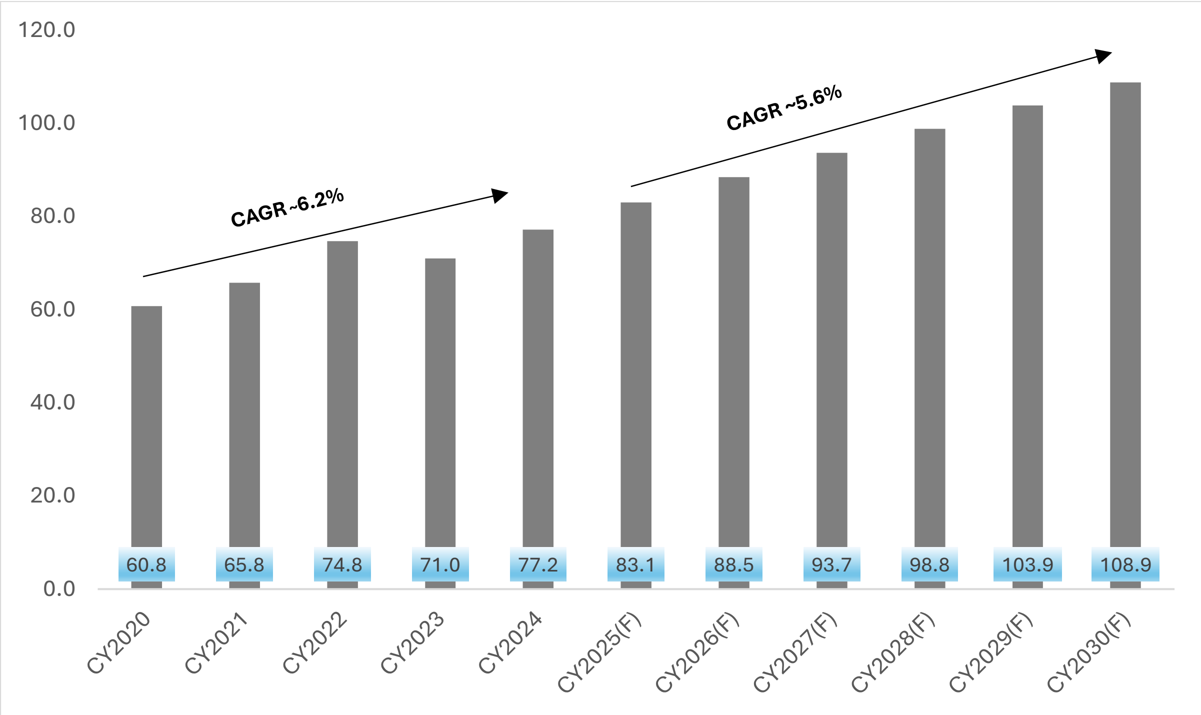
- **Addressing challenges and sustainability:** R&D plays a critical role in tackling major challenges such as climate change, water scarcity, and soil degradation. Through targeted research, domestic players can develop sustainable farming practices and technologies that mitigate these issues. Innovations from R&D can lead to solutions that conserve water, enhance soil health, and adapt to changing climatic conditions. By integrating sustainable practices, R&D supports long-term agriculture viability, ensuring that farming remains productive and resilient in the face of environmental challenges while contributing to overall ecological balance.
- **Enhancing competitiveness and growth:** A robust R&D framework boosts competitiveness and drives growth by attracting multinational corporations (MNCs) interested in leveraging India's skilled workforce and cost advantages. A well-established R&D setup stimulates local economies by fostering job creation and supporting related industries. Increased public investment in agriculture R&D demonstrates a commitment to fostering innovation and development within the sector. This investment not only aids the growth of domestic players but also positions the industry as a global leader in agriculture advancements, attracting further investment and promoting economic development.
- **Innovation and productivity:** A strong R&D setup is essential for fostering innovation and enhancing productivity in agriculture. By investing in research and development, domestic players can develop new technologies, crop varieties, and farming practices that significantly improve agriculture efficiency and output. This enables companies to remain competitive in both domestic and international markets by adopting cutting-edge solutions and refining farming methods. Effective R&D efforts lead to advancements that optimize crop yields, lower production costs, and address emerging agriculture challenges, thereby strengthening the industry's capacity to meet increasing food demands.
- **Improving Farmer Livelihoods:** R&D investments play a significant role in improving farmer livelihoods by developing new marketing strategies and distribution channels that increase farmers' incomes and create new opportunities. Research-driven advancements lead to better farming practices and more efficient resource use, directly benefiting farmers. By offering practical solutions, training, and guidance, R&D helps farmers optimize their operations, increase productivity, and achieve higher profitability. This focus on enhancing farming practices and economic outcomes contributes to the overall well-being and financial stability of farming communities.

5.Global agrochemical market

Agrochemicals, commonly referred to as crop protection chemicals, have been designed to protect crops from insects, diseases, and weeds. Insecticides, fungicides, herbicides, and PGR are examples of the chemical substances which are used to control harmful organisms like fungi, nematodes, mites, insects, rodents, and viruses that can damage crops. The application of agrochemicals is crucial for ensuring productive crop growth and is a key component of contemporary agriculture practices.

The global agrochemical market reached a value of $ 77.2 billion in CY2024, representing a CAGR of 6.2% during CY2020 to CY2024. Going forward, the global agrochemical market is expected to reach a market value of $ 108.9 billion by CY2030, growing at a CAGR of 5.6% from CY2025 to CY2030. Going forward, the rate of growth in sales realisations is likely to be higher than the volume growth, thereby keeping the overall sales value growth higher than the volumetric growth. This is due to several factors driving price increases. Firstly, input costs including raw materials, energy, and transportation have surged, compelling producers to raise prices to maintain margins. Additionally, heightened regulatory standards and a shift toward sustainable, eco-friendly agrochemical solutions often require more complex, higher-cost formulations, which are priced accordingly. Finally, demand for specialized products like biopesticides and herbicides is rising, adding premium pricing to the market. These factors collectively ensure that the sales value growth rate remains ahead of volume growth.

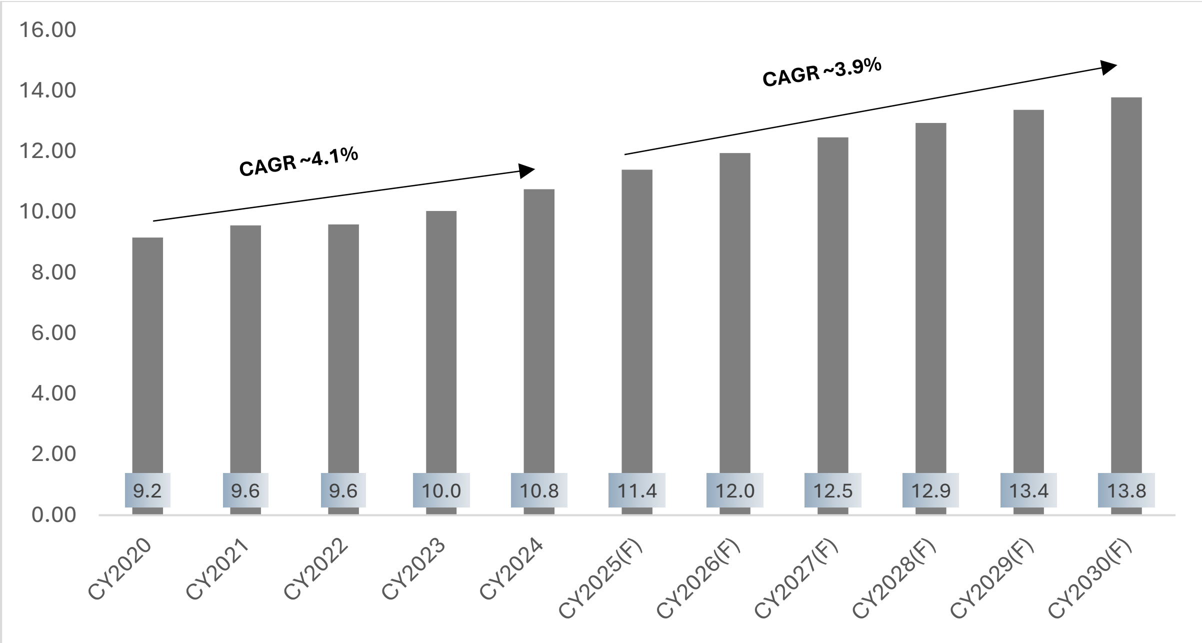
Chart 22: Global agrochemical sales value in (Billion $), CY2020- CY2030F



Source: Food and Agriculture Organization of the United Nations (FAO), IMARC Group, ICRA Analytics

On the other hand, in terms of volume, the global agrochemical market reached a volume of 10.8 million tonnes in CY2024, growing at a CAGR of 4.1% during CY2020-CY2024. Looking forward, it is expected to reach a volume of 13.8 million tonnes by CY2030, with a CAGR of 3.9% during CY2025-CY2030.

Chart 23: Global agrochemical sales volume in (in Million Tonnes), CY2020- CY2030F



Source: FAO, IMARC Group, ICRA Analytics

5.1 Market drivers, restraints and threats in the global agrochemical market

5.1.1 Market drivers in the global market-

- **Rising demand for increasing agriculture output:** With the global population on the rise, the necessity for food production is also increasing. This situation has created significant pressure on the agriculture sector to cultivate more crops in an efficient and sustainable manner. Agrochemicals, including pesticides, herbicides, fungicides, and PGR are essential in improving crop yields and safeguarding crops against pests and diseases. The application of these agrochemicals enables farmers to maximize farmland productivity, thereby minimizing the requirement to convert additional land for agriculture use, which is vital for environmental preservation.
- **Modern agriculture techniques by farmers worldwide**: The growing recognition and implementation of modern techniques are contributing to the expansion of the agrochemical market. Educational initiatives, including training programs, workshops, and extension services offered by agriculture organizations and agrochemical firms, are helping farmers getting information about the correct application of these products. As larger number of farmers embrace integrated pest management (IPM) and other modern farming methods, the demand for agrochemicals is expected to increase, thereby bolstering the ongoing growth of the market.
- **Increasing government assistance and advantageous regulations:** Several countries are putting in place policies that support the use of agrochemicals to secure food supplies and increase agriculture exports. They are providing subsidies and financial incentives for farmers to buy and use agrochemicals in regions where agriculture is a significant sector of the economy. Additionally, regulatory frameworks that encourage the safe and efficient use of agrochemicals, help to build consumer trust and ensure that the market continues to grow while adhering to safety standards.
- **Technological advancements:** The development of more effective and environmentally friendly agrochemical products is a result of innovations in chemical formulations and application techniques. Precision agriculture technologies, for instance, allow for targeted application of agrochemicals, reducing waste and minimizing impact on

surrounding ecosystems. The increasing popularity of biopesticides and organic fertilizers is due to their sustainable nature, appealing to environmentally conscious consumers and regulatory bodies advocating for greener agriculture practices.

5.1.2 Threats and challenges witnessed in the global market are-

- **Environmental and health issues:** This factor present considerable challenges. Although pesticides and fertilizers enhance crop yields, their improper application can result in harmful consequences for the environment. Key issues include soil degradation, water pollution, and a decline in biodiversity. Additionally, negative impact on human health conditions cannot be ruled out. These concerns have prompted heightened scrutiny from environmental organizations and the public, leading to a demand for more stringent regulations and the creation of safer, more sustainable alternatives.
- **Increased competition:** The agrochemical industry is characterized by intense competition, which necessitates continuous innovation, as companies strive to create new and enhanced products that align with the changing requirements of farmers and regulatory guidelines. Nevertheless, the substantial expenses associated with research and development, coupled with the possibility of new products not being embraced by the market, results in considerable pressure. Smaller companies, in particular, may find it challenging to keep up with larger, established firms that have greater resources to allocate to innovation and marketing efforts.
- **Emergence of resistance in pests and weeds:** A significant obstacle in the agrochemical sector is the emergence of resistance in pests and weeds. The continuous application of identical agrochemicals over time can result in the evolution of resistant populations, diminishing the efficacy of these substances. This situation adversely affects agriculture productivity and compels the creation of new formulations, a process that is often time-consuming and expensive. The occurrence of resistance highlights the necessity for integrated pest management approaches and the rotation of various chemical classes to address this concern. Nevertheless, the execution of these strategies can be intricate and demands the education of farmers regarding optimal practices.
- **Environmental activism and the evolving public perception:** The growing awareness and concern about any negative impacts of agrochemicals on biodiversity, soil health, and water quality have led to increasing opposition from environmental groups and the general public. Any campaigns and reports emphasizing any dangers of certain chemicals can create substantial public pressure on governments and companies to reduce or eliminate their use. This can lead to bans on products, stricter regulations, and a fall in market demand as consumers and farmers choose more environmentally friendly alternatives.
- **Strict regulations**: The agrochemical market is facing a significant threat due to the increasingly strict regulations governing the production, sale, and use of agrochemicals to ensure environmental safety and human health. Governments and regulatory bodies around the world are tightening their controls due to geopolitical tension, trade wars etc, which can lead to shortage of raw materials,. This includes imposing stricter limits on residue levels, more comprehensive testing requirements, and bans on certain high-risk chemicals. As a result, companies may face higher compliance costs, delays in product approvals, and the need to reformulate or discontinue products. The increasing practice of organic farming and the expanding demand for biopesticides and organic fertilizers are challenging the conventional agrochemical market. The growing consumer preference for organic products is leading farmers to decrease their use of synthetic chemicals and

transition to organic practices. Biopesticides, made from natural sources such as animals, plants, bacteria, and specific minerals, are becoming more popular because of their reduced environmental impact and perceived safety. This transition is driven by consumer choices and regulatory incentives, compelling traditional agrochemical companies to evolve and adjust to the shifting market dynamics.

- **Climate change and erratic weather patterns:** Variations in temperature and rainfall can significantly affect the behaviour of pests and diseases, necessitating the development of new or modified chemical solutions. Additionally, severe weather events such as floods, droughts, and storms can interrupt agriculture operations and supply chains, thereby influencing both demand and distribution. To effectively respond to these changes, agrochemical companies must invest heavily in research and development, which places an additional financial burden on them.
- **Challenges related to intellectual property**: In the international agrochemical sector, challenges related to intellectual property are of considerable importance, particularly in relation to patents and their expiration. Patents grant agrochemical firms exclusive rights to manufacture and market innovative products for a duration of typically 20 years. This timeframe enables companies to recuperate the significant investments made in research and development (R&D) and to achieve a return on their investments. However, as patents reach their expiration, these formerly exclusive products become accessible to generic manufacturers, who can offer similar products at reduced prices. For example, several active ingredient patents are anticipated to expire by 2030, including prominent compounds such as chlorantraniliprole, flubendiamide, and sulfoxaflor. The emergence of generic competitors frequently results in a substantial decline in prices, which can diminish the market share and profitability of the original patent holders. The financial burden of developing new agrochemical products is considerable, often necessitating extensive investment in research and development. The projected market size for off-patent molecules may exceed $ 4.1 billion by 2026, as reported by AgriBusiness Global (2021).

  Prominent molecules include Chlorantraniliprole (Corteva/FMC), which had a market size of $ 1.75 billion in 2019 and is utilized for controlling chewing insects in crops such as soybean, cotton, and maize. Other significant molecules, including Flubendiamide ($ 507 million, 2024), Sulfoxaflor ($ 190 million, 2027), and Cyantraniliprole ($ 120 million, 2026), have either lost or will lose patent protection, thereby creating opportunities for generic products and intensifying competition in the fungicide and insecticide markets for various crops.

  According to the same report, 30%-40% of off-patent active ingredients are generally adopted by generic manufacturers, with a preference for fungicides and insecticides over herbicides. However, 60%-70% of off-patent molecules remain unadopted due to factors such as limited market potential, manufacturing complexities, and unavailability.

  Labor deficit: The labor deficit in the agrochemicals manufacturing sector represents a significant challenge to the global market, jeopardizing production capabilities, product integrity, innovation, and cost efficiency. This scarcity of skilled professionals not only impacts production levels but also compromises the quality of agrochemical products, as there is a shortage of personnel who possess a thorough understanding of the intricate processes involved in chemical formulation and manufacturing. Additionally, the limited pool of workers with the requisite skills to operate advanced machinery and comply with stringent safety regulations increases the likelihood of operational inefficiencies and potential safety risks. Beyond these operational issues, labor shortages can result in heightened production expenses. With a reduced workforce, companies may be compelled to raise wages or invest in automation solutions to sustain production output, both of which can escalate costs.

- **Sustainability and corporate social responsibility (CSR):** The necessity for CSR within the agrochemical sector is growing stronger. Various stakeholders, such as consumers, governmental bodies, and non-governmental organizations, are paying closer attention to the environmental consequences of agrochemical products and their associated practices. This increasing scrutiny will compel companies to lessen their dependence on harmful chemicals, create environmentally friendly alternatives, and adopt sustainable agriculture methods. Meeting these demands will necessitate considerable modifications to product lines and business operations, often incurring substantial expenses. Furthermore, the shift towards more sustainable practices introduces regulatory complexities, as companies must navigate diverse global standards and expectations concerning environmental and social accountability.

5.2 Value Chain Analysis of the agrochemical market

The global agrochemical market value chain involves raw material suppliers, active ingredient manufacturers, formulators, distributors or traders, and end users. A detailed perspective on the same has been provided below:

Raw Material Supplier: The raw material supplier plays a pivotal role at the beginning of the agrochemical value chain, offering essential inputs such as basic chemicals, minerals, and plant extracts necessary for the production of agrochemicals. The supplier's duties involve sourcing high-quality raw materials, managing inventory, and ensuring timely delivery to avoid any production delays.

Active ingredients manufacturers: Manufacturers of active ingredients specialize in producing the core chemical components that form the functional part of agrochemicals. They focus on creating substances such as herbicides, pesticides, and fertilizers that directly impact plant health and productivity. These manufacturers ensure that their active ingredients meet strict safety and efficacy standards by utilizing advanced chemical processes and rigorous quality control measures. Their role is crucial as they make sure the agrochemicals are both effective and safe for agriculture use.

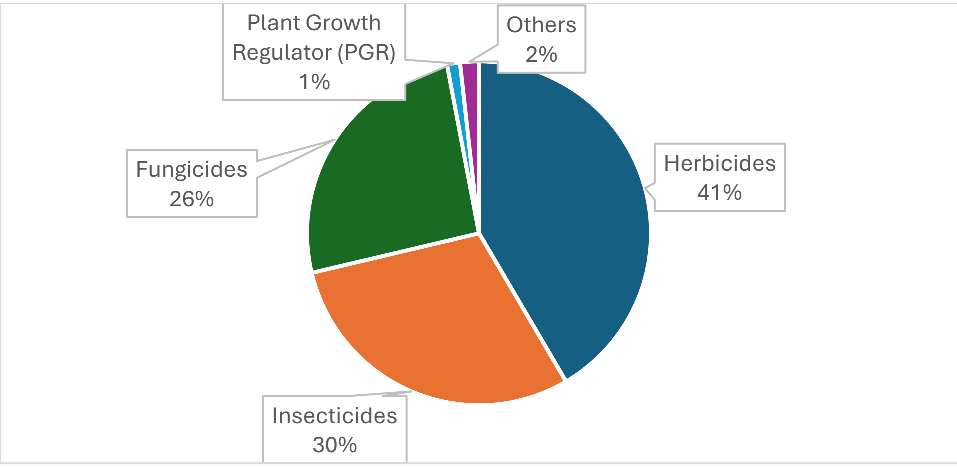
Formulators: The formulator combines the active ingredients produced by manufacturers with other components to create finished agrochemical products. This process involves designing formulations that improve the stability, efficacy, and usability of these products. The formulator must consider various factors, such as interactions of ingredients, application methods, and environmental impact. They ensure that the final agrochemical products effectively achieve their intended purposes, such as pest control or nutrient delivery, while also complying with regulatory requirements and safety standards.

Distributors or traders: Distributors or traders connect manufacturers with end users. They handle logistics, including transportation, warehousing, and inventory management, ensuring products are delivered on time and in optimal condition. Their responsibilities also encompass marketing and sales, promoting products, offering market insights, and helping manufacturers refine strategies based on demand trends and customer preferences. Additionally, distributors provide technical support and customer education on the proper use of agrochemicals, safety precautions, and best practices to maximize product efficacy. They also ensure regulatory compliance by managing necessary documentation and adhering to local regulations.

End-users: The end users in the agrochemical value chain primarily include farmers, agriculture producers, and agribusinesses who directly apply agrochemical products to crops and soil to achieve specific agriculture outcomes. Their role is crucial as they use these products to increase crop yields, control pests, and manage soil health, directly affecting their productivity and profitability. The experiences and feedback from end users provide valuable insights into the effectiveness, safety, and usability of agrochemicals. Additionally, end users often need support and guidance on optimal application methods and best practices, highlighting the importance of effective communication and service from distributors and manufacturers.

5.3 Global Market Breakup by Product Type

Chart 24: Global Market breakup by product type during CY2025 (value in terms of consumption)

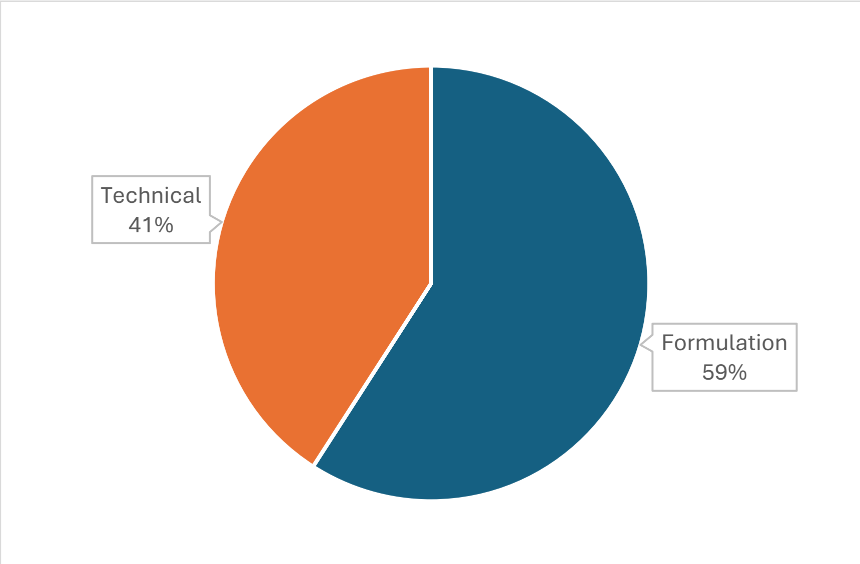


Source: IMARC Group, ICRA Analyticsx

During the year CY2025, herbicides dominated the market share in the global agrochemical market accounting for a share of ~42% followed by insecticides at ~30%, fungicides at ~26%, plant growth regulator at ~1% and others at ~2%.

5.4 Global breakup by business segments

Chart 25: Global breakup by business segments during CY2025 (in %), (in terms of consumption)

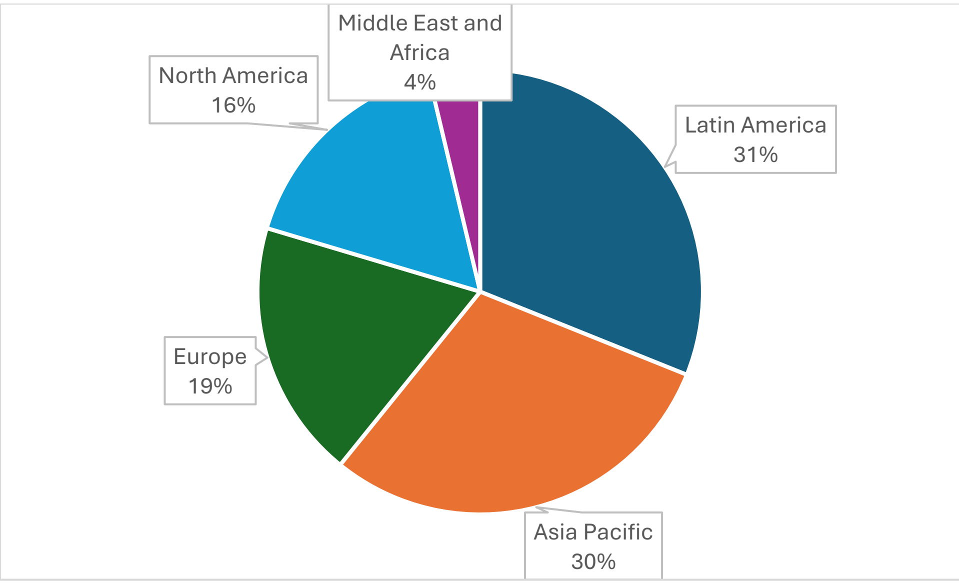


Source: IMARC Group, ICRA Analytics

During the year CY2025, formulation represented the largest business segment accounting for a share of ~59% of the total global agro chemical market followed by technical segment at ~41%.

5.5 Global market Breakup by Region

Chart 26: Global market breakup by region in CY2025 (in terms of consumption)

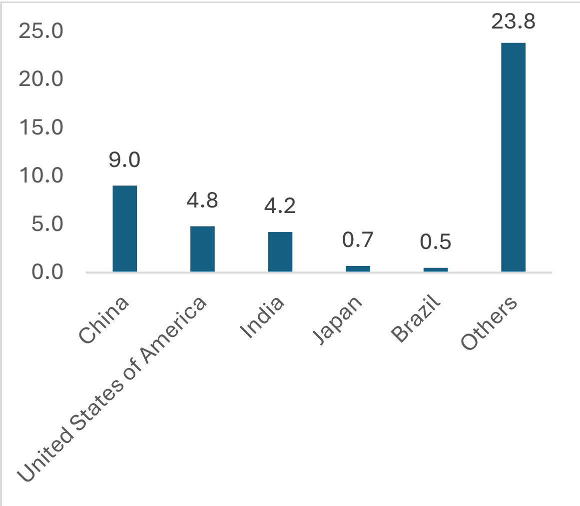


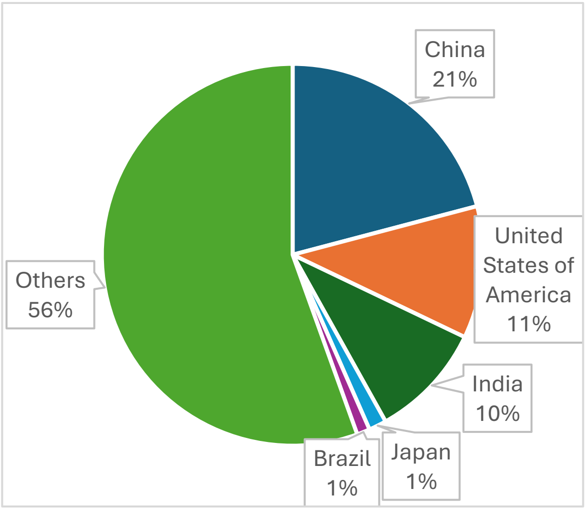
Source: IMARC Group, ICRA Analytics

During CY2025, Latin America dominated the global agrochemical market segment with a share of ~31% while Asia Pacific represented a market share of ~30%, followed by Europe at ~19%, North America at ~17% and Middle East & Africa at ~4%.

5.6 Global Export Breakup by Country

Chart 27: Global Export Breakup by Country (value terms in $ Billion and in % Share for CY2024)





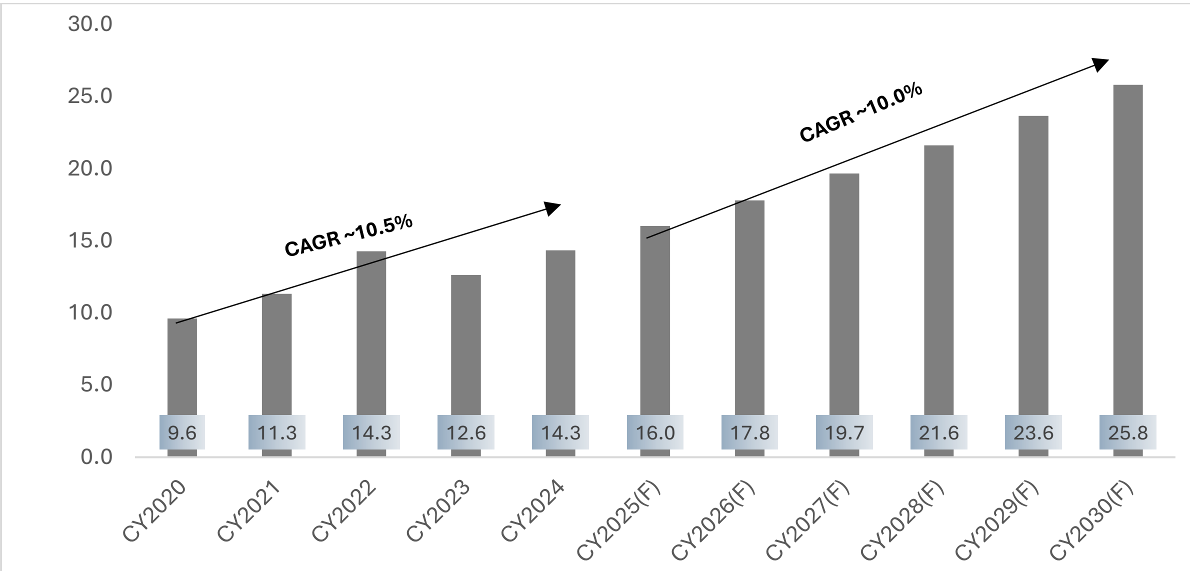
Source: IMARC Group, ICRA Analytics

During CY2024, total agrochemical exports stood at $ 43.0 billion with China leading the market at $ 9.0 billion followed by United States at $ 4.8 billion, India in the 3rd position at $ 4.2 billion, Japan at $ 651 million, Brazil at $ 466 million and others at $ 23.8 billion.

5.7 Brazil Agrochemical Market overview

The agrochemical market for Brazil reached a value of $ 14.3 billion in CY2024 (in terms of consumption) and has grown at a CAGR of ~10.5% during CY2020-CY2024. Going ahead, the agrochemical market for Brazil is expected to grow at a CAGR of ~10.0% from CY2025 to CY2030 valued at $ 25.8 billion.

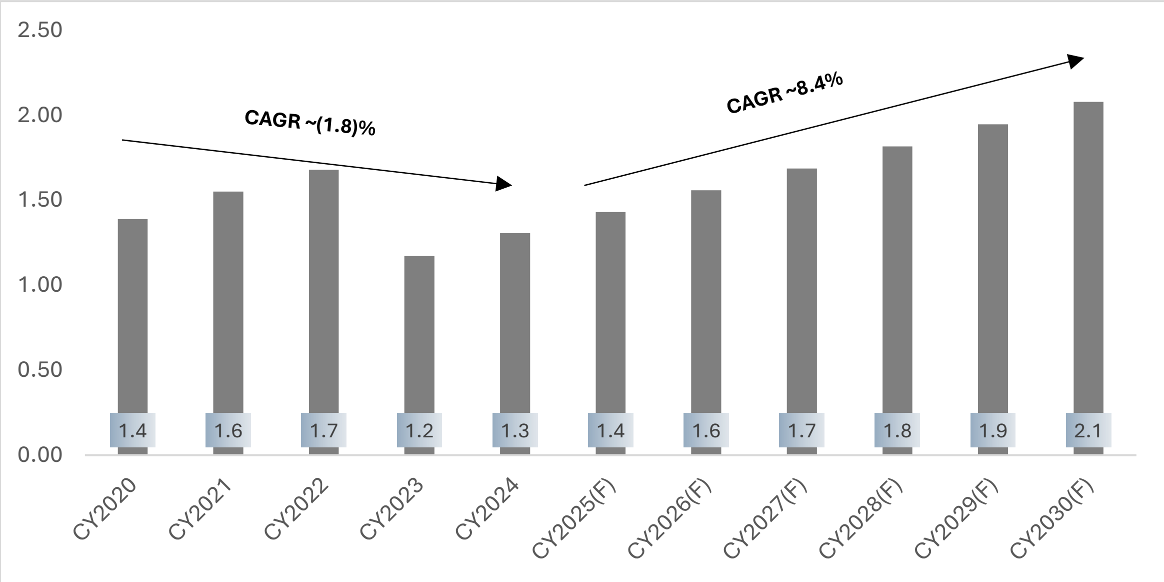
Chart 28: Brazil agrochemical sales value in ($ Billion)



Source: IMARC Group, ICRA Analytics

In terms of volumes, the agrochemical market for Brazil reached a volume of 1.3 million tonnes during CY2024, declining at a CAGR of 1.8% during CY2020-CY2024. Going ahead, the agrochemical volumes for Brazil are expected to touch 2.1 million tonnes by CY2030, growing at a CAGR of 8.4% during CY2025-CY2030. Going forward, sales realisations in Brazil are likely to grow at a higher rate than sales volumes thereby keeping the overall sales value growth higher than the volumetric growth.

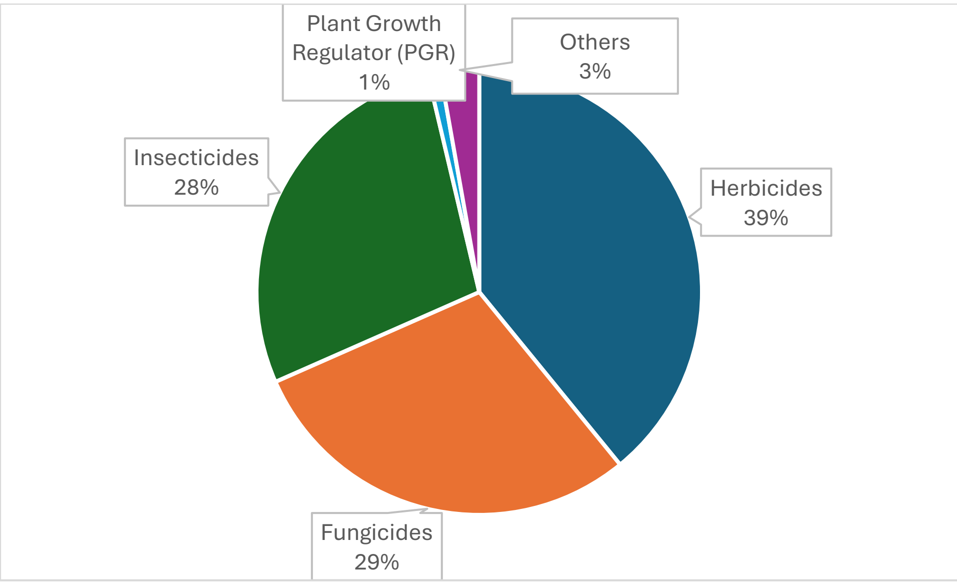
Chart 29: Brazil agrochemical sales volume (in Million Tonnes)



Source: IMARC Group, ICRA Analytics

5.8 Brazil Market Breakup by Product Type

Chart 30: Brazil Market Breakup by product type, breakup by product type (in %), CY2025 (in terms of consumption)



Source: IMARC Group, ICRA Analytics

During CY2025, herbicides dominated the market in terms of product type in Brazil agrochemical market with a share of 39%. Fungicides has the second highest market share of approximately ~29% followed by insecticides at ~28%, plant growth regulator at ~1% and others at ~3%.

5.9 Market drivers for Brazil's agrochemical market

- The agrochemical market in Brazil is experiencing substantial growth due to the continuous expansion of agriculture land and production, expected to reach $16.0 billion by CY2025. As one of the top global producers of soybeans, corn, sugarcane, and coffee, Brazil has been increasing its cultivation areas to meet the growing global and domestic demand. This expansion necessitates extensive use of agrochemicals to boost crop yields and ensure efficient production.
- Brazil's favourable tropical and subtropical climates, along with its diverse ecosystems, support crop growth but also lead to increased pests, weeds, and diseases, which necessitates the use of agrochemicals.
- Government policies and agriculture support programs in Brazil have significantly boosted the agrochemical market. The Brazilian government promotes agriculture productivity and sustainability through subsidies for agrochemical purchases, tax incentives for agriculture inputs, and funding for agriculture research and development.
- Technological advancements in agriculture are driving the growth of the agrochemical market in Brazil. Innovations like precision agriculture, genetically modified crops, and advanced pest management techniques have made agrochemical applications more efficient and effective.
- The rising awareness and adoption of Integrated Pest Management (IPM) practices are positively affecting the agrochemical market in Brazil. IPM promotes the strategic use of biological, cultural, mechanical, and chemical methods to control pests sustainably. Although it encourages reduced reliance on chemical pesticides, IPM also incorporates specific agrochemicals as part of a comprehensive pest management strategy.
- Investment in agriculture R&D is essential for Brazil's agrochemical market. Both the government and private sector are developing new agrochemical products to tackle challenges like resistance management, climate change, and sustainable practices. The Brazilian government, through "Embrapa" (Brazilian Agricultural Research Corporation), supports agriculture R&D to foster innovation in farming practices and agrochemical products.
- The rising demand for organic and sustainable agriculture products is influencing Brazil's agrochemical market. Global consumers increasingly seek organic and sustainably produced foods, leading Brazilian farmers to adopt environmentally friendly practices. This shift challenges traditional agrochemical products but also creates opportunities for biopesticides, organic fertilizers, and other eco-friendly agrochemicals.
- The Brazilian government's efforts to improve agriculture infrastructure and provide technical assistance to farmers also stimulate demand for agrochemical products. As a major exporter of agriculture commodities to countries like China, the European Union, and the United States, Brazil requires high productivity and quality, achievable through effective agrochemical use. Meeting the quality standards of international markets is crucial for maintaining and expanding Brazil's export footprint, further driving the demand for agrochemical products.

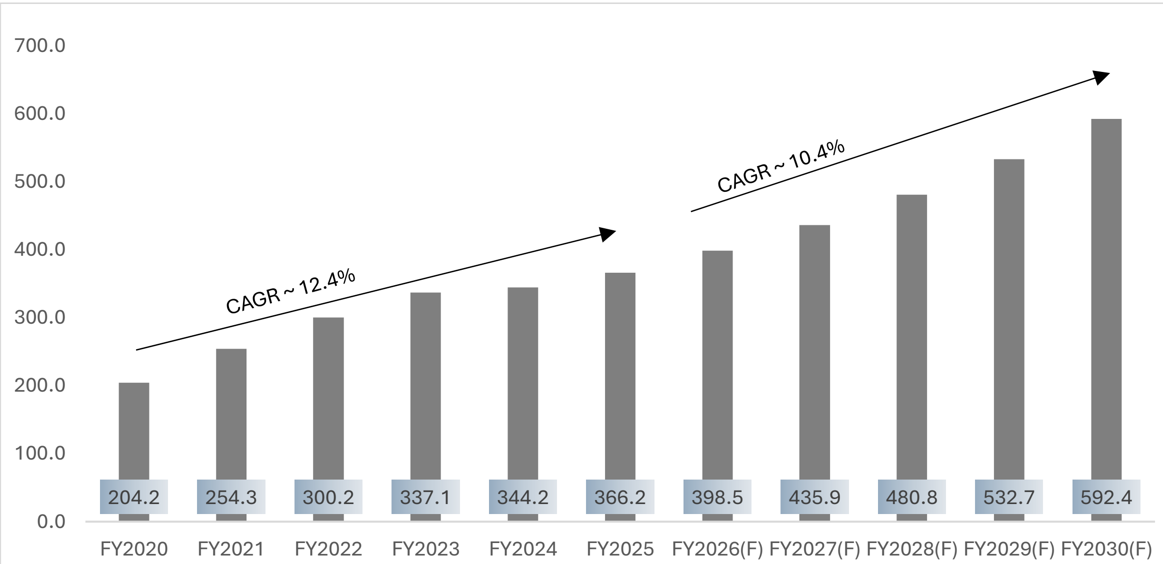
6. Indian agrochemical market

The size of the agrochemicals market in India reached Rs. 366 billion during FY2025, reflecting a compound annual growth rate (CAGR) of 12.4% from FY2020 to FY2025. With its varied agro-climatic conditions and extensive agriculture terrain, India stands as one of the foremost producers and consumers of agrochemicals on a global scale. This market encompasses a diverse array of products, including insecticides, herbicides, fungicides, and plant growth regulators, all of which are vital for safeguarding crops against pests, diseases, and weeds, thus optimizing production levels.

The expansion of the Indian agrochemical market is influenced by multiple factors. The rising population and the resulting food demand have created a need for increased agriculture output, subsequently driving the demand for agrochemical products. Furthermore, the implementation of modern agriculture techniques and the growth of irrigated arable land have also contributed to market growth. In addition, government initiatives designed to assist farmers, such as subsidies for agrochemical products and the encouragement of integrated pest management strategies, have supported this sector.

There is a noticeable trend towards the adoption of bio-pesticides and organic farming methods, spurred by heightened awareness regarding the detrimental impacts of chemical pesticides on both human health and the environment. The industry has been encountering obstacles, including rigorous regulatory requirements and the prevalence of counterfeit products. Nevertheless, the Indian agrochemical market is set for consistent growth, bolstered by advancements in agriculture technology, increased mechanization, and ongoing initiatives to boost agriculture productivity to satisfy the food needs of an expanding population.

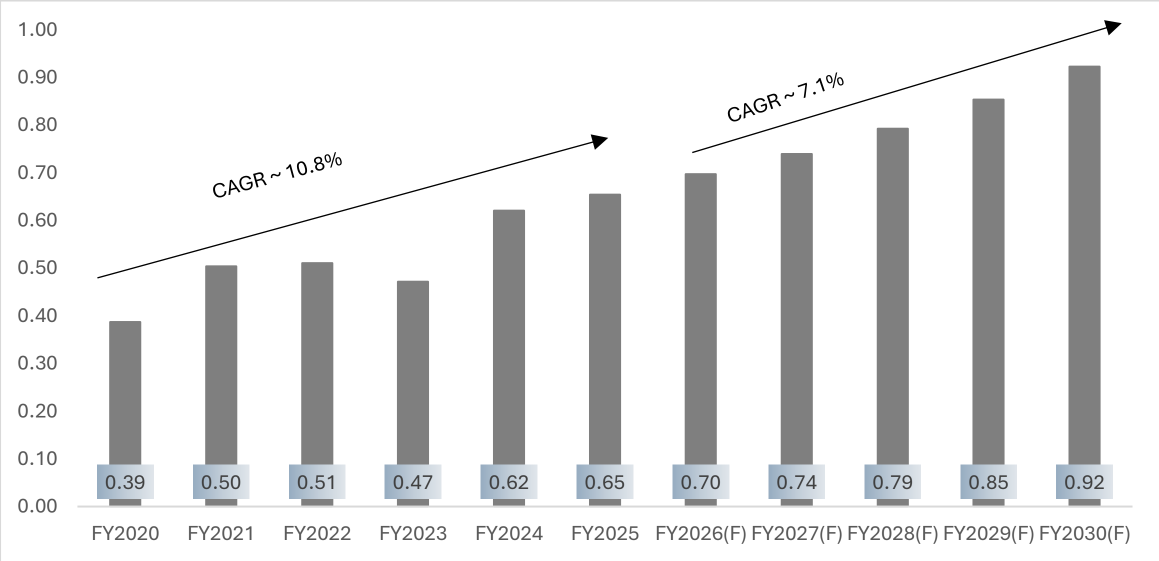
Chart 31: India Agro Chemical Market (sales in Rs billion)



Source: Department of Commerce, IMARC Group, ICRA Analytics

The India agrochemicals market reached a volume of 0.65 million tonnes in FY 2025, growing at CAGR 10.8% of during FY2020-FY2025. In terms of value, the market has reached a value of Rs 366 billion during FY2025, exhibiting a CAGR of ~12.4% during the same period.

Chart 32: India Agro Chemical Market (volume in Million Tonnes)



Source: Department of Commerce, IMARC Group, ICRA Analytics

Going forward, the Indian agrochemicals market is expected to reach a volume of 0.92 million tonnes by FY2030, growing at a CAGR of 7.1% during FY2026-FY2030. In terms of value, it is expected to reach Rs 592 billion by FY2030, at a CAGR of 10.4% during the same period.

6.1 Major drivers of the Indian agrochemical market

The major drivers of the Indian agrochemical market are as follows-

- **Rise in population-** The Indian market is undergoing rapid transformation, influenced by notable shifts in consumption behaviours stemming from urbanization, changes in the gender dynamics of the workforce, and rising consumption levels. As the population continues to grow, the demand for food grains is increasing at a rate that outpaces production, highlighting the urgent need for effective agriculture strategies. Furthermore, a significant portion of crop yield is lost annually due to insufficient application of crop protection products. Agrochemicals are essential for enhancing crop productivity, improving yields, and managing pest populations. Additionally, food demand is projected to escalate, potentially reaching $1.2 trillion by FY2025-FY2026. These changing dynamics emphasize the critical role of agrochemicals in tackling food security issues and fostering growth within the agrochemical industry.
- **Low manufacturing and labour costs**- India is rapidly becoming a major global manufacturing hub for agrochemicals, thanks to low manufacturing and labour costs, technically trained manpower, and high production capacity. These factors have positioned the country as a competitive player in the agrochemical industry.
- **Growth in India's agriculture sector:** The agriculture sector in India has shown robust growth, averaging 5 per cent annually from FY17 to FY23, significantly contributing around ~18% of the nation's GVA (Gross Value Added). The Economic Survey FY2024-FY2025 reveals that India remains a net exporter of agriculture products, with exports reaching $46.44 billion in FY2023-FY2024. This surge in agriculture productivity and exports is increasing the demand for agrochemicals, highlighting the sector's role in driving the agrochemical industry.
- **Regulatory board:** The Pesticides Manufacturers & Formulators Association of India (PMFAI), representing 221 entities in the Indian agrochemical sector, has been crucial in

driving agrochemical exports by organizing the International Crop Science Conference & Exhibitions (ICSCE) in various countries. Through various conferences and exhibitions, both in India and internationally, and numerous trade delegations, PMFAI has significantly enhanced global visibility for Indian agrochemicals.

- **Innovations:** Innovations like direct selling through Farmer Producer Organizations (FPOs) and direct-to-consumer (D2C) e-commerce platforms are transforming the agriculture ecosystem. These advancements enhance the efficiency and accessibility of agrochemical products, revolutionizing their marketing and distribution. By leveraging these channels, agrochemical companies can reach farmers more effectively, reducing reliance on traditional distribution networks and intermediaries, resulting in cost savings and increased accessibility for farmers.
- **Increase in Cultivated Land:** The growth of agricultural land and the introduction of new crop varieties heighten the demand for insecticides. The cultivation of new crops and the expansion of farming areas necessitate effective pest management strategies to promote healthy plant development and mitigate crop losses. According to the Land Use Statistics for FY2019, India's total geographical area is 328.7 million hectares, with 139.3 million hectares classified as the net sown area and 197.3 million hectares as the gross cropped area, indicating a cropping intensity of 141.6%. Additionally, the total cropped area has risen from 201.18 million hectares in FY2019 to 219.16 million hectares in 2021-22, with Maharashtra experiencing an increase from 24.92 million hectares in FY2021 to 25.73 million hectares in FY2022. This expansion, coupled with the adoption of diverse and high-yield crop varieties, further intensifies the requirement for agrochemicals.

6.2 Threats and challenges in the Indian agrochemical market

- **Lack of knowledge:** Many Indian farmers lack scientific knowledge of agronomy and agrochemical usage, relying heavily on dealer recommendations, leading to suboptimal application practices. This issue, coupled with low usage of agrochemicals, limits crop yields and agriculture productivity. With an average agrochemical usage of only 0.6 kg per hectare—6 times lower than the Asian average and 4 times lower than the global average (source: PwC) —there is a significant gap between current practices and optimal usage. Enhanced education, training for farmers, and science-based application practices are essential to improve crop performance and yields.
- **Lack of mega production facilities:** India lacks mega production facilities like those in China. In 2023, increased supplies of low-priced agrochemical products from China led global companies to raise their inventory levels by about 45 days between January and June 2023. This surge was followed by a destocking period due to a slowing global economy, resulting in a decline in India's agrochemical exports during the first half of FY2024.
- **Complex registration process:** India's registration process for agrochemicals is complex, costly, and time-consuming, posing significant barriers to new entrants and slowing the introduction of innovative products.
- **Shortage of yellow phosphorus:** India faces a significant challenge due to a shortage of yellow phosphorus, a crucial raw material for producing various agrochemical intermediates, including certain phosphorus-based pesticides and fungicides. This shortage impacts the production of these essential agrochemical products.

6.3 Opportunities in the Indian agrochemical market

- **Rise in investment:** Indian agrochemical companies are investing heavily in backward integration, investing on the production of off-patent molecules to reduce dependency on imports from China. They are registering off-patent products and building strong distributor relationships to increase volumes and offer competitive prices. Indian manufacturers are recognized for their superior quality and cost-effectiveness, particularly in producing organophosphorus compounds, carbon disulfide, and pyrethroid chemistries.

- **Increase in Research & Development:** Traditionally focused on generic products, India's agrochemical industry is now investing in R&D for patented and novel molecules. This shift is essential for sustaining long-term growth and addressing the annual loss of ₹1.48 lakh crore from pests, weeds, and fungal diseases. Developing novel agrochemical molecules will provide advanced pest control and modern weed management solutions, establishing India as a leader in agrochemical innovation.
- **International collaborations:** Collaborations between domestic manufacturers and global entities have accelerated technology transfer and knowledge sharing, driving innovations in manufacturing processes.
- **Subsidy rationalization driving bio-input adoption:** The government's ongoing subsidy rationalization is accelerating the shift toward sustainable agriculture by promoting the use of bio-inputs. Under the revised framework, states are now incentivized to reduce indiscriminate fertilizer use and redirect subsidies toward compost, biofertilizers, and nano-nutrient liquids. The Union Budget 2025 introduced the Prime Minister Dhan-Dhanya Krishi Yojana, establishing a formal reimbursement mechanism for farmers adopting certified biological alternatives. In parallel, initiatives like PM-PRANAM tie central funding to reductions in chemical fertilizer usage, prompting state administrations to expedite farmer training, awareness campaigns, and large-scale field demonstrations.

6.4 Value Chain Analysis

The agrochemical industry's value chain in India consists of several essential stages, each playing a vital role in the production, distribution, and application of agrochemical products. The following outlines a comprehensive value chain for the industry:

Research and Development (R&D): This foundational stage is dedicated to the discovery and formulation of novel agrochemical compounds and technologies. The primary objective of R&D initiatives is to develop innovative solutions for pest control, weed management, and disease prevention, specifically designed to address unique agriculture challenges.

Identification and Registration: Newly developed agrochemical products are required to undergo a rigorous registration process to confirm their compliance with regulatory standards. This process includes extensive evaluations of efficacy, safety, and environmental impact. Adhering to regulatory requirements is essential for market entry and guarantees that the products are both safe for use and effective for their designated purposes.

Technical Manufacturers: In India, technical manufacturers are integral to the value chain, specializing in the production of potent chemical compounds. Their responsibilities encompass the synthesis and refinement of active ingredients, which are subsequently utilized by formulators to develop final products. These manufacturers guarantee that the ingredients are not only highly effective but also customized to meet the specific requirements of various crops or plants, thereby addressing distinct agriculture challenges.

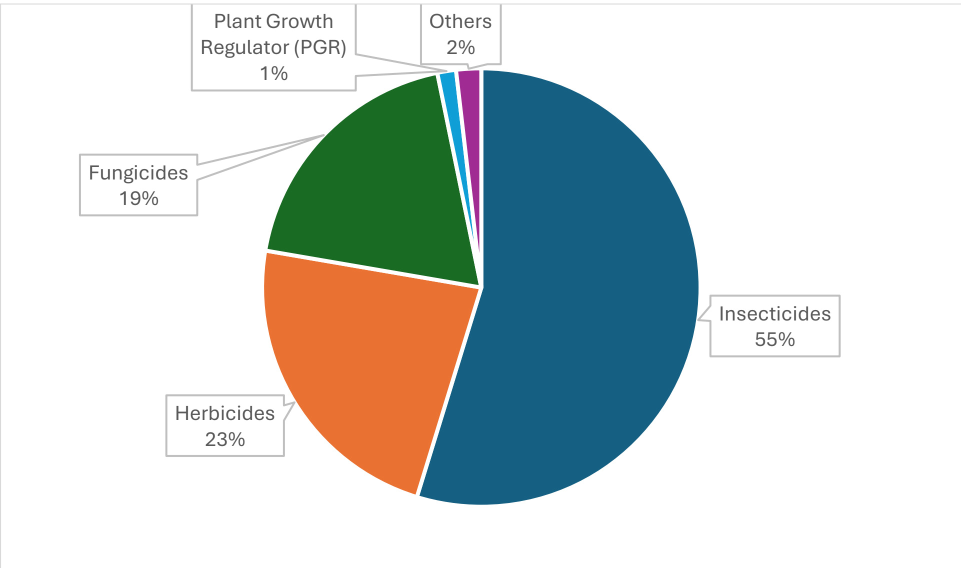
Formulation and Packaging: Formulators are responsible for creating end products by combining active ingredients with various substances, including solvents, carriers, stabilizers, and additives. This formulation process is essential to ensure that the agrochemical is not only effective but also safe and user-friendly. The design of effective formulations is vital for the overall performance of agrochemical products, significantly impacting their efficacy, safety, and the experience of the user.

Sales and Distribution: This stage pertains to the marketing, distribution, and sale of agrochemical products to farmers and distributors. It includes management of supply chains, inventory, and logistics to ensure that products are delivered to end-users efficiently.

End Users: End users, such as farmers and gardeners, apply agrochemical products to control pests, weeds, and diseases. The overall success of these products is largely dependent on their proper application by end users and their effectiveness in improving agriculture yields and protecting crops.

6.5 Market Breakup by Product Type (value wise)

Chart 33: Breakup by product type (in %), FY2025 (in terms of consumption)

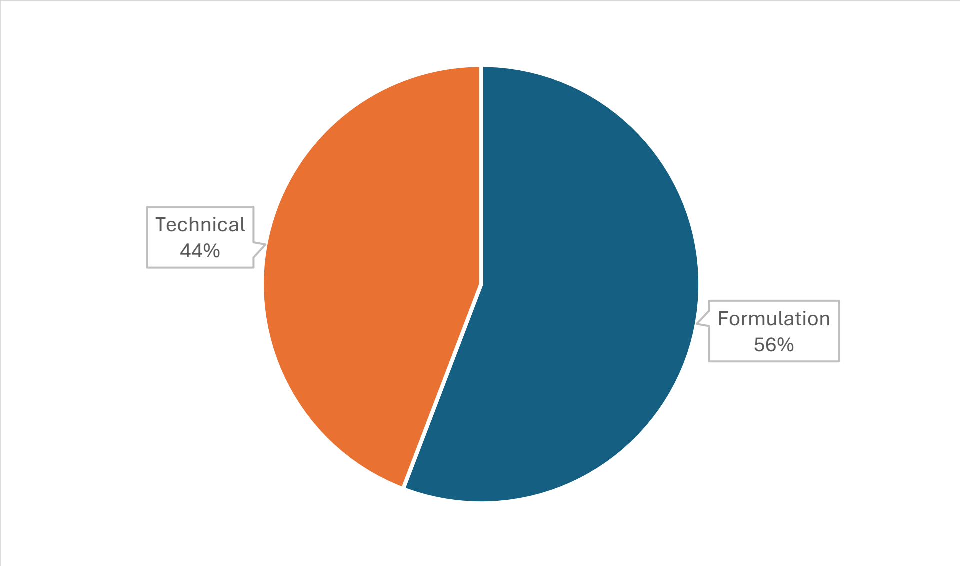


Source: IMARC Group, ICRA Analytics

Insecticides currently dominate the Indian agrochemical market at 55% of the total market size followed by herbicides at ~23%, fungicides at ~19%, plant growth regulator at ~1% and others at ~2%.

6.6 Market Breakup by Business Segments (Value Wise)

Chart 34: Breakup by business segments (in %), FY2025 (in terms of consumption)

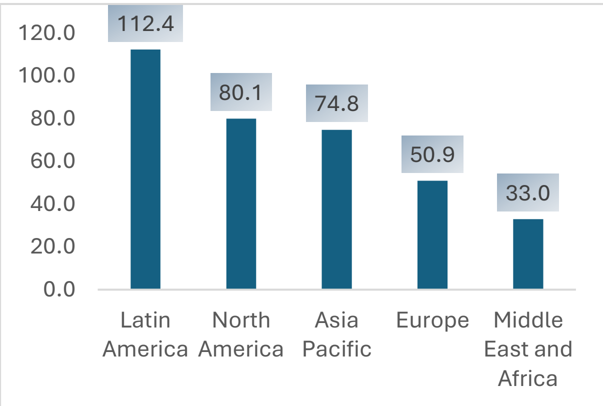


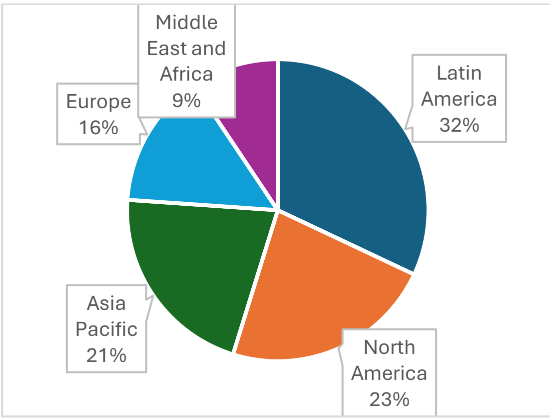
Source: IMARC Group, ICRA Analytics

During FY2025, the formulation business segment dominated the market, accounting for a share of 56% while the share of technical segment stood at ~44%.

6.7 Export Market Breakup by Region (Value Wise)

Chart 35: Breakup by region (sales value in Rs billion and export share in % terms), FY2025





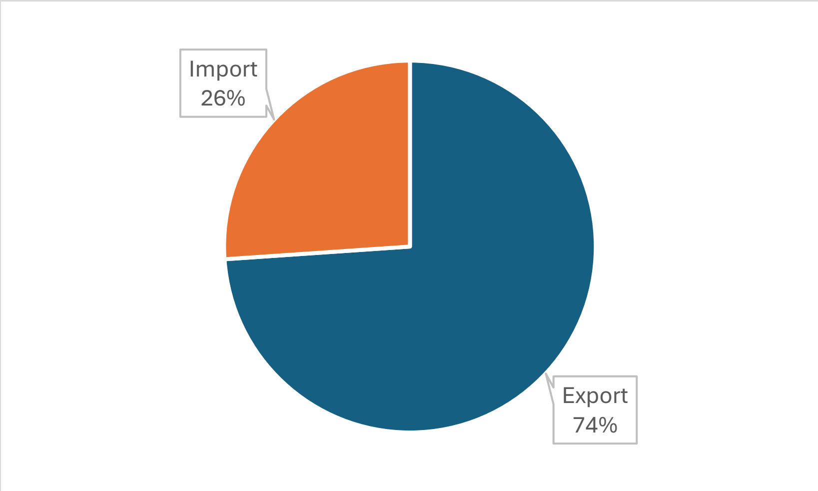
Source: Department of Commerce, IMARC Group, ICRA Analytics

During FY2025, Latin America represented the largest market segment for exported agrochemicals from India with a market share of 32% of the total export in terms of value followed by North America at ~23%, Asia Pacific at ~21%, Europe at ~15% and Middle East and Africa at ~9%.

6.8 Trade flows (Export vs Import)

India's total exports of agrochemicals in FY2025 stood at Rs. 351.2 billion while its total imports stood at Rs. 124.0 billion making India a net exporter of agrochemicals.

Chart 36: Export-Import breakup (percentage wise)



Source: Department of Commerce, IMARC Group, ICRA Analytics

Within exports, insecticide exports increased by 6.4% in FY2025 to Rs. 121.84 billion, fungicide exports grew by 11.2% to Rs. 84.4 billion, while herbicide exports declined by 2.2% to Rs. 131.61 billion during the year. Latin America remained the key market for Indian insecticide exporters, accounting for a 48.9% share, and was also the top destination for fungicide exports with a 34.8% share. For herbicide exports, North America emerged as the leading destination, with a share of 40.2%.

On the import side, insecticide imports rose by 13.3% to Rs. 50.3 billion, while fungicide imports surged by 41.6% to Rs. 32.7 billion, and herbicide imports increased by 24.6% to Rs. 39.0 billion in FY2025. China and USA remained the largest exporters of insecticides to India with a share of 35% and 25% respectively in India's total imports. For fungicides, China and Netherlands remained to top two exporters to India with a share of 26% and 23% respectively. For herbicides, China and USA continued their dominance with a share of 36% and 20% respectively.

6.9 Regulatory Framework for Domestic Agrochemical Market

India's agrochemical regulations encapsulate India's various agriculture needs, socio-economic factors and development aims. They aim at effective use of and agrochemicals while maintaining agriculture productivity and addressing environmental and wellbeing concerns.

- **The Insecticides Act, 1968 and Insecticides Rules, 1971:** This regulates the import, registration, process, manufacture, sale, transport, distribution and use of pesticides while ensuring prevention of risk to humans or animals.

- **The Pesticide Management Bill, 2020:** It was launched on March 23, 2020, by the Minister of Agriculture and Farmer Welfare. Its aim is to revamp the pesticides regulatory framework in India. This bill is set to substitute the prevailing Insecticides Act of 1968. Its primary purpose is to regulate the manufacture, import, sale, storage, distribution, use and disposal of pesticides, thereby guaranteeing the safety of humans, animals and overall environment. This bill aims at addressing the shortcomings of the existing Act, enhancing pesticides safety standards, developing regulatory processes and promoting environmentally friendly and effective pesticides.

- **Regulatory Bodies:**

- **Central Insecticides Board and Registration Committee (CIBRC):** Under the Pesticide Management Bill, 2020, the Central Pesticides Board is set to be established by the government, with the purpose of providing expert guidance on scientific and technical issues related to pesticide regulation. The Board will assume responsibility in advising both central and state governments on several issues including the planning of norms, best practices for pesticide manufacturers, laboratories and pest control operators. In addition, the board will be accountable for developing model protocols for pesticides management and response, thereby ensuring an all-encompassing approach towards public health and safety.
- **Food Safety and Standards Authority of India (FSSAI):** It regulates the presence of pesticide residues in food products, thereby guaranteeing consumer food safety. FSSAI ensures safety in food supply chain by establishing standards for permissible residue levels and monitors compliance.

6.10 India's rise as a Hub for Agrochemicals

- **Low-Cost Manufacturing:** Owing to the low labour costs and favourable fiscal policies, India has developed an important cost advantage in agrochemical manufacturing. India's cheap labour force has enabled agrochemical companies to reduce their production costs as compared to other developed nations. India has become a competitive player in the global agrochemical market as a result of these cost efficiencies.
- **Manpower & Production Capacity:** India has a large number of technically trained people, which is required for the complicated processes involved in agrochemicals production. India has considerable amount of unexploited production capacity, which can be used to meet both international and local demand.
- **Government Focus:** Make in India, Start-up India, PLI scheme are few of the many programs launched by the Indian government to encourage domestic manufacturing and attract foreign investment. These schemes provide financial incentives, foster innovation and improve infrastructure, thereby enhancing the competitiveness of Indian manufacturing.
- **Supplier diversification post COVID-19:** Many global manufacturing giants have rethought their dependency on China after the pandemic and are looking for alternative manufacturing hubs, including India. This shift away from China, reduces Chinese production and creates opportunities for Indian manufacturers to gain a larger share of the global market.
- **Stringent Environment Norms:** India's stringent environmental regulations (Insecticides Act and the forthcoming Pesticide Management Bill) has created a strong framework for environmental protection in agrochemical manufacturing. These regulations are comprehensive and well-defined, ensuring that environmental impacts are addressed in a systematic manner. On the other hand, the Ministry of Agriculture and Rural Affairs (MARA) in China regulates pesticides. The highest guideline is "Regulations on the Management of Pesticides" (State Council Decree 677). Pesticide registration, production, distribution, and use in China are all subject to these strict regulations.

7. Registration process and IPR for Agrochemicals in India

7.1 Regulatory Landscape – Relevant Acts and Regulations

Insecticides Act, 1968 principally administers India's regulatory framework for agrochemicals. This regulatory environment is intended to guarantee the safe and successful utilization of agrochemicals while balancing agriculture efficiency with considerations for health and the environment. Insecticides Act, 1968 an, The Insecticides Rules, 1971, and Pesticide Management Bill, 2020 are the key legislative frameworks governing domestic agrochemical market.

7.1.1 The Insecticides Act of 1968:

India's pesticide regulation is based on The Insecticides Act, 1968. It directs the use of pesticides, as well as their import, production, sale, transportation, and distribution, to lower the risk of harm to environment, animals, and people. While minimizing adverse effects, the act aims to guarantee the safe and efficient use of pesticides.

Characteristics of the Insecticides Act, 1968:

- Objective: To regulate the use of insecticides and keep the environment, animals, and humans safe.
- Central Insecticides Board (CIB): It has been established to prompt the central and state legislatures on issues connected with pesticide guideline. It assumes an essential part in updating and maintaining the Insecticide Schedules.
- Registration Committee (RC): It is liable for the registration of insecticides subsequent to assessing their safety, adequacy, and environmental effect. Only approved pesticides are permitted in the market, as ensured by RC.
- Central Insecticide Laboratory (CIL): It serves as the primary laboratory for insecticide testing and evaluation to ensure that safety regulations are followed.
- Phase 3(e) and Insecticide Schedules: In order to be considered for import, manufacture, transportation, distribution and use in India, pesticides, including fungicides and weedicides, should be listed in the Insecticide Schedules. In case it is not included in the list, it should initially be added by fulfilling the information necessities for schedule inclusion. This process involves discussion with the Central Insecticides Board and Official Gazette to be notified.
- Compliance and Enforcement: To ensure only registered and approved pesticides are used, the Act provides the compliance and enforcement framework. The framework summarises penalties for violations which includes imprisonment or fines in cases of non-compliance.
- Important Sections of the Insecticides Act, 1968:
  - Section 3: Definitions and Scope of the Act-
  - Section 9: Registration of Insecticides, including conditions and procedures
  - Section 18: Licensing for Manufacture, Sale, and Distribution of Insecticides
  - Section 27: Prohibition of Import, Manufacture, and Sale of Misbranded Insecticides
  - Section 36: Powers of the Central Government to make rules after consultation with the Central Insecticides Board.

7.1.2 The Insecticides Rules, 1971:

The Insecticides Rules, 1971 provide the detailed procedures and guidelines necessary to implement the Insecticides Act, 1968. They provide a clear framework for the regulation of pesticides and outline the responsibilities of various bodies.

Characteristics of the Insecticides Rules, 1971:

- Functions of the Central Insecticides Board (CIB):
    - Advises on technical matters related to the regulation of pesticides.
    - Recommends measures for the safety and efficacy of pesticide use.
- Role of the Registration Committee (RC):
    - Reviews applications for pesticide registration.
    - Evaluates the safety, efficacy, and environmental impact of pesticides.
    - Conducts regular reviews of registered pesticides.
- Duties of the Central Insecticide Laboratory (CIL):
    - Analyses samples of insecticides for compliance with prescribed standards.
    - Provides technical support and expertise to regulatory bodies.
- Licensing and Labelling Requirements:
    - Specifies the procedures for obtaining licenses for manufacturing, selling, and distributing pesticides.
    - Details labelling requirements to ensure that consumers receive accurate information about pesticide use and safety.
- Inspection and Enforcement:
    - Empowers inspectors to conduct inspections and take samples for analysis.
    - Provides guidelines for enforcement actions against violations.

7.1.3 The Pesticide Management Bill, 2020:

The Pesticide Management Bill, 2020 has been proposed in India as an extensive replacement for the present Insecticides Act, 1968. Some of the key issues with the Insecticides Act, 1968 are (i) restrictive definition of insecticide that only includes formulations specified in the Schedule of the Act, (ii) absence of tolerance limits for pesticide residue as a pre-condition for registration and (iii) inadequate penalties for contravention of provisions of the Act. The purpose of Pesticide Management Bill, 2020 is to better regulate the pesticide industry, keep an eye on poisonings caused by pesticides, and ensure that victims are compensated. In February 2020, the Union Cabinet of India endorsed this bill, and in June 2021, it was referred to the Standing Committee on Agriculture for additional consideration. It is anticipated that the bill, which is still being considered, will succeed the Insecticides Act of 1968 once it is approved by the Standing Committee.

Key Highlights of the Pesticide Management Bill:

- Registration Compliance: Pesticides will not be registered if they exceed the maximum residue limits on crops as established by the Food Safety and Standards Act of 2006. This regulation ensures that pesticide residues in food products remain within safe limits to protect consumer health.
- Regular Reviews and Suo Moto Authority: The Registration Committee (RC) has the authority to initiate suo moto reviews of any pesticide at any time. Additionally, the RC is required to conduct regular reviews of registered pesticides to ensure they continue to meet safety and effectiveness standards.

- Unchanged Data Requirements: The bill retains the existing data requirements and guidelines for pesticide registration, ensuring that the scientific evaluation processes remain rigorous, transparent, and consistent with current practices.
- Consumer Protection and Compensation: Under the Consumer Protection Act of 1986, consumers have the right to seek compensation for any damage or injury caused by pesticides. The bill further mandates the establishment of a compensation fund, administered by relevant authorities, to support individuals who suffer harm or death due to pesticide poisoning.
- Stringent Penalties: The bill introduces strict penalties for non-compliance, including fines, imprisonment, or both, to deter violations and ensure adherence to safety standards. These penalties are designed to enforce compliance and promote the safe use of pesticides in the market.

7.2 Different Types of Registration

Insecticides Act, 1968 governs the registration of agrochemicals in India and is overseen at the central level by the Central Insecticides Board & Registration Committee (CIB&RC). The issues related to the Act's implementation, such as the issuance of manufacturing licenses, are dealt with at the state level. There are 3 essential types of registrations accessible for agrochemicals.

1. **Provisional Registration under Section 9(3b):**
   When a chemical or molecule is presented for the first time in India, provisional registration is permitted. They are commonly permitted for a time of two years. It might call for less extensive information at first, concentrating on preliminary security and viability.
2. **Regular Registration under Section 9(3):**
   This is an exhaustive registration process for chemicals, requiring total information submission. It demands a total arrangement of information, covering all parts of chemistry, toxicity, bio-efficacy, and packaging. It is intended for importers or producers who wish to register a current pesticide with various pollutions or determinations.
3. **"Me-Too" Registration under Section 9(4):**
   After a molecule has already been registered under Section 9(3), this registration is available. Some other organization or individual can apply for registration of a similar molecule. It might necessitate demonstrating equivalence to an already registered product, thereby requiring less exhaustive data in some categories.

7.3 Data Requirements and Overall Patent Application Process

- **Toxicity:** Toxicity data is important for understanding the potential risks related with the agrochemicals. This incorporates studies on intense toxicity, evaluating the impacts of momentary exposure through oral, dermal, and inhalation routes. Constant toxicity studies analyze long haul exposure impacts, concentrating on carcinogenicity, mutagenicity, furthermore, regenerative harmfulness. Ecotoxicology assessments evaluate the effect on non-target creatures, for example, aquatic life and advantageous bugs, while environmental fate information depict the substance's degradation, bioaccumulation, and development through soil, water, and air.
- **Packaging:** Packaging is a basic perspective that guarantees the safe handling and storage of agrochemicals. To ensure product stability and safety during transportation, information on packaging materials and design should be given. Users must be informed about proper handling regarding the Compliance with labeling requirements, including

safety instructions, usage guidelines, and hazard warnings. The provision of Safety Data Sheets (SDS) is additionally compulsory, illustrating detailed precautions for handling, stockpiling, and removal to prevent mishaps and natural damage.

- **Chemistry:** The chemistry section involves providing detailed information on the agrochemical's identity and composition, ensuring transparency regarding the chemical's purity. This includes a thorough description of the manufacturing process, detailing the raw materials and intermediates used. Additionally, the physical and chemical properties, such as solubility, stability, volatility, and compatibility with other substances, must be documented. Analytical methods for determining the active ingredients and impurities are also crucial to establish the product's consistency and reliability.
- **Bio-efficacy:** The bio-efficacy section requires field trial results that demonstrate the agrochemical's effectiveness in controlling targeted pests, diseases, or weeds. This section should also include a detailed explanation of the product's mode of action, providing insight into how it works and its range of activity. Data on the dose-response relationship is crucial to establish the connection between the dosage and its effectiveness. Additionally, strategies for resistance management must be outlined to prevent or mitigate the potential development of resistance in pests or pathogens.

7.3.1 Data Requirements and Overall Patent Application Process

Table 7: Type & Depth of Data Requirements Depends on Category Of Pesticide (Category I-IX).

Category	Description
I	Technical grade pesticide, which is not registered for manufacturer/ Import and use in India
II	Technical grade pesticide, which is registered for manufacturer/ Import and use in India
III	Indigenous manufacturer of technical grade pesticide, which is not registered use in India
IV	Indigenous manufacturer of pesticide already registered for use in India
V	Indigenous manufacturer of new pesticide formulation(s), not registered for manufacturer and use in India
VI	New combination pesticide formulation, not registered for use in India
VII	Import of new formulation of pesticide, not registered for import/manufacture and use in India
VIII	Indigenous manufacturer of registered/unregistered formulation of microbial bio pesticides.
VIII (a)	Bio-pesticides: non-Bt & Bs based
VIII (b)	Bio-pesticides: Bt & Bs based
IX	Indigenous manufacturer of bio-pesticides-Botanical-Technical/Formulation

7.3.2 A complete list of Insecticide Registration documents

The registration of insecticides in India requires the submission of various documents to ensure compliance with the regulatory standards set by the Central Insecticides Board & Registration Committee (CIBRC). These documents are essential for verifying the insecticide's safety, efficacy, and adherence to legal requirements. Below is a comprehensive list of the key documents required for insecticide registration:

Application Form (Form I): The Application Form (Form I) is a crucial document that initiates the insecticide registration process. It requires the applicant to provide detailed information, including their name, address, contact details, and specifics about the insecticide, such as its name, composition, and intended use. The form also requires business information, indicating whether the applicant is a manufacturer, importer, or distributor. Accurate completion of this form is vital to avoid registration delays.

Manufacturing License: A Manufacturing License is mandatory for manufacturers seeking to register an insecticide. This license serves as proof of the applicant's legal authority to produce insecticides and includes details such as the license number issued by the relevant state or national authority, the validity period of the license, and the production capacity of the manufacturing facility. This document confirms compliance with regulatory requirements and demonstrates the facility's capability to manufacture the product.

Import Authorization: The Import Authorization document is essential for importers registering an insecticide. It verifies the applicant's legal permission to import the specific product into the country. This document typically includes the import license number issued by the government, information about the approved ports of entry, and a compliance assurance statement confirming that the imported product meets national standards. This ensures that the import process adheres to all regulatory norms.

Proof of Address: Proof of Address is required for all applicants to establish the business's physical location. Acceptable documents include a lease agreement for the business premises, recent utility bills (such as electricity or water) showing the address, or a government-issued certificate verifying the business address. These documents confirm that the business operates at a legitimate, recognized location, which is essential for regulatory compliance.

Certificate of Analysis: The Certificate of Analysis is a detailed report that provides laboratory testing results for the insecticide, verifying its chemical composition, purity, and quality. This document is prepared in accordance with CIBRC guidelines and includes a comprehensive breakdown of both active and inactive ingredients, purity assessment results, and adherence to national or international quality standards. The Certificate of Analysis ensures that the product is safe and effective for use.

Safety Data Sheet (SDS): The Safety Data Sheet (SDS) contains crucial information about the hazards associated with the insecticide and provides guidance on safe handling practices. It includes detailed descriptions of the product's physical and chemical properties, potential health and environmental risks, and recommended safety precautions for handling, storage, and disposal. The SDS is an essential document for ensuring the safe use and management of the insecticide.

Toxicological Data: Toxicological Data provides important information on the insecticide's toxicity levels for mammals, wildlife, and aquatic life. This data includes both acute toxicity studies, which assess the effects of short-term exposure, and chronic toxicity studies, which examine the long-term health risks. Additionally, ecotoxicological assessments evaluate the impact on non-target species and the environment. These studies are conducted at recognized facilities in compliance with CIBRC guidelines to ensure a thorough safety evaluation.

Bio-efficacy Data: It validates the insecticide's efficacy against targeted pests or diseases. It incorporates results from field preliminaries that duplicate genuine circumstances identification of pests the insecticide can control, and a relative investigation of its viability against standard medicines. To establish the product's practical efficacy in pest management, testing is required to be conducted at the approved facilities following CIBRC guidelines.

Technical Specifications: The insecticide's composition must be detailed in Technical Specifications submitted by applicants. This incorporates an exact list of active ingredients with their focuses, data on pollutions and their rates, and facts on any adjuvants used to upgrade the product's performance. To ensure the regulatory standards, these particulars are vital for understanding the product's formulation.

Shelf-Life Data: Data related to insecticide's stability during storage needs to be submitted under this. It incorporates results from stability tests that confirm the item's consistency over the long run, claims about the item's life span, and prescribed stockpiling conditions to keep up with ideal timeframe of realistic usability. Such information is essential for guaranteeing the insecticide stays powerful all through its expected use period.

Labels and Leaflets: In accordance with the Insecticide Rules of 1971, seven copies of the proposed labels and leaflets must be submitted. The name, composition, intended use, safety instructions, precautions, first aid measures, and details regarding regulatory compliance ought to be included in these materials. Appropriate labelling is required for directing clients on the protected and powerful utilization of the insecticide.

Analytical Test Reports: Analytical Test Reports are important for a sample of the insecticide applied for registration. To guarantee the product's consistency and dependability, these reports, which should be produced by well-known testing facilities, ought to include in-depth analysis, graphs, spectra, calculations, and validation. These reports support the product's quality and compliance with CIBRC testing standards.

Characterization of Active Ingredient: Data from the characterization of active ingredient must be provided by applicants for technical-grade insecticides. To confirm the active ingredient's chemical structure and purity, spectroscopic analysis like Ultraviolet, Infra-Red, Mass, and Nuclear Magnetic Resonance spectra are used. To ensure the ingredient's consistency, comparative data with standard reference materials are also required.

Fee Payment Receipt: As a proof of payment, the Fee Payment Receipt is used for the registration cycle, usually in the form of a bank draft or demand draft made out to the relevant authority. The payee's information, the amount paid in accordance with the fee schedule for the registration category, and confirmation of the transaction ought to be included in this receipt. Presenting this record is fundamental for finishing the registration application.

7.3.3 Pesticides Registration Process

The CIBRC requires an online application for pesticide registration. A web-based system called the Computerized Registration of Pesticides (CROP) application was developed to make this process easier. Its purpose is to streamline the entire registration process and make it more effective**.** To add an insecticide to the list, the product must be classified either into Category 9(3) or Category 9(4).

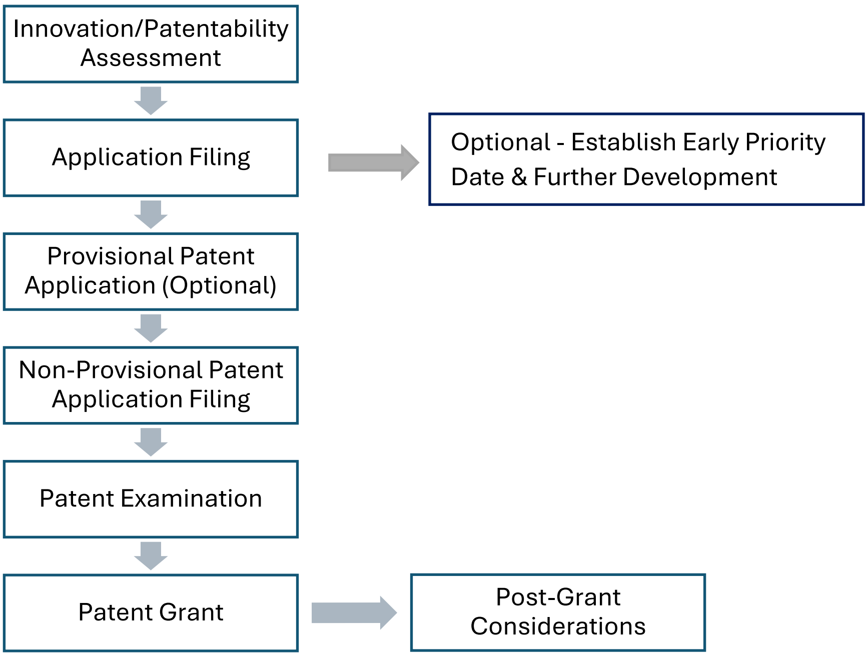
Registration under Category 9(3):

1. **Inclusion in the Insecticide schedule and Registration Category 9(3)-** Category 9(3) involves detailed data requirements, including bio efficacy and toxicity testing. Section 9(3) includes TI (Technical Import), FI (Formulation Import), TIM (Technical Indigenous Manufacture), F (Formulation Indigenous Manufacture.), B/F (Bio-Pesticides), Export.
2. **Data Requirements:** Category 9(3) requires comprehensive data, including results from bio efficacy and toxicity tests for determining the insecticide's safety and effectiveness.
3. **Application for Import Permission:** Under Category 9(3), to import samples for bio efficacy and toxicity testing, an application for Registration Testing Trial (RTT) should be submitted utilizing Form C. T. The RTT application makes it easier to import the samples that need to be tested to make sure they meet regulatory requirements.
4. **Submission and Payment:** Application in form I to Registration Council (RC) + Payment of the fees by demand draft. Form I is required to submit the registration application to the RC alongside the instalment of charges. The charges are normally paid through an interest draft, which should be included with the application.
5. **Data Scrutiny and Registration Grant:** When the application and associated data are submitted, they are examined by the expert group. The RC may grant the registration certificate based on their evaluation. This endorsement is given in Form II or III, contingent upon the case and class of enlistment.

Registration under Category 9(4):

1. **Inclusion in the Insecticide schedule and Registration Category 9(4)-** Category 9(4) has a more streamlined process with fewer requirements. It includes TI (Technical Import), FI (Formulation Import), TIM (Technical Indigenous Manufacture), F (Formulation Indigenous Manufacture.)
2. **Data Requirements:** Category 9(4) requires lesser extensive data.
3. **Application for Import Permission:** It is not required under this category.
4. **Submission and Payment:** Application in form I to Registration Council (RC) + Payment of the fees by demand draft. Form I is required to submit the registration application to the RC alongside the instalment of charges. The charges are normally paid through an interest draft, which should be included with the application.
5. **Data Scrutiny and Registration Grant:** When the application and associated data are submitted, they are examined by the expert group. The RC may grant the registration certificate based on their evaluation. This endorsement is given in Form II or III, contingent upon the case and class of enlistment.

7.3.4 Flowchart of the Patent Application Process



7.3.4 (a) Patent Application Process in details:

The patent application process for agrochemicals involves several key steps to secure intellectual property rights for innovative solutions. Here's an overview of the process:

Innovation/Patentability Assessment: The first step in the patent application process is to evaluate the patentability of the agrochemical innovation. This involves determining whether the invention is novel and non-obvious. It is also essential to identify all inventors involved and establish clear ownership rights to prevent any future disputes.

A comprehensive prior art search is conducted to identify existing patents and related literature. This search helps assess the novelty of the innovation and ensures that it does not overlap with existing patents. Analysing prior art also provides valuable insights into the competitive landscape and helps inform the patent strategy.

Application Filing: Once the innovation's patentability is confirmed, the next step is to prepare the patent application. This involves drafting a detailed description of the invention, including supporting experimental data and creating any necessary drawings or diagrams that illustrate the invention's design and functionality.

Provisional Patent Application (Optional): Filing a provisional patent application is an optional step that establishes an early priority date for the invention. This allows the inventor to secure a filing date while continuing to develop and refine the invention before submitting a full non-provisional application.

Non-Provisional Patent Application Filing: The final step is to submit a complete non-provisional patent application. This application includes a thorough description of the invention, specific claims that define the scope of protection, and any required drawings. The application must be accompanied by the payment of the requisite fees. This non-provisional application initiates the formal examination process, during which the patent office evaluates the invention's novelty, non-obviousness, and industrial applicability.

These steps ensure that the agrochemical innovation is protected under intellectual property laws, providing the inventor or company with exclusive rights to the invention and the ability to prevent others from using, selling, or manufacturing the patented product without permission.

Patent Examination: The patent application goes through assessment by the patent office, after filing. During this stage, the applicant should respond to solicitations for additional data, tending to any concerns or complaints raised by the examiner to push the application ahead.

Patent Grant: The patent is granted, if the application meets all prerequisites and effectively explores the assessment cycle. The inventor gets a patent certificate, which awards selective privileges to the development, keeping others from making, utilizing, or selling the licensed agrochemical without consent.

Post-Grant Considerations: After the patent is granted, the creator should screen for potential infringements and enforce their rights if needed. Also, to keep the patent active and enforceable, renewal fees at regular intervals must be paid.

7.4 Timelines and Fees

As shown in the table below, the registration procedure consists of a number of essential steps, each of which has its own distinct timetable:

Table 8: Timelines and Fees

Activity	9(4) – "Me-Too" Registration	9(3) and 9(3b) – Fresh Registration
Documentation and Form 1 Verification	0.5 month	1 month
CIB&RC Analysis	1-3 months	6-12 months
Sample Submission, Collection & Analysis	2-6 months	2-6 months
MRL Fixation (Ministry of Health)	1-2++ months	3-12 months
Registration Certificate Issuance	2 months	2 months
OVERALL PROCESS	Minimum 6 months	Minimum 12-36 months

The application fee for registering an unregistered insecticide is ₹5,000. For applicants seeking registration of an insecticide already registered under another person's name, the fee is ₹2,500. The fee ranges given here are approximate ranges and ca change.

Testing and Analysis Fees for Agrochemicals:

In addition to registration fees, testing fees are essential for verifying the safety and efficacy of agrochemical products. According to Gazette Notification No. 892 dated 13.12.2018, the testing fees are revised based on the method of analysis:

1. Insecticides with Known Active Ingredients:
    a. Gas Chromatography: ₹6,500 per sample
    b. High-Performance Liquid Chromatography (HPLC): ₹7,500 per sample
    c. UV-Visible Spectrometer: ₹5,500 per sample
    d. Fourier Transform Infra-Red Spectrometer (FTIR): ₹6,000 per sample
    e. Titrimetric: ₹4,000 per sample.
2. Bio-Pesticides with Known Active Ingredients: Testing Fee - ₹4,000 per sample
3. Bio-Pesticides with Unknown Active Ingredients:
    a. Nuclear Polyhedrosis Virus or Granulosis Virus: ₹2,000 per sample
    b. Bacteria Only: ₹2,000 per sample
    c. Fungi Only: ₹2,000 per sample
    d. Comprehensive (I, II, III): ₹6,000 per sample
4. Insecticides/Bio-Pesticides with Unknown Active Ingredients:
    a. Liquid Chromatography-Mass Spectrometry (LC-MS): ₹15,500 per sample
    b. Gas Chromatography-Mass Spectrometry (GC-MS): ₹10,500 per sample
5. Other Formulations: The fees for testing or analysis of formulations not specified in the schedule will be determined by the Central Government or authorized officers as needed.

7.5 Coverage on Post Registration Obligations

After agrochemicals have been registered with the CIBRC or identical regulatory bodies, a few commitments should be satisfied to keep up with the compliance and guarantee the safe and effective utilization of these products. These commitments include different perspectives, for example, product labelling, quality control, reporting, and adherence to safety and environmental regulations. The most important post-registration commitments for agrochemical items are:

1. **Labelling and Packaging Compliance**
    - Accurate labelling: To guarantee that all agrochemical items are named as per the regulatory guidelines. It includes important information like the active ingredients, directions for use, safety precautions, and capacity conditions.
    - Packaging Standards: Maintain packaging standards to guarantee the wellbeing and dependability of the item all through its timeframe of realistic usability. During transportation and handling, improper packaging also prevents accidental spills or exposure.
2. **Quality Control and Manufacturing Standards**
    - Adherence to Quality Standards: In order to ensure that the quality of the agrochemical product remains in line with the registered specifications, Great Manufacturing Practices (GMP) should be followed.
    - Batch Testing: In order to ensure that the product meets the required chemical and biological standards, regular quality control tests on production batches to be conducted. Records of such tests also to be maintained for regulatory inspections.
3. **Safety and Environmental Compliance**
    - Environmental Protection: To prevent contamination and harm to ecosystems, agrochemical products should comply with environmental regulations, with proper disposal of waste and unused products.
- Safety Measures: To protect workers handling agrochemicals during production, transportation, and application, safety measures should be implemented. Along with

that, safety training and appropriate personal protective equipment (PPE) should be provided.

4. **Monitoring and Reporting**
    - Adverse Effects Monitoring: Lay out frameworks to screen and report any adverse impacts or incidents because of the utilization of agrochemical items. Regulatory authorities to be promptly notified in case of any safety concerns or product failures.
    - Usage Data Collection: Gather and retain information on the use of the product, including application rates and geographical dispersion. This data might be expected for occasional surveys by regulatory bodies.
5. **Product Stewardship and Customer Support**
    - Customer Guidance: End users must be informed about the benefits and risks associated with the product and also guidance must be provided on correct use and handling of agrochemicals.
    - Technical Support: For effective application and management of the product, technical support and advice must be provided to the customers.
6. **Compliance with Regulatory Updates**
    - Regulatory Changes: The product must remain compliant with the regulatory requirements and all updates must be tracked. Changes in labelling, safety data sheets and usage instructions must be amended as per the new regulations.
    - Renewal and Re-registration: In case of changes in product formulation, use pattern, or safety profile, renewal of the registration must be applied.
7. **Documentation and Record-Keeping**
    - Record Maintenance: Comprehensive records of production, quality control tests, adverse effects must be maintained and should be readily available for inspection by regulatory authorities.
    - Confidentiality Agreements: As per intellectual property regulations, confidential business information and trade secrets must be protected.

8. Global Insecticide Market:

Insecticides are specialized agents, either chemical or biological in nature, that are formulated to manage or eradicate insects which present considerable risks to agriculture, public health, and infrastructure. These substances are integral to contemporary agriculture practices, safeguarding crops from detrimental pests, thus improving yields and supporting global food security. By specifically targeting insect pests, insecticides play a crucial role in curbing the transmission of diseases and reducing harm to both crops and structures.

They are classified into various categories based on their chemical composition, modes of action, and sources, including synthetic insecticides, biological insecticides, insect growth regulators (IGRs), and natural insecticides. Each category provides unique advantages and uses, illustrating the wide range of strategies available for effective pest control in different agriculture and environmental setting.

1. **Synthetic insecticides** are chemically engineered substances designed to effectively address specific insect-related challenges. Among these are organophosphates, which disrupt the nervous systems of insects, rendering them incapacitated; pyrethroids, which imitate natural repellents to ensure broad-spectrum and long-lasting control; and

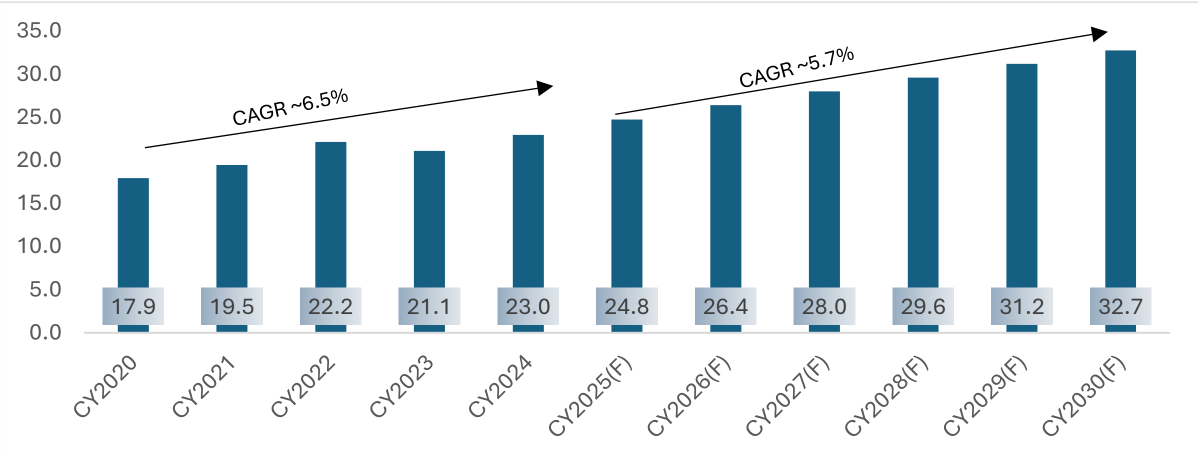
neonicotinoids, which obstruct nerve transmission, providing targeted and effective pest management options.

2. **Biological insecticides** are derived from natural sources such as bacteria, fungi, or viruses, and specifically target insect pests. For example, Bacillus thuringiensis (Bt) produces proteins that are highly toxic to certain insects while being completely harmless to humans and animals, offering a safe and environmentally friendly option for pest management.
3. **Insect Growth Regulators (IGRs)** are substances that disrupt the developmental processes of insects, interfering with their growth and reproductive cycles. IGRs are employed to manage pest populations over time, representing a strategy that is generally safer and less toxic to humans and animals compared to traditional insecticides.
4. **Natural insecticides** are derived from plant or other natural sources, for e.g. neem oil and pyrethrum. These materials are often preferred due to their lower environmental impact and reduced toxicity to non-target species, making them sustainable and eco-friendly alternatives to synthetic chemicals.

8.1 Market size of the global insecticide market:

During CY2024, the global insecticides market reached a market value of $ 23.0 billion exhibiting a CAGR growth of ~6.5% during CY2020-CY2024. Going forward, global insecticides market is expected to reach a value of $ 32.7 billion by CY2030, representing a CAGR of 5.8% during CY2025-CY2030.

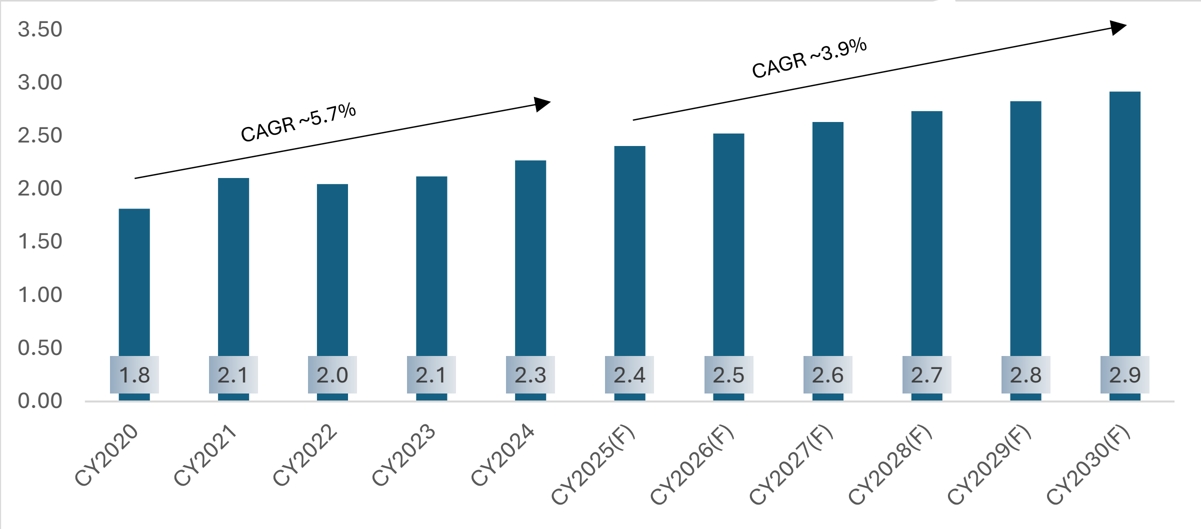
Chart 37: Insecticides Market: Sales value (in $ Billion)



Source: FAO, IMARC Group, ICRA Analytics

In terms of volume, the global insecticides market reported a volume of 2.3 million tonnes in CY2024, representing a CAGR of 5.7% during CY2020-CY2024. Looking forward, global insecticides market is expected to reach a volume of 2.9 million tonnes by CY2030, exhibiting a CAGR of 3.9% during CY2025-CY2030. Higher sales value CAGR of 5.7% than volume CAGR of 3.9% is on account of higher sales realisations expected during the period CY2025-2030.

Chart 38: Insecticides Market: Sales volume (in Million Tonnes)



Source: FAO, IMARC Group, ICRA Analytics

8.2 Market drivers, restraints and success factors of the global insecticide market-

8.2.1 Market drivers-

The global market for insecticides is driven by several essential factors that tackle significant challenges in pest control for both agriculture and public health sectors-

- **Rising demand for enhanced agriculture productivity**: A primary catalyst for this market is the rising demand for enhanced agriculture productivity. With the world's population on the rise, there is an urgent necessity to boost crop yields to ensure food security and satisfy the needs of an expanding population. Insecticides are crucial in this endeavor, as they safeguard crops from pests which can lead to substantial yield reductions. For instance, in India, the use of insecticides is vital for sustaining cotton production levels, which are important not only for local consumption but also for international trade. This increasing demand for greater agriculture output emphasizes the pivotal role that insecticides play in modern farming practices, underscoring their significance in achieving food security.
- **The increasing prevalence of vector-borne diseases:** This factor represents a significant factor driving market expansion. Insecticides play a vital role in managing disease vectors, particularly mosquitoes, which transmit illnesses such as malaria and dengue fever. The World Health Organization (WHO) has emphasized the essential function of insecticides in decreasing malaria cases, particularly in areas like sub-Saharan Africa, where their application has resulted in notable declines in both disease incidence and mortality rates. The WHO's ambitious targets for 2030, which aim for a 90% reduction in global malaria incidence and mortality, highlight the persistent necessity for effective insecticides in public health strategies aimed at addressing these life-threatening diseases and enhancing overall health outcomes.
- **Growth of agriculture endeavours into new and previously underexplored regions**: The growth of agriculture endeavours into new and previously underexplored regions is significantly increasing the demand for insecticides. As farming extends into areas such as the northern latitudes of Russia and Canada, new pest challenges emerge that require

effective management strategies. This geographical expansion brings forth a range of pest species that have not been encountered before, highlighting the need for the development and use of insecticides tailored to target these unique conditions. For example, as agriculture activities advanced into the northern territories of Canada, the implementation of specialized, pest-resistant insecticides becomes crucial for safeguarding newly established crops from emerging and potentially harmful threats.

- **Increasing sustainable practices:** The growing trend toward sustainable agriculture practices is fuelling a rising demand for eco-friendly insecticides. As environmental awareness increases among farmers and consumers, there is a marked preference for natural and less toxic insecticides that align with sustainability objectives. Products derived from plant sources, such as neem oil and pyrethrum, are gaining popularity due to their lower environmental impact and reduced toxicity to non-target species.
- **Technological advancement:** In addition, advancements in technology related to insecticide development and formulation are significantly contributing to market expansion. Innovations like targeted delivery systems and integrated pest management (IPM) strategies are enhancing the efficacy of insecticides while simultaneously reducing their environmental impact. A notable example is the emergence of smart insecticides that release active ingredients upon detecting specific pests, representing a major technological breakthrough. This method not only increases the efficiency of pest control but also promotes sustainability by minimizing chemical usage and focusing solely on the pests that are present.
- **Advancement of precision application technologies**: The advancement of precision application technologies, including drones and automated sprayers, has transformed the way insecticides are distributed. These innovations allow for more accurate and efficient application, reducing waste and lessening the environmental impact of pest control efforts. By utilizing these cutting-edge technologies, the industry can more effectively meet the complex demands of modern agriculture while prioritizing environmental stewardship. This emphasis on precision and sustainability is crucial for adapting insecticide use to the evolving needs of agriculture and environmental challenges.

8.2.2 Restraints witnessed in the global insecticide market:

The global insecticides market encounters several key challenges that hinder its growth and development.

- **Increasing regulatory scrutiny:** One of the key significant restraints is the increasing regulatory scrutiny and the implementation of stringent environmental regulations. Governments across the world are enforcing tighter controls on the use of chemical insecticides to reduce their potential environmental and health impacts. For instance, the European Union's REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals) regulation mandates thorough safety assessments for insecticides, which can delay the approval of new products and limit the use of certain chemicals. These regulatory hurdles lead to higher compliance costs for manufacturers, ultimately impacting market growth and slowing the pace of innovation.
- **Insecticide resistance:** The development of insecticide resistance among pests presents a serious challenge. Over time, many insect species have evolved resistance to commonly used insecticides, diminishing their effectiveness and requiring the continuous development of new formulations. For example, the resistance of malaria-carrying mosquitoes to pyrethroids has become a significant concern for public health efforts, complicating the control of vector-borne diseases.

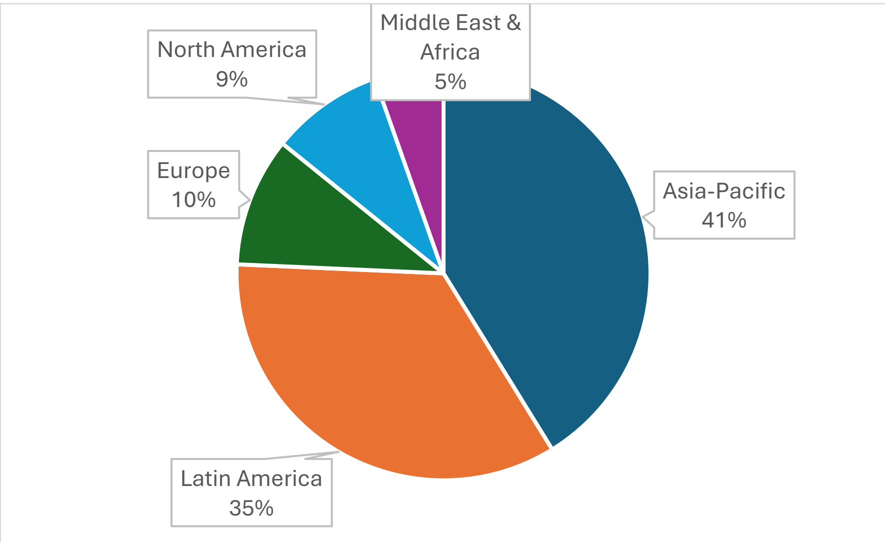
- **Increasing apprehension:** A notable limitation is the increasing apprehension regarding the detrimental effects of insecticides on non-target species and ecosystems. There is an escalating recognition and critique of the influence of chemical insecticides on beneficial insects, particularly bees, which play a crucial role in pollination. The reduction in bee populations has been associated with specific insecticides, leading to calls for more sustainable and environmentally friendly pest management strategies. This transition in consumer and regulatory inclinations towards safer alternatives exerts pressure on the industry to evolve and may ultimately reduce the market share of conventional insecticides.

8.2.3 Success factors in the global insecticide market:

- **Sustainability:** A significant factor contributing to success is the rising demand for sustainable and environmentally friendly insecticides. As public awareness of environmental issues increases, there is a noticeable transition towards products that pose minimal risks to the ecosystem and non-target organisms. Insecticides sourced from natural ingredients, such as neem oil, are gaining popularity due to their lower ecological impact. Firms that prioritize these eco-friendly alternatives can secure a substantial market share and attract consumers who are environmentally conscious.
- **Technological progress:** A key determinant of success in the global insecticides market is the adoption of innovation and technological progress. Firms that allocate resources towards the creation of advanced insecticide formulations and sophisticated application technologies, including precision agriculture tools and intelligent insecticides, are strategically positioned for expansion. For example, the use of drones for targeted insecticide application not only improves efficiency but also reduces environmental repercussions.
- **Emergence of smart insecticides:** The emergence of smart insecticides, particularly those featuring controlled-release mechanisms, guarantees that active ingredients are dispensed solely in the presence of pests, thereby enhancing their effectiveness. These technological advancements address the growing demand for efficient and environmentally sustainable pest control solutions, rendering them essential for maintaining a competitive edge in the market.
- **Expansion into regions of agriculture industries:** Moreover, establishing strategic alliances and venturing into emerging markets are crucial for achieving success. Collaborations among industry leaders, academic institutions, and regulatory agencies can foster innovation and support the creation of integrated pest management (IPM) approaches. These partnerships also aid in navigating intricate regulatory landscapes and identifying new market prospects. Expanding into regions where agriculture industries are experiencing rapid growth, enables companies to meet the increasing demand for effective pest control solutions. Organizations that adopt these strategies will be well-equipped to thrive in the global insecticides market. Additionally, investing in local manufacturing facilities and distribution systems in these emerging markets can further enhance market presence and optimize supply chain operations.

8.3 Market breakup by region

Chart 39: Market breakup by region during CY2025 (in %, value in consumption terms)

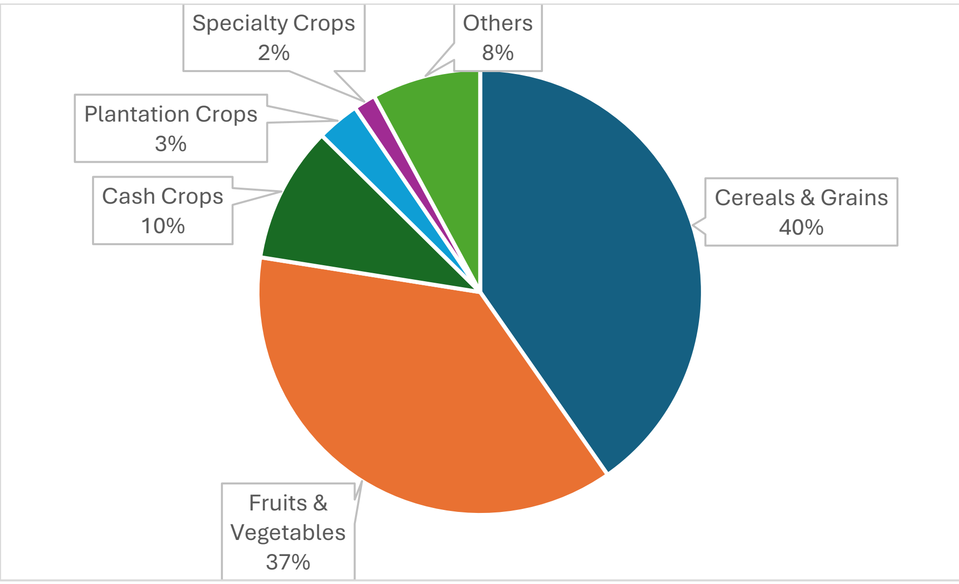


Source: IMARC Group, ICRA Analytics

During CY2025, Asia Pacific region dominated the given market segment with a market share of ~41%. It was followed by Latin America at ~35%, Europe ~10%, North America at ~9% and Middle East and Africa at ~5%.

8.4 Market breakup by application

Chart 40: Market breakup by application during CY2025 (in % terms) (value in consumption terms)



Source: IMARC Group, ICRA Analytics

During CY2025, the key segment attracting the application of insecticides was the cereals & grains at ~40% followed by fruits & vegetables segment at ~37%, cash crops at ~10%, plantation crops at ~3%, speciality crops at ~2% and others at ~8%.

8.5 Value chain analysis:

The global insecticide market value chain involves research & development, raw material procurement, manufacturing, quality control and assurance, packaging, distribution & logistics, end-user industries and post-market surveillance. A detailed perspective on the same has been provided below:

- **Research and Development (R&D):** The research and development (R&D) phase plays a pivotal role in the global insecticides market, concentrating on the formulation of new products and improving the existing ones. This phase encompasses comprehensive laboratory investigations aimed at identifying potent active ingredients and understanding their mechanisms. Field trials are essential for assessing both efficacy and safety in practical settings. Regulatory assessments are critical to guarantee adherence to international standards established by organizations such as the U.S. Environmental Protection Agency (EPA) and the European Chemicals Agency (ECHA). Additionally, the R&D phase involves the exploration of innovative technologies, including biological control agents and integrated pest management (IPM) strategies, to ensure that new products effectively tackle emerging pest issues and environmental challenges. Collaboration with academic institutions and research organizations further strengthens R&D initiatives, providing access to cutting-edge scientific knowledge and novel technologies.
- **Raw Material Procurement:** The procurement of raw materials is a critical component in the manufacturing of insecticides, necessitating the sourcing of active ingredients and additional elements required for formulation. Typical raw materials include synthetic chemicals such as pyrethroids and neonicotinoids, alongside natural products like neem oil and various plant extracts. Suppliers are required to comply with rigorous quality standards and regulatory mandates to guarantee the efficacy and safety of these materials. This process also entails the establishment of dependable supply chains to ensure the consistent availability of high-quality raw materials. Procurement strategies frequently involve evaluating suppliers for their capacity to provide traceability and transparency, which are essential for adherence to international regulations and maintaining the integrity of the final product. Furthermore, effective procurement practices include the assessment of supplier's environmental and ethical standards, which are increasingly shaping global purchasing choices.
- **Manufacturing:** The manufacturing process entails transforming raw materials into finished insecticides through a series of intricate procedures. This process involves the careful combination of active ingredients with carriers and solvents, resulting in various formulations such as sprays, powders, or granules. Typically, the process begins with the creation of a concentrated formulation, which is subsequently diluted to reach the desired concentration. State-of-the-art manufacturing facilities utilize automated systems for mixing, blending, and granulation, thereby improving accuracy and minimizing human error. High-shear mixers and reactors are frequently employed to

facilitate the effective blending of components. The production line integrates in-process quality control measures to verify that the formulations are uniform and comply with regulatory standards. Furthermore, contemporary facilities make use of computer-controlled systems to continuously monitor and adjust manufacturing parameters, ensuring consistent product quality and compliance with safety regulations.

- **Quality Control and Assurance:** The processes of quality control and assurance are essential for guaranteeing the safety and effectiveness of insecticides. This phase encompasses thorough testing and inspection throughout the production cycle to uphold product standards. International standards, including those established by the International Organization for Standardization (ISO) and various national regulatory bodies, inform these practices. Testing procedures involve confirming the chemical composition, potency, and the presence of any potential contaminants to ensure that insecticides fulfill safety and performance benchmarks. Furthermore, comprehensive quality control systems integrate regular audits, cross-verifications, and validation procedures to maintain consistent quality and adherence to changing regulatory standards. The application of sophisticated analytical methods, such as high-performance liquid chromatography (HPLC) and mass spectrometry, significantly improves the precision and dependability of quality evaluations, ensuring that products function as intended and are safe for both users and the environment.
- **Packaging:** Packaging is a critical step that involves designing and producing containers that securely protect insecticides during transportation and storage. This process must adhere to regulatory standards and incorporate safety features to prevent accidental exposure. Packaging also includes detailed labeling that provides clear instructions, safety warnings, and regulatory information. For global markets, packaging designs must comply with a variety of regulations, such as those from the U.S. EPA and the European Union's Classification, Labeling, and Packaging (CLP) Regulation. There is a growing focus on selecting packaging materials based on their environmental impact, with an increasing preference for recyclable, biodegradable, and eco-friendly options to support sustainability goals. Additionally, tamper-evident seals and child-resistant packaging are crucial for ensuring consumer safety and preventing misuse. The use of innovative packaging technologies further enhances protection and usability.
- **Distribution and logistics**: It involves the transportation and delivery of packaged insecticides to various markets. Efficient logistics are crucial for ensuring timely and cost-effective delivery. This process includes managing supply chains, warehousing, and transportation while adhering to international shipping regulations. Companies must also navigate customs regulations and documentation for cross-border shipments. Advanced logistics technologies, such as GPS tracking and automated inventory systems, help optimize distribution, ensuring that insecticides reach their destinations promptly and in optimal condition. Real-time monitoring of shipments allows for quick responses to delays or disruptions, preserving product integrity and ensuring customer satisfaction.
- **End-User Industries:** Insecticides are distributed to various end-user industries, including agriculture, public health, and pest control services. In agriculture, insecticides protect crops by combating pests that threaten yields and quality. In public health, they are used for vector control, targeting insects like mosquitoes that spread diseases. Pest control companies use insecticides to manage pests in residential, commercial, and industrial settings. This stage involves understanding the specific needs of each sector and ensuring insecticides are applied effectively to address different pest challenges. Tailoring formulations and application methods to the unique requirements of each

industry enhances efficacy and user satisfaction. Additionally, collaborating with end-users for field trials and feedback helps refine products to better meet specific needs and regulatory standards.

- **Post-Market Surveillance:** It refers to the ongoing assessment of insecticide's performance and effects following their introduction to the market. This process encompasses the evaluation of product efficacy, gathering consumer feedback, and identifying any new challenges, such as the development of resistance. Surveillance efforts are undertaken by manufacturers, regulatory agencies, and research organizations. The World Health Organization (WHO) and various national health authorities may perform studies to evaluate the effectiveness of insecticides in managing vector-borne diseases. This feedback mechanism is crucial for enhancing current products, directing future research and development, and ensuring that insecticides adhere to safety and efficacy standards. The collection and analysis of real-time data from end-users play a significant role in facilitating prompt updates and enhancements. Additionally, effective post-market surveillance includes public reporting systems and databases that monitor adverse effects and enable swift responses to any emerging safety issues.

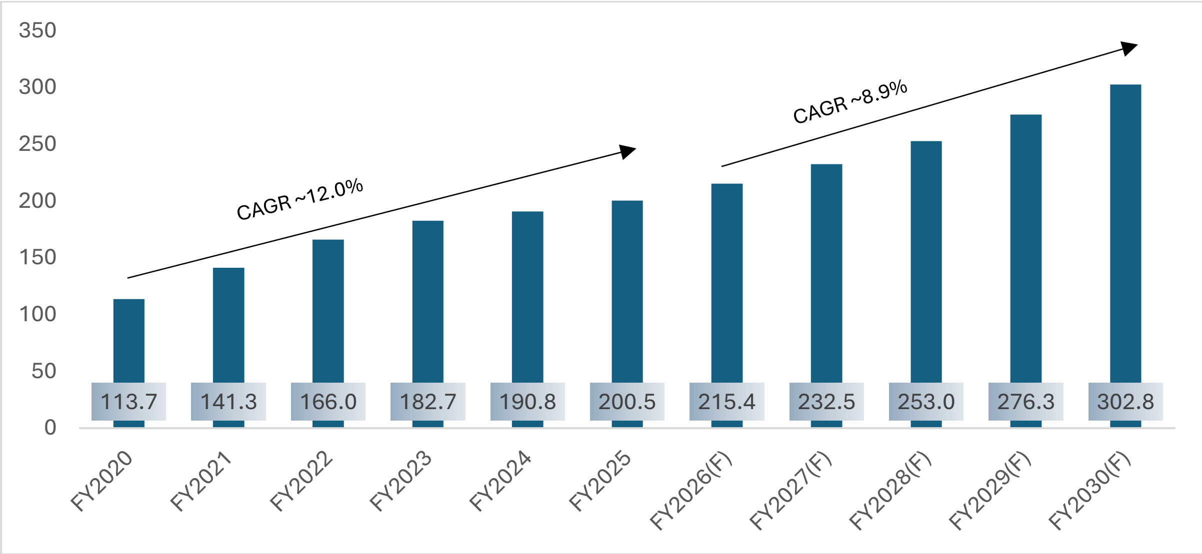
9. Indian Insecticide Market:

The insecticide market in India is experiencing significant growth, primarily fuelled by the necessity for increased food production in response to a rapidly expanding population. Farmers are becoming more aware of the financial advantages associated with insecticides, including enhanced crop quality and diminished losses from pest infestations. Innovations in technology, particularly in precision agriculture, are improving the efficiency and effectiveness of insecticide application, thereby reducing waste.

Government initiatives aimed at modernizing the agriculture sector and encouraging the use of advanced inputs are further bolstering the market. There are numerous opportunities, especially in the area of environmentally friendly options such as biopesticides, as companies are increasingly investing in sustainable alternatives. The growth of precision agriculture is driving the demand for sophisticated insecticides that can seamlessly integrate with these systems, providing targeted solutions. Educational programs designed to inform farmers about the advantages and correct application of insecticides can enhance adoption rates. Furthermore, the rising global demand for agriculture products offers Indian manufacturers the chance to penetrate international markets by adhering to global standards. Partnerships with research institutions and other stakeholders can foster innovation and promote market expansion.

The Indian insecticides market reached a value of Rs 200.5 billion during FY2025, growing at a CAGR of 12.0% during FY2020-FY2025. Going forward, the India insecticides market is expected to reach a value of Rs 302.8 billion by FY2030, growing at a CAGR of 8.9% during FY2026-FY2030.

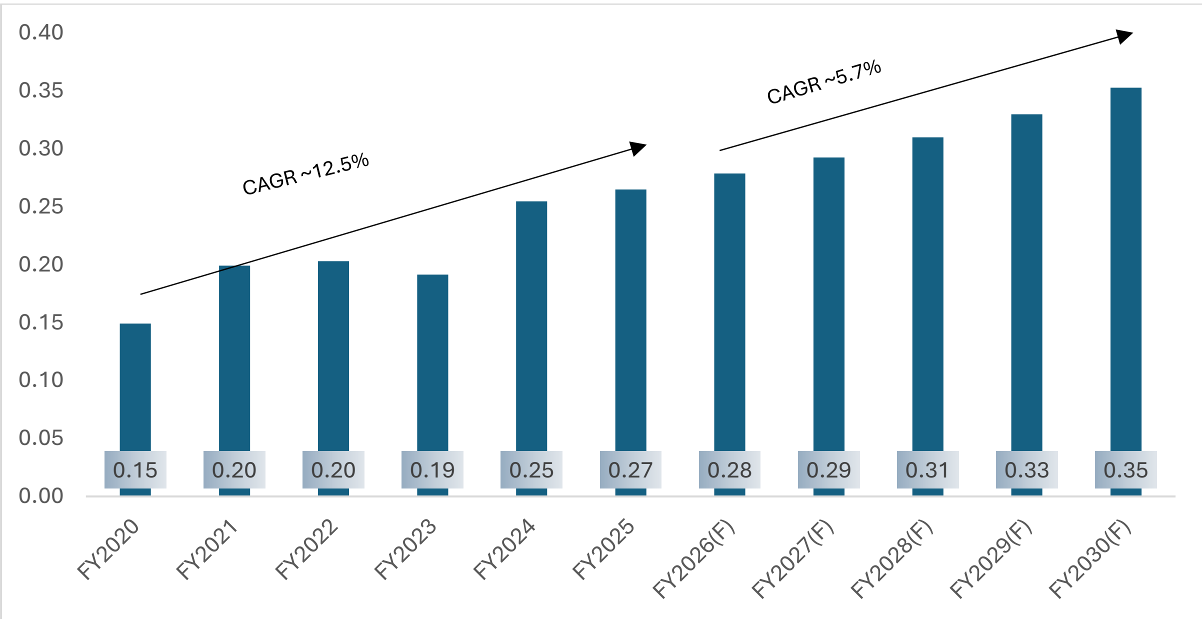
Chart 41: India: Insecticides Market: sales value in Rs billion



Source: Department of Commerce, IMARC Group, ICRA Analytics

In terms of volume, the Indian insecticides market stood at 0.27 million tonnes during FY2025 growing at a CAGR of ~12.2% during FY2020-FY2025 and is expected to reach a volume of 0.35 million tonnes by FY2030, at a CAGR of ~6.1% during FY2026-FY2030. Higher value growth than volume growth highlights the expectations of higher sales realisations during the forecasted period.

Chart 42: India: Insecticides Market: sales volume in Million Tonnes



Source: Department of Commerce, IMARC Group, ICRA Analytics

9.1.1 Market drivers:

- **Expansion of Cultivated Land:** The growth of agriculture land and the introduction of new crop varieties heighten the necessity for insecticides. The cultivation of new crops and the expansion of farming areas demand effective pest management strategies to promote healthy plant development and avert crop losses. According to the Land Use

Statistics for 2018-19, India's total geographical area encompasses 328.7 million hectares, with 139.3 million hectares identified as the net sown area and 197.3 million hectares as the gross cropped area, indicating a cropping intensity of 141.6%.

- **Increasing Pest Incidences in Agriculture:** India is grappling with significant challenges posed by escalating pest incidences in agriculture. The findings reveal that the nation suffers an annual crop yield loss of approximately 18%, equating to an alarming economic deficit of around ₹90,000 crore. This considerable loss highlights the urgent necessity for effective pest management strategies to protect agriculture productivity. Additionally, India is home to 173 invasive species, including 47 that affect agriculture ecosystems, with 23 being insects. Pest infestations not only diminish crop yields but also compromise the quality of agriculture products, resulting in financial difficulties for farmers and threatening food security.
- **Enhancing Agriculture Output:** India, with a population of 1.4 billion poses rising demand for increased agriculture productivity to cater to this growing populace. This leads to the utilization of insecticides to shield crops from pests and diseases. As the necessity for enhanced agriculture yields becomes more pressing, insecticides are becoming more essential in protecting crops from various threats. Furthermore, agriculture and its associated sectors represent the primary source of livelihood in India, with 70% of rural households relying predominantly on agriculture, and 82% of farmers classified as small and marginal.
- **Government Initiatives and Policies:** A range of government programs, including subsidies for pest control and agriculture insurance, facilitate the application of insecticides. The Indian government endorses the use of insecticides through initiatives such as the Pradhan Mantri Fasal Bima Yojana (PMFBY), which offers crop insurance and stimulates the demand for pest control products. The scheme titled "Strengthening and Modernization of Pest Management Approach in India" advocates for Integrated Pest Management (IPM) through the establishment of Farmer’s Field Schools and 31 Central IPM Centres. Furthermore, initiatives like the Rashtriya Krishi Vikas Yojana and the National Horticulture Mission contribute to enhancing plant protection and agriculture resilience by implementing various pest management techniques.

9.1.2 Threats and challenges in the domestic insecticide market:

- **The Emergence of Pest Resistance:** Metabolic resistance stands as the most common form of resistance observed in insects, posing a considerable obstacle to effective pest management. Insects that display metabolic resistance typically possess increased levels or more proficient variants of enzymes that convert insecticides into harmless substances, thus reducing the efficacy of the applied chemicals. This type of resistance is largely influenced by genetic factors and the frequent use of insecticides. Prolonged reliance on the same insecticides can result in the swift emergence of resistance among insect and mite populations. This persistent cycle intensifies the challenge, complicating efforts to manage pest populations and highlighting the urgent need for the creation of more innovative and varied pest management approaches.
- **Environmental and Health Concerns:** The use of chemical insecticides has raised significant environmental and health concerns, leading to increased regulatory scrutiny. Insecticides, while effective at killing insects, can also pose risks to human health, causing symptoms such as eye irritation, coughing, heart problems, and breathing difficulties when ingested, inhaled, or absorbed through the skin. The Indian government is increasingly promoting sustainable agriculture practices and imposing restrictions on harmful chemicals, which could impact the growth of the agrochemical market.

- **Regulatory Hurdles:** The approval process for new insecticide products in India is stringent, requiring extensive assessments of safety, efficacy, and environmental impact. The Central Insecticides Board (CIB) oversees the registration of pesticides, and the lengthy approval process can delay market entry and increase costs. Meeting these regulatory standards demands significant investment, creating a potential barrier to market growth.

9.1.3 Opportunities to be tapped in the Indian Insecticide market:

- **Implementation of Precision Agriculture:** The adoption of precision agriculture technologies, including drones and remote sensing, is anticipated to transform insecticide application practices in India, facilitating more targeted and efficient pest management strategies. The Digital India initiative is instrumental in this transition, as it encourages technological innovations in the agriculture sector. For example, states such as Uttar Pradesh, Andhra Pradesh, and Bihar have launched dedicated programs to scale drone usage. States such as Uttar Pradesh, Andhra Pradesh, and Bihar have launched dedicated programs to scale drone usage. Uttar Pradesh initiated a pilot spraying program across six districts under the Atmanirbhar Krishak Samanvit Vikas Yojana and Agriculture Infrastructure Fund, training farmers to cover 3–12 acres per hour using drones. Andhra Pradesh introduced the AP Drone Mart portal to expand access to certified drone services for pesticide spraying and crop monitoring across all districts. Meanwhile, Bihar plans to train 101 farmers under its FY 2025–26 aerial spray scheme, offering a 60% subsidy (up to ₹3.65 lakh) per drone and ₹35,000 for training via the OFMAS platform.
- **Increase in R&D and Patents:** Investing in research and development is driving the creation of innovative insecticide solutions and improved formulations. Collaboration with research institutions and government bodies supports new product development and technological advancements.
- **Introduction of New Products**: The introduction of innovative insecticide formulations, which are specifically designed to improve pest control in essential crops, is expected to propel future expansion within the Indian market.

9.2 Value chain analysis:

The domestic insecticide market value chain involves research & development, registration, technical manufacturer, formulations & packaging, distribution and end-user. A detailed perspective on the same has been provided below:

Research and Development (R&D): R&D serves as the fundamental basis for innovation within the agrochemical sector. This phase focuses on the creation of new insecticide molecules and formulations, driven by rigorous scientific inquiry. Researchers aim to improve the efficacy, safety, and ecological footprint of these products. The process entails thorough testing and refinement of new formulations to guarantee compliance with established standards. Additionally, the preparation of detailed documentation for regulatory approval, which includes safety and efficacy assessments, is vital during this phase. The successful execution of R&D

initiatives lays the groundwork for the launch of cutting-edge pest control solutions in the marketplace.

Registration: The registration phase requires adherence to regulatory protocols to facilitate the introduction of new insecticide products into the market. Companies are obligated to present comprehensive product information to the Central Insecticides Board & Registration Committee (CIBRC). This information encompasses details regarding the product's formulation, safety profile, environmental considerations, and effectiveness. The approval process entails a thorough examination of scientific data, risk evaluations, and verification of compliance with national regulations. Upon receiving approval, companies acquire the necessary certifications and develop product labels that align with legal standards while providing clear instructions for use. This phase is essential in ensuring that products are both safe for consumers and environmentally responsible.

Manufacturing: Manufacturing is the process of converting raw materials into finished insecticide products. Raw materials are sourced from domestic suppliers or imported when local options are unavailable. These materials are transported by road and stored based on production schedules and market demand. The manufacturing process involves blending active ingredients with other components to create the final product, all while adhering to strict quality control standards to ensure consistency and effectiveness. Rigorous quality checks throughout the process ensure that the products meet industry standards and comply with regulatory requirements.

Formulation: The formulation process involves creating insecticides in various forms, such as liquids, powders, granules, and emulsifiable concentrates, depending on the intended use and target pests. This stage includes extensive testing to ensure that the formulations are effective against pests and meet safety standards for both users and the environment. Large manufacturers often have in-house formulators who develop and refine these formulations, ensuring that insecticides are tailored to specific agriculture needs and are safe for application.

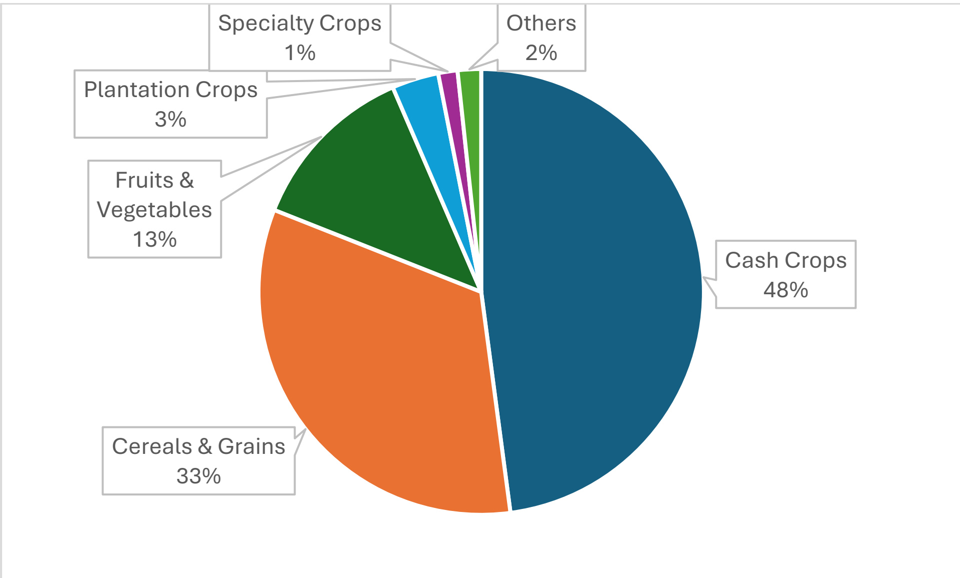
Distribution: Distribution encompasses the logistics of transporting finished insecticide products from manufacturing facilities to distribution centres and regional warehouses. Effective inventory management is essential to match market demand and accommodate seasonal variations. Products are stored under controlled conditions in warehouses to maintain their quality and efficacy until they reach retailers and end-users. Efficient distribution ensures that insecticides are available when needed and retain their effectiveness throughout the supply chain.

Retail: The retail sector encompasses the promotion and sale of insecticides through a variety of channels. This includes engaging in agriculture exhibitions, executing advertising campaigns, and implementing direct marketing strategies. A significant component of this phase is the education of farmers and retailers regarding the advantages and correct application of insecticides. Distribution occurs through a network of agrochemical retailers, cooperatives, and direct sales to farmers. Retailers are instrumental in facilitating access to insecticides and assisting farmers in selecting the appropriate products for effective pest management.

End Users: End users, primarily farmers, utilize insecticide products to control pests, weeds, and diseases. The efficacy of these products is contingent upon their correct application in accordance with established guidelines. Effective pest management not only enhances agriculture yields but also safeguards crops from potential damage, thereby increasing productivity and profitability for farmers. The proper application of insecticides is vital for achieving optimal results and ensuring that these products positively impact agriculture practices.

9.3 Market breakup by application

Chart 43: Market breakup by application during FY2025 in % terms (value in consumption terms)

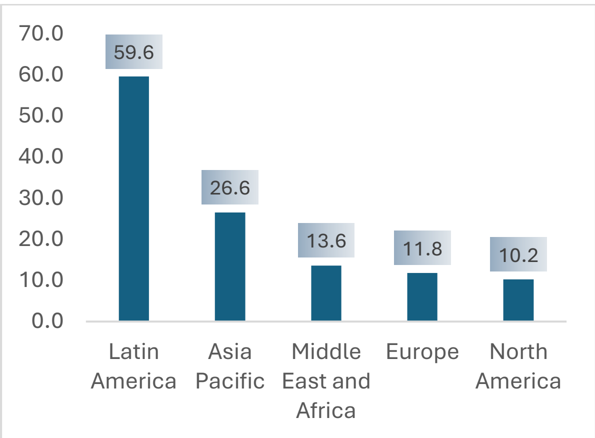


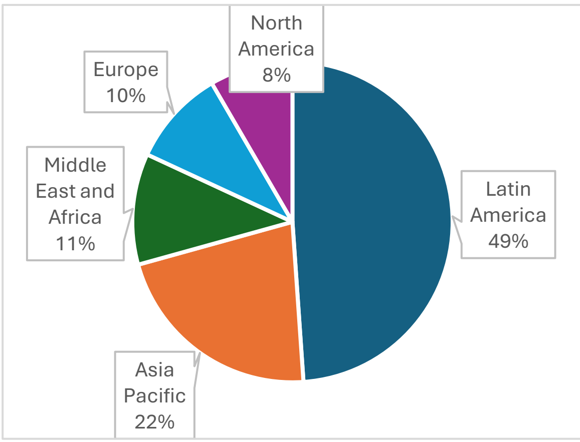
Source: IMARC Group, ICRA Analytics

During FY2025, as per application, cash crops had the lion's share of 48% of the total market followed by cereals & grains at ~33%, fruits & vegetables at ~12%, plantation crops at ~3%, specialty crops at ~1% and others at ~2%.

9.4 Insecticides export market

Chart 44: Breakup by region (sales value in Rs billion and export share in % terms), FY2025





Source: Department of Commerce, IMARC Group, ICRA Analytics

During FY2025, the total traded insecticides market in terms of value in India stood at Rs 172.14 billion, out of which total export stood at ~Rs 121.84 billion while import stood at ~Rs 50.3 billion. Latin America represented the largest market for exported insecticides from India, accounting for a share of 49% of the total export in term of value. It was followed by Asia Pacific at ~22%, Middle East and Africa at ~11%, Europe at ~10% and North America at ~8%.

Herbicide Market

10. Global Herbicide Market:

Herbicides, often known as weed killers, are chemical agents specifically formulated to manage undesirable vegetation, commonly referred to as weeds. They play a crucial role in enhancing agriculture efficiency, promoting crop vitality, and optimizing harvest yields. Prior to the introduction of herbicides, conventional methods for weed management included manual weeding, utilization of cover crops, and alterations to soil characteristics such as pH, nutrient content, or salinity.

Additionally, natural substances like sea salt, industrial by-products, and various oils were utilized for controlling weeds. However, significant innovations during World War II resulted in the creation of modern herbicides, which are capable of effectively targeting a broad spectrum of weeds while preserving the integrity of crops. In contemporary practices, herbicides are essential components of weed management strategies across multiple sectors, particularly in agriculture, where their rapid adoption by farmers is attributed to their high efficiency and effectiveness. Herbicides can be categorized based on several factors, including their selectivity, application methods, and timing of use.

A comprehensive classification is provided below:

Types of Herbicides Based on Specificity

- **Selective Herbicides**: These herbicides are designed to target particular plant species, effectively managing undesirable weeds while preserving the integrity of the desired crops. Their application is prevalent in agriculture practices, as they play a crucial role in promoting crop health by specifically addressing only the weed population.
- **Non-Selective Herbicides**: Non-selective herbicides serve as comprehensive solutions that impact plant life upon application. They are frequently utilized for both pre-sowing and post-sowing burndown, as well as in chemical fallow and industrial contexts where total eradication of vegetation is necessary.

Classification of Herbicides According to Application Method

- **Soil-Applied Herbicides**: These herbicides are incorporated into the soil, where they are taken up by the roots or shoots of developing weed seedlings. To achieve optimal effectiveness, it is crucial to apply them accurately to the soil layer and ensure sufficient soil moisture to facilitate absorption.
- **Foliar-Applied Herbicides**: These herbicides are administered directly to the aerial portion of the weeds, where they penetrate through the exposed plant tissues above the soil. Foliar applications are particularly effective against established weeds, as they depend on direct contact with the leaves of the plants.

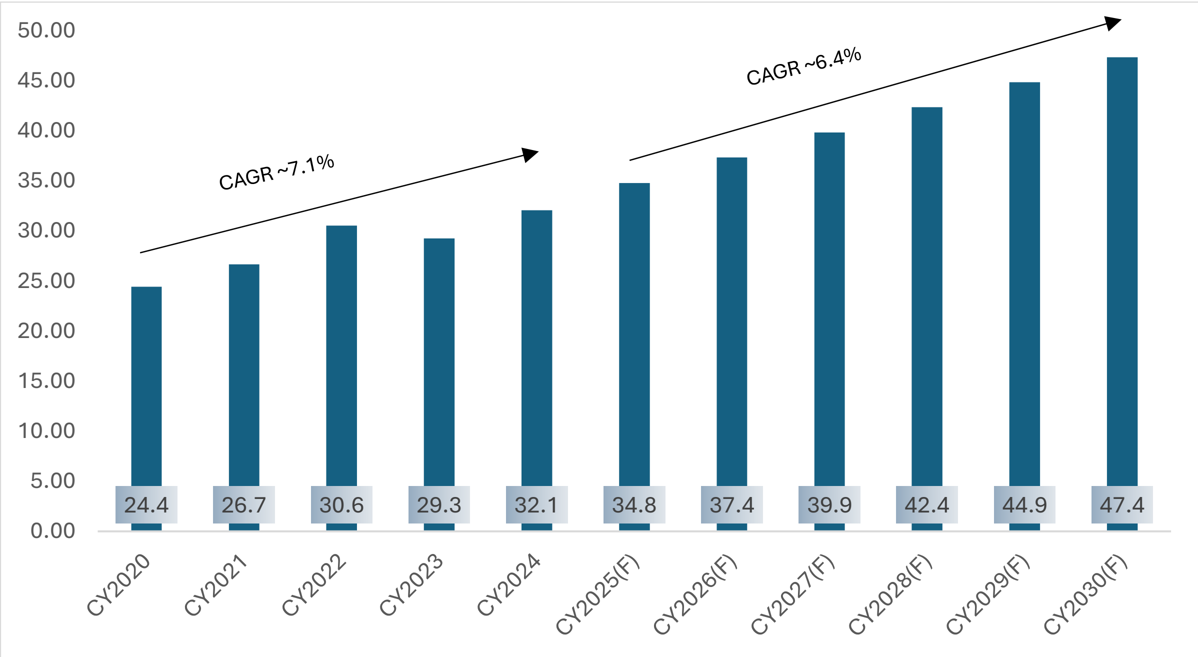
Classification of Herbicides According to Application Timing

- **Pre-Plant Herbicides**: These herbicides are utilized on the soil prior to the planting of crops, effectively managing weed populations before sowing occurs. They may be categorized as either selective or non-selective. By removing weeds before planting, these herbicides create favorable conditions for the growth of crops.

- **Pre-Emergence Herbicides:** Administered before the emergence of weed seedlings from the soil, these herbicides are effective in controlling weeds at the sprouting stage, but they do not affect plants that are already established.
- **Post-Emergence Herbicides**: These herbicides are applied after weeds have appeared and can be either selective or non-selective, with applications possible on soil or foliage. They often necessitate multiple applications to achieve desired results and should be used cautiously during rainy conditions, as moisture can reduce their effectiveness.

During CY2024, the global herbicides market reached a value of $32.1 billion, exhibiting a CAGR of 7.1% during CY2020-CY2024. Going forward, global herbicides market is expected grow at a CAGR of ~6.4% between CY2025-CY2030 to reach a value of $ 47.4 billion by CY2030.

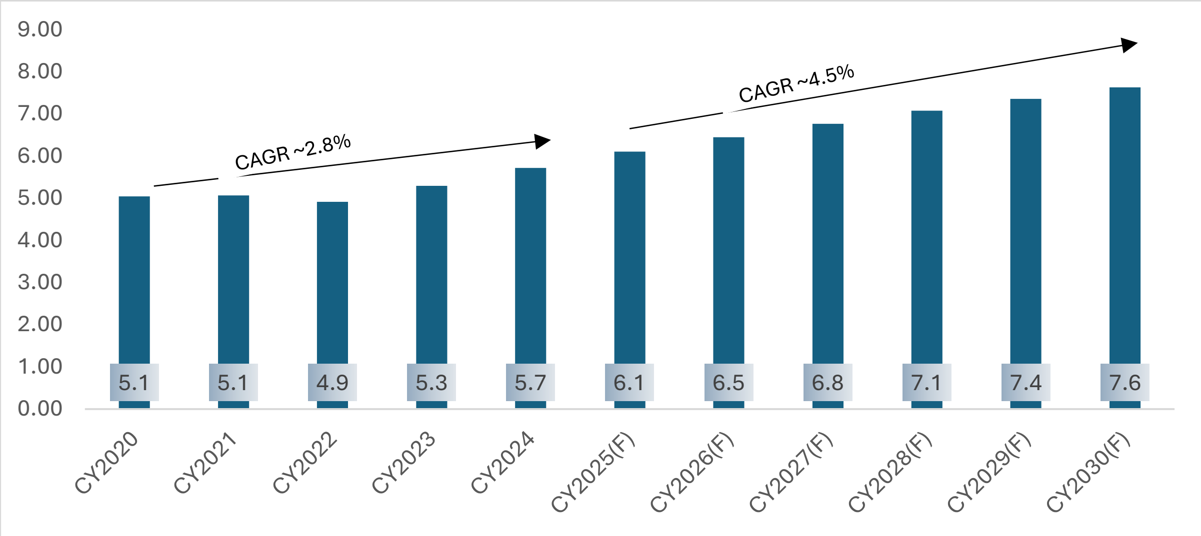
Chart 45: Global Herbicides Market: Sales Value (in $ Billion), CY2020-CY2030



Source: FAO, IMARC Group, ICRA Analytics

In term of volume, the global herbicides market reached a volume of 5.7 million tonnes in CY2024, representing a CAGR of 2.8% during CY2020-CY2024. Moving forward, global herbicides market is expected to reach a volume of 7.6 million tonnes by CY2030, representing a CAGR of 4.5% during CY2025-CY2030.

Chart 46: Global Herbicides Market: Sales Volume (in Million Tonnes), CY2020-CY2030



Source: FAO, IMARC Group, ICRA Analytics

10.1 Market drivers, restraints and success factors of the global herbicide market

10.1.1 Market drivers-

- **Increasing investment in R&D:** Companies are increasingly leveraging investment in research and development (R&D) as a means to secure a competitive advantage. By innovating and refining herbicides with distinct modes of action and improving bioherbicide formulations, these organizations are achieving notable market positioning and developing customer loyalty through enhanced product offerings. Furthermore, strategic alliances and collaborations among herbicide producers, agriculture research institutions, and government agencies play a vital role in advancing product development and expanding market presence. Such partnerships allow for the exchange of technological advancements and broadened market outreach, creating significant growth prospects in a competitive landscape.
- **Rising demand for food:** The global herbicides market is experiencing substantial growth, driven by the rising global demand for food owing to population growth and the need for increased agriculture productivity. According to projections by the Food and Agriculture Organization (FAO), the global population is expected to increase by nearly one-third, or 2.3 billion people, between CY2009 and CY2050. This population surge, along with rising per capita income, is anticipated to elevate the demand for high-quality food products. As the need for food rises, so does the demand for effective crop management solutions, making herbicides a vital component of modern agriculture practices. Herbicides play a crucial role in maximizing crop yield by effectively controlling weed populations, ensuring the optimal use of increasingly scarce arable land, which is under pressure from urbanization and climate change.
- **Shortage of labour:** The growing shortage of labour in agriculture sectors across the globe is prompting farmers to turn to herbicides as a practical substitute for traditional, labour-intensive weeding techniques, thereby increasing the demand for these chemicals. Furthermore, the herbicide market is anticipated to benefit from advancements in precision farming technologies, which employ herbicides to improve soil and crop health, minimize weed competition, and ultimately boost agriculture

productivity. As farmers increasingly adopt technologies such as GPS, drones, and IoT devices for enhanced field management, the demand for herbicides is projected to grow. This strategy not only improves crop yields but also enhances cost efficiency, establishing precision agriculture as a significant growth opportunity for herbicide producers.

- **Technological advancement:** Advancements in herbicide formulations have led to the development of more effective and environmentally friendly products, such as slow-release formulations, microencapsulation, and reduced-risk herbicides. These innovations have resulted in greater adoption among farmers who seek superior weed control with minimal environmental impact, thereby propelling market growth. The expansion of genetically modified (GM) crops is another key factor driving herbicide demand. GM crops like soybeans and corn, engineered to resist specific herbicides like glyphosate, enable more targeted and efficient weed management. This has led to high herbicide usage in major GM crop-producing regions such as the United States, Brazil, and Argentina, where agriculture practices heavily depend on GM technology.

10.1.2 Restraints witnessed in the global herbicide market:

- **Rising prices for bio-based herbicides:** The significant expenses linked to bioherbicides represent a considerable limitation for the market. Although bioherbicides are recognized for their ecological advantages, they frequently entail higher production and application costs in comparison to synthetic alternatives. This financial gap restricts their broader adoption, especially among small-scale farmers in developing regions, where sensitivity to pricing is a crucial factor. As a result, the market penetration of bioherbicides is limited in these areas, highlighting the need for innovations that can lower costs and enhance the accessibility and affordability of bioherbicides.

  As consumers grow more aware of the potential health hazards posed by chemical residues in food, there is a rising demand for organic farming practices that minimize or eliminate the use of chemical herbicides. Consequently, there is a noticeable trend towards the creation of organic herbicide solutions that meet consumer expectations for safer and more sustainable agriculture products.
- **Regulatory restrictions:** Environmental concerns and regulatory restrictions are significant restraints on the herbicides market, as the harmful impact of synthetic herbicides on ecosystems, particularly through soil and water contamination, has led to increasingly stringent regulatory measures worldwide. Many countries have imposed bans or restrictions on widely used herbicides like glyphosate due to health and environmental concerns. These regulatory actions have slowed market growth in regions with strict environmental regulations, forcing companies to explore alternative solutions.
- **Development of resistance:** Another critical challenge facing the herbicides market is the development of herbicide-resistant weeds. The continuous and excessive use of specific herbicides has led to the emergence of weed species that can withstand these chemicals, reducing their effectiveness. This resistance issue poses a significant challenge for farmers, who must constantly seek new methods to control these resilient weeds.

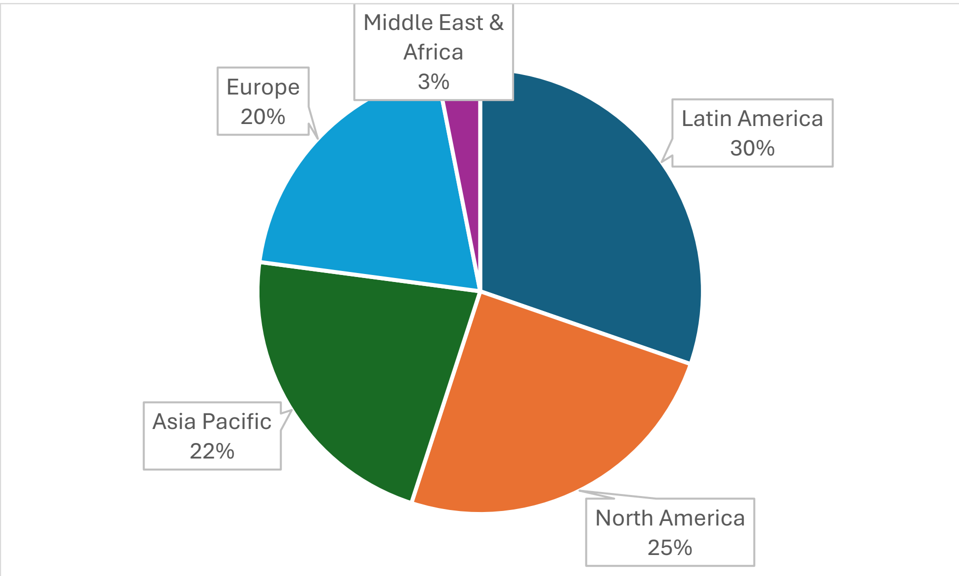
10.1.3 Success factors in the global herbicide market:

- **Advanced agriculture practices:** As the global population continues to expand and food security emerges as a critical issue, the need for innovative herbicide solutions is anticipated to increase significantly. Companies are progressively channelling investments into research and development to formulate more efficient and environmentally sustainable herbicide products. The advent of precision agriculture technologies, including in-field wireless sensors and AI-driven drones, is expected to invigorate the market by equipping farmers with real-time data and precise herbicide application capabilities, thereby improving the overall effectiveness of weed control efforts.

Innovations: The expansion of herbicide product portfolios to include targeted solutions for specific crop types and regional weed challenges presents a lucrative opportunity for companies to address diverse agriculture needs across different geographies. As companies continue to innovate and broaden their offerings, the herbicides market is expected to experience robust growth, driven by the increasing demand for efficient, sustainable, and precise weed management solutions. Syngenta, a major industry player, is capitalizing on its extensive research capabilities to commercialize novel herbicides like Tetflupyrolimet, designed to meet the specific weed management needs of Asian markets. This strategy highlights Syngenta's approach to addressing regional challenges with tailored solutions, providing farmers with effective tools for crop protection.

10.2 Market breakup by region

Chart 47: Global herbicides market: Breakup by region (in % terms) during CY2025 (in terms of consumption)

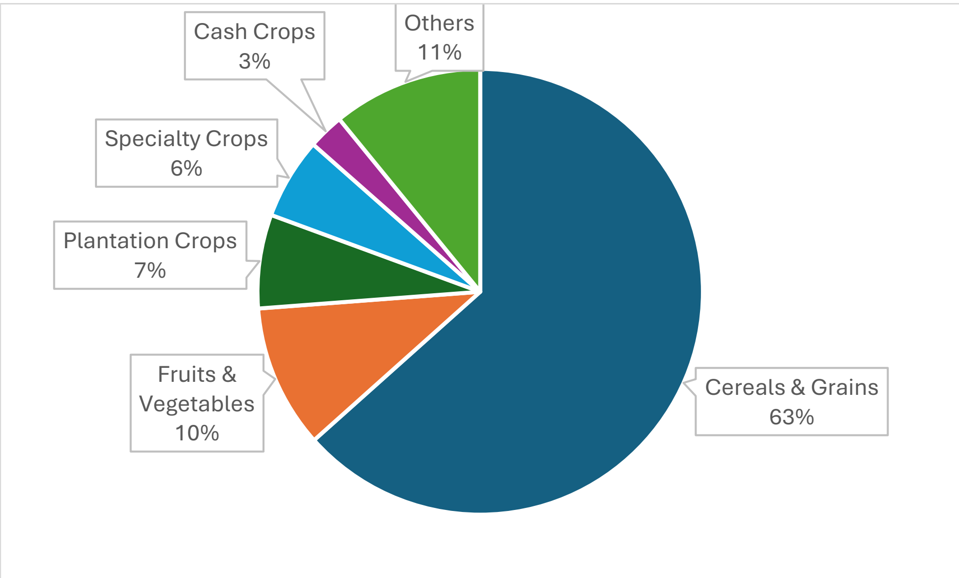


Source: IMARC Group, ICRA Analytics

During CY2025, Latin America represented the largest chunk of global market for herbicides with a share of ~30%. This was followed by North America at ~25%, Asia Pacific at ~22%, Europe at ~20% and Middle East and Africa at ~3%.

10.3 Market breakup by application

Chart 48: Global herbicides market: Breakup by application (in % terms) during CY2025 (in terms of consumption)



Source: IMARC Group, ICRA Analytics

During CY2025, cereals & grains used herbicides extensively, with a share of 63% of the total market. Cereals & grains was followed by fruits & vegetables at ~10%, plantation crops at ~7%, specialty crops at ~6%, cash crops at ~3% and others at ~11%.

10.4 Value chain analysis

Global: Herbicides Market: Value Chain Analysis

The herbicide industry's value chain encompasses several key stages given as follows.

Research and Development: This stage involves extensive scientific research aimed at identifying and developing new active ingredients with herbicidal properties. It includes significant laboratory work to synthesize new compounds, followed by rigorous testing through both laboratory and field trials to assess their effectiveness against various types of weeds. Additionally, this phase involves filing patents to protect intellectual property and submitting necessary documents to regulatory bodies for approval. These steps ensure that new herbicides meet safety and efficacy standards before being introduced to the market.

Raw Material Suppliers: Raw material suppliers are responsible for procuring essential materials from producers and delivering them to herbicide manufacturers. These suppliers, along with chemical manufacturers, play a critical role in the production process. Key materials include active ingredients, solvents, diluents, surfactants, adjuvants, and packaging materials like bottles, drums, and bags, all of which contribute to the herbicide's overall performance. These materials must adhere to specific quality standards to ensure the herbicide products are securely contained and preserved during storage and transportation. This stage also involves negotiating contracts and managing logistics to maintain a steady supply chain. Ensuring the purity and quality of raw materials is crucial, as any compromise can impact the final product's effectiveness and safety.

Herbicide Manufacturers: Manufacturers of herbicides source raw materials and then transform them into the final products, through steps such as mixing, blending, and filtering, among others. Initially, plants are cultivated in extensive fields and harvested at their optimal maturity. The harvested plant material is subsequently processed to extract the active ingredient, artemisinin, known for its herbicidal properties. Extraction techniques may involve solvent extraction, steam distillation, or supercritical fluid extraction. Following extraction, artemisinin is purified and concentrated. The final stage of production involves formulating the herbicide into its ultimate product form, which may be a liquid, powder, or in granular form. This formulation can also incorporate additional components, such as surfactants or emulsifiers, to improve the herbicide's effectiveness.

Quality Control & Assurance: The importance of quality control and assurance cannot be overstated when it comes to ensuring product safety, efficacy, and reliability. These processes involve thorough testing at multiple stages of production, starting from the sourcing of raw materials to the packaging of the final product. Advanced analytical methods, including chromatography and spectroscopy, are employed to identify impurities and confirm the composition of active ingredients. Additionally, formulations are subjected to stability testing to guarantee their effectiveness throughout the designated shelf life. Quality assurance teams also evaluate manufacturing processes to ensure adherence to regulatory standards and industry best practices, implementing corrective measures as needed to rectify any discrepancies or potential concerns.

Packaging: Packaging for herbicides is a critical aspect due to the hazardous nature of the product. The packaging design must incorporate clear labeling, safety instructions, and hazard symbols to protect both users and the environment. Innovations in packaging are increasingly focused on enhancing user-friendliness, reducing material usage, and improving recyclability. Features like easy-to-open caps and precise measuring tools are designed to make the application process safer and more efficient for end-users, ensuring that herbicides can be applied effectively and safely. Herbicides are typically packaged in bottle formats made from materials such as Polyethylene Terephthalate (PET), barrier bottles, and Polyvinyl Chloride (PVC). PET is particularly favored for common pesticide bottles due to its durability, chemical resistance, and recyclability, making it the material of choice in the industry.

Marketing and Distribution: This phase of the supply chain focuses on bringing herbicide products to market and encompasses all activities related to promoting and selling these products. Marketing and sales efforts are crucial for driving herbicide adoption within the agriculture sector. This stage includes developing marketing strategies and launching promotional campaigns to emphasize the benefits of herbicides. The distribution process involves transporting the manufactured herbicides from production facilities to various markets globally. Distributors play a key role in managing inventory levels to ensure a consistent supply that meets market demand.

End-User: The final stage of the value chain involves the end-users who apply the herbicide products. This includes farmers, agriculture businesses, and landscapers who use herbicides in agriculture settings to control weed growth and enhance crop yields, following recommended guidelines. Post-market surveillance is a critical component at this stage, ensuring the ongoing safety and effectiveness of herbicides after they enter the market. Post-market support also involves providing technical assistance and product training to customers as needed.

Collaboration with cross-functional teams is essential to optimize product offerings and meet customer needs. Regular audits and inspections are conducted to ensure compliance with regulatory standards and to identify any deviations from expected performance.

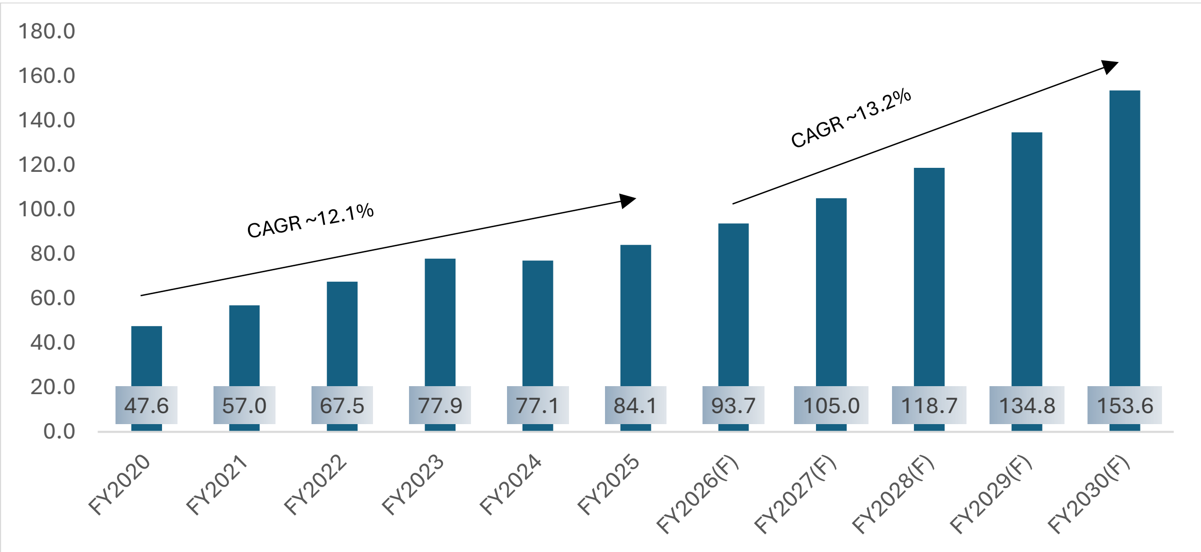
11. Indian Herbicides Market:

The expansion of the herbicide market in India is largely influenced by the growing necessity to enhance food production in order to sustain an increasing population. Farmers are progressively utilizing herbicides to improve crop yields by effectively controlling weed growth that could otherwise hinder productivity. Advances in technology, such as the creation of selective and systemic herbicides, contribute to greater efficiency while minimizing adverse effects on non-target species. Government efforts to modernize agriculture methods and promote the use of advanced farming inputs further strengthen the herbicide market. The emergence of sustainable agriculture practices, including the implementation of bioherbicides and integrated weed management strategies, presents additional growth opportunities by addressing environmental and health issues.

Furthermore, the rising adoption of precision agriculture technologies is fueling the demand for herbicides that can be applied with greater accuracy and efficiency. Educational initiatives that emphasize the advantages and correct application of herbicides can improve adoption rates among farmers. Additionally, as global markets seek a variety of agriculture products, Indian herbicide manufacturers have the potential to expand their reach internationally by complying with global quality standards and partnering with research institutions to foster innovation. Key chemical classes in the Indian herbicide market include glyphosate, atrazine, 2,4-D, and newer formulations designed to address evolving weed resistance issues.

The herbicides market in India stood at Rs 84.1 billion during FY2025, reflecting a compound annual growth rate (CAGR) of 12.1% from FY2020 to FY2025. The same is expected to reach Rs 153.6 billion by FY2030, exhibiting a CAGR of ~13.2% from FY2026 to FY2030.

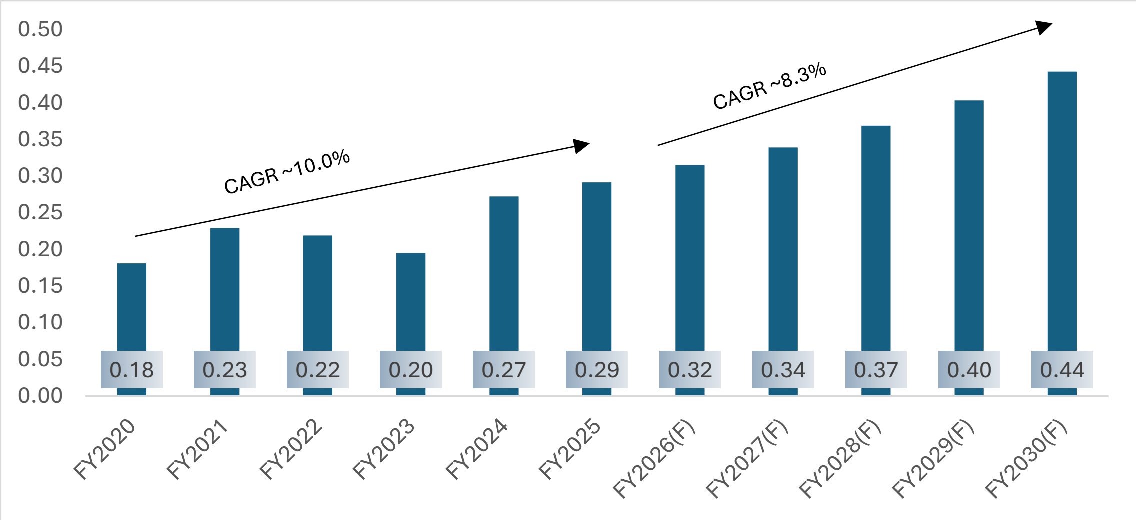
Chart 49: Indian Herbicides Market: Sales Value (in $ Billion), FY2020-FY2030



Source: IMARC Group, ICRA Analytics

In terms of volume, the India herbicides market reached a volume of 0.29 million tonnes in FY2025, growing at a CAGR 10.0% of during FY2020-FY2025. Going forward, the Indian herbicides market is expected to reach a volume of 0.44 million tonnes by FY2030, growing at a CAGR of ~8.3% during FY2026-FY2030.

Chart 50: Indian Herbicides Market: Sales Volume (in Million Tonnes), FY2020-FY2030



Source: Department of Commerce, IMARC Group, ICRA Analytics

11.1 Drivers, Restraints, and Opportunities in the Indian herbicide market:

11.1.1 Market drivers-

- **Increasing demand for effective weed control:** The report titled 'Land Use Statistics-at a Glance 2012-13 to 2021-22' indicates a slight decline in agriculture land, from 180.6 million hectares in FY2019 to 180.1 million hectares in FY2022. This decrease in available agriculture land underscores the necessity for innovative farming techniques that optimize the use of existing plots. Proper weed management is essential for enhancing the productivity of these constrained resources. Weeds not only diminish crop yields but also elevate production expenses, degrade product quality, and interfere with harvesting operations. Furthermore, they obstruct irrigation water flow and can serve as hosts for disease pathogens. In light of these issues, the reliance on herbicides for effective weed management is becoming increasingly prominent.
- **Economic viability:** Weeds represent a significant challenge to the agriculture industry in India, leading to considerable annual losses in crop production. In response to this issue, farmers implement various strategies, including crop rotation, cultural practices, manual weeding, and the application of chemical herbicides. With the increasing expenses associated with alternative weed management techniques, a growing number of farmers are opting for chemical herbicides. These substances allow farmers to efficiently control weed proliferation and mitigate its adverse effects on crop yields, ultimately enhancing overall agriculture productivity.
- **Increasing crop losses**: Weeds have a considerable adverse effect on crop production by competing with agriculture plants for vital resources, including light, water, and nutrients, which results in significant economic loss. To address this challenge, weed management strategies must prioritize two key goals: minimizing immediate yield losses and decreasing the quantity of weed seeds present in the soil seed bank. Consequently, there has been a notable rise in the use of herbicides to mitigate crop losses.

- **Increasing need for enhanced crop production in India:** The swift rise in India's population, coupled with a growing consciousness regarding health, has led to a substantial surge in the demand for superior agriculture products. To meet this demand, it is crucial to optimize crop yields, which necessitates efficient management of agriculture land to eliminate unwanted vegetation. Weeds, known for their rapid growth, present a significant obstacle to both crop cultivation and yield improvement thus facilitating the use of herbicide will be beneficial to achieve the targeted crop yield.

11.1.2 Restraints witnessed in the Indian herbicide market:

- **Herbicide resistance in weeds:** While herbicides have greatly enhanced crop yields and production efficiency, their overuse and repeated application within the same chemical class can lead to the emergence of herbicide-resistant weed biotypes. In India, although herbicides are not as widely used as in developed countries, the continuous use of butachlor and isoproturon has led to resistance in weeds such as *Echinochloa colona* and *Phalaris minor*. This resistance poses a significant threat to the sustainability of the rice-wheat cropping system in the country. Given that plants have natural defense mechanisms, herbicide resistance is likely to remain a persistent issue, necessitating ongoing vigilance and the development of new strategies to manage this challenge in the future.
- **Environmental and Health Concerns:** Environmental concerns associated with herbicides include soil persistence, groundwater pollution, and the presence of toxic residues in food, feed, and fodder. Herbicides that are highly soluble in water and weakly adsorbed to soil particles, such as sulfonylurea and imidazolinone, are particularly problematic because they can easily contaminate groundwater. Additionally, some herbicides can negatively impact microbial populations and harm subsequent crops when used in succession. From a health perspective, herbicides pose risks to humans and animals, potentially causing skin allergies, respiratory issues, and other health problems.
- **Regulatory Hurdles:** In India, herbicide regulation is governed by the 'Herbicides Act, 1968,' under the supervision of the Ministry of Agriculture. The Central Herbicides Board (CIB) provides technical advice, while the Registration Committee (RC) is responsible for approving the use of herbicides and new formulations. This process involves a thorough review of the herbicide’s chemistry, bioefficacy, and toxicology. As of October 20, 2015, there were 60 technical herbicides and 17 combination herbicides registered in India, but some previously approved herbicides have been debarred due to toxicity and safety concerns. The stringent approval process, ongoing scrutiny, and the potential for deregistration based on new safety data create significant regulatory challenges. For example, on October 21, 2022, the Union Ministry of Agriculture and Farmers Welfare issued a notice restricting the use of glyphosate, a widely used herbicide, due to concerns about its impact on human and animal health

11.1.3 Opportunities tapped in the Indian herbicide market:

- **Sustainable agriculture:** Herbicides are essential in modern agriculture, playing a crucial role in controlling weeds and supporting sustainable crop productivity. By effectively managing weed populations, herbicides help prevent competition for vital resources such as water, nutrients, and sunlight, which are critical for optimal crop growth. This weed control not only maximizes crop yields but also reduces the need for more labour-intensive and costly weed management methods.

- **Advancements in Herbicide Technology:** Recent advancements in herbicide technology present significant opportunities for companies to address evolving agriculture needs. Innovations such as selective herbicides, improved formulations, and integrated weed management solutions are leading the way in this progress. For example, the introduction of Tetflupyrolimet represents a groundbreaking development in herbicide technology, marking the first major new mode of action (DHODH – HRAC Group 28) in over 30 years. Discovered by FMC Corporation with support from Syngenta Crop Protection, Tetflupyrolimet is designed to effectively control grass weeds in rice crops across Asia. Syngenta plans to commercialize products containing Tetflupyrolimet in key markets including India, Vietnam, Indonesia, Japan, and South Korea, positioning this innovation as a significant advancement in herbicide technology and offering promising solutions for managing weed resistance and enhancing crop productivity.

11.2 Value chain analysis:

The herbicide industry in India involves several key stages given as follows.

Research and Development (R&D): R&D is a vital stage in the herbicide value chain, where innovations and advancements are made to meet evolving agriculture challenges. This phase focuses on creating new herbicide formulations and improving existing ones through extensive scientific research, testing, and experimentation to develop effective weed control solutions.

Registration: After the R&D phase, the registration stage is crucial for ensuring that new herbicides comply with regulatory standards before they can be marketed. This process involves submitting detailed data on the herbicide's efficacy, safety, and environmental impact to regulatory bodies, such as the CIBRC in India. The registration process ensures that the product is safe for use and effective in controlling weeds, meeting all required standards before it enters the market.

Raw Material Supply: The raw material supply stage is critical in the herbicide value chain, as it involves the provision of essential chemicals and ingredients required for herbicide production. Chemical manufacturers produce active ingredients, solvents, surfactants, and other components that are vital for formulating herbicides. These materials are sourced from both domestic and international suppliers and play a key role in the quality and effectiveness of the final herbicide products. The availability and quality of these raw materials directly influence the efficacy, safety, and cost of the herbicide formulations, making this stage crucial for ensuring the overall success of the herbicide manufacturing process.

Manufacturing: The manufacturing process involves blending active ingredients with other essential components to produce the final herbicide product. This process is carried out under strict quality control standards to ensure consistency, safety, and effectiveness. Rigorous quality checks are conducted at various stages of manufacturing to ensure that the products meet industry standards and comply with regulatory requirements.

Formulation: The formulation of herbicide refers to the material in which it is carried on and its concentration in that carrier. This stage involves creating herbicides in various forms such as liquids, powders, granules, and emulsifiable concentrates. The choice of formulation is determined by the intended use, application method, and target weeds. Large manufacturers typically employ in-house formulators who specialize in developing and refining these formulations to optimize their performance.

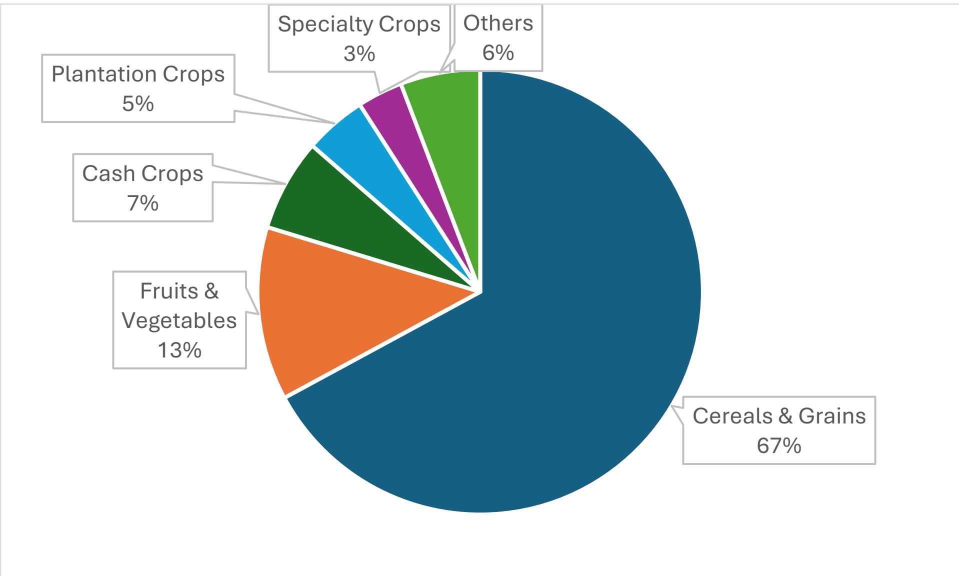
Distribution: The distribution stage is responsible for managing warehousing, inventory, and transportation to ensure that herbicides reach retailers and end-users across different regions. Distributors play a key role in maintaining a steady supply chain, ensuring that herbicides are available when and where they are needed.

Retail: The retail stage involves promoting and selling herbicides through various channels. This includes participation in agriculture fairs, running advertisements, and conducting direct marketing campaigns. Herbicide products are distributed through a network of agrochemical retailers, cooperatives, and direct sales to farmers. Retailers play a crucial role in educating farmers about the proper use of herbicides and their benefits.

End Users: End users, primarily farmers, are the final consumers of herbicides. They apply these products to control weeds and enhance crop yields. Farmer's decisions on herbicide use are influenced by factors such as crop type, weed pressure, and economic considerations. Effective herbicide application is essential for improving agriculture productivity and sustainability, helping farmers manage weeds efficiently while maximizing crop yields.

11.3 Market breakup by application (value wise)

Chart 51: Indian herbicides market: Breakup by application type (in %), FY2025 (in terms of consumption)

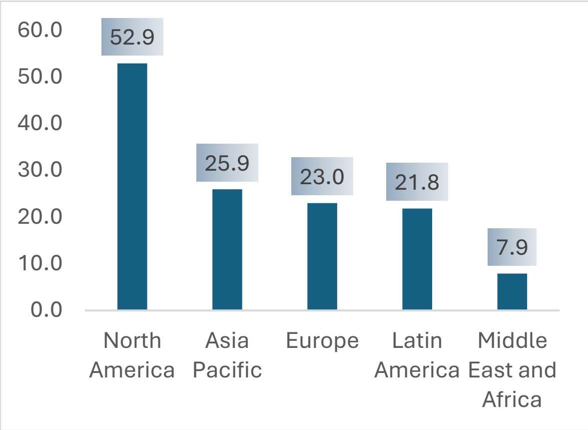


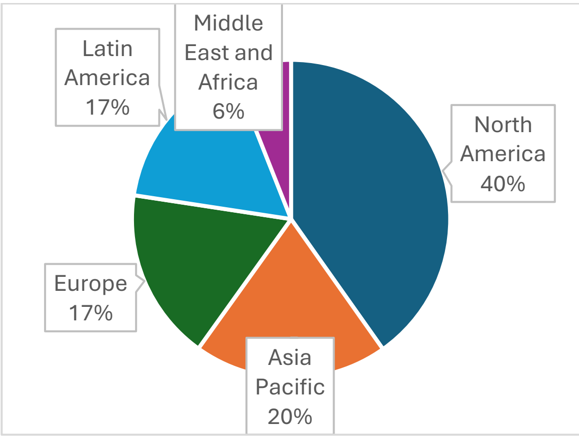
Source: IMARC Group, ICRA Analytics

During FY2025, cereals & grains used herbicides extensively in India, accounting for a share of 67% of the total market followed by fruits & vegetables at ~13%, cash crops at ~7%, plantation crops at ~5%, speciality crops at ~3% and others at ~6%.

11.4 Export market breakup by region (value wise)

Chart 52: Herbicides export market breakup by region (in % terms and value in Rs billion), FY2025





Source: Department of Commerce, IMARC Group, ICRA Analytics

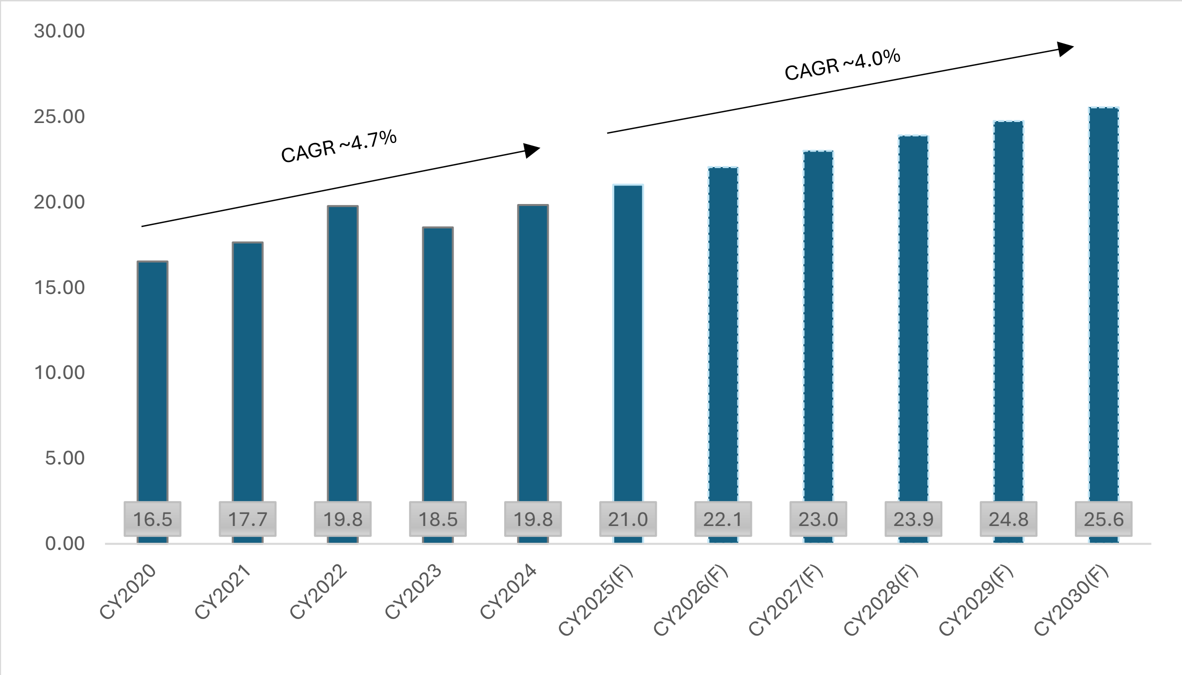
During FY2025, North America represented the largest market for exported herbicides from India, accounting for a share of 40.2% of the total export in term of value. This was followed by Asia Pacific at ~20%, Europe at ~18%, Latin America at ~17% and Middle East and Africa at ~6%. The market size of total export market stood at Rs 131.6 billion during FY2025 while the import market size stood at Rs 39.0 billion during FY2025.

Fungicide Market

12. Global Fungicide Market Overview:

Fungicides are necessary for safeguarding crops against different fungal diseases that can ruin agriculture efficiency. Fungi, which include mold, mildew, blights, and rusts, due to the lack of chlorophyll are unable to produce their own carbohydrates. Majority of the crop diseases are fungal in nature as the fungi survives by feeding on living plants or dead organic matter. In recent years, bio-fungicides, formulations derived from living microorganisms are used as an alternative to conventional chemical fungicides. These are ecofriendly in nature, aligns with modern agriculture practices which focus on sustainability. Fungicides are grouped in view of different measures, identifying their adaptability for the plant, their method of activity, and their job in safeguarding plants.

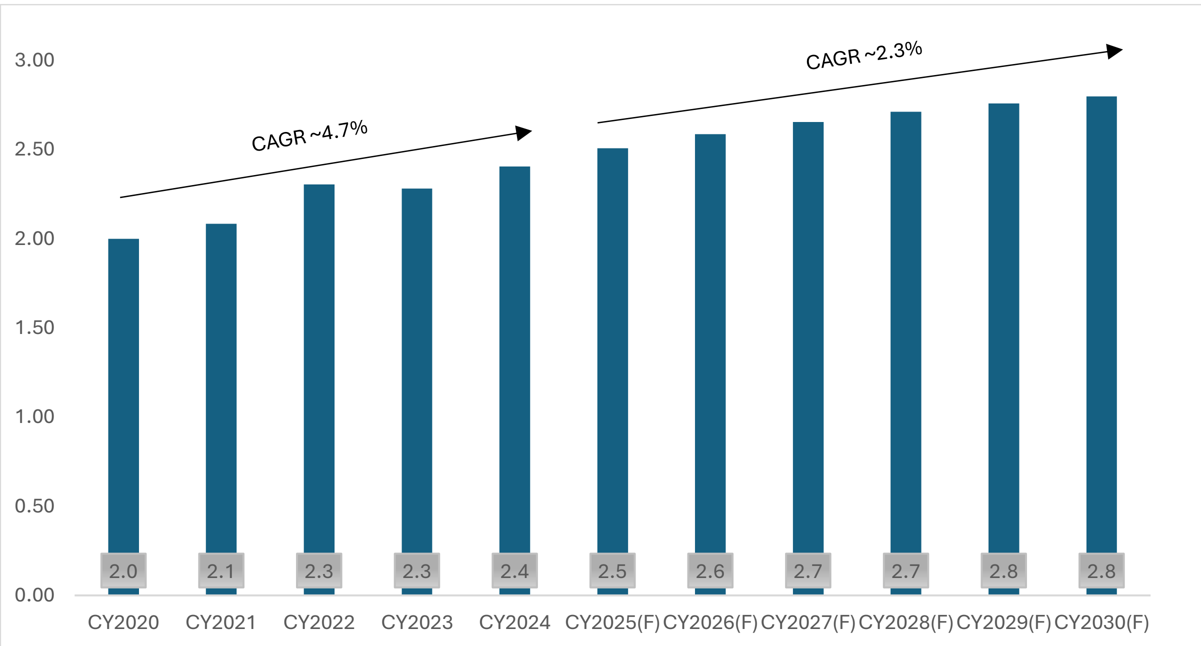
Chart 53: Global fungicides market sales value and forecast (in $ Billion), CY2020-CY2030



Source: IMARC Group, ICRA Analytics

The global fungicides market reached a value of $ 19.8 billion in CY2024, representing a CAGR of 4.7% during CY2020- CY2024. Going ahead, global fungicides market is expected to reach a value of US$ 25.6 Billion by CY2030, exhibiting a CAGR of 4.0% during CY2026-CY2030.

Chart 54: Global Fungicide market sales volume and forecast (in Million Tonnes), CY2020-CY2030



Source: IMARC Group, ICRA Analytics

The global fungicides market reached a volume of 2.4 million tonnes in CY2024, representing a CAGR of 4.7% during CY2020-CY2024. Going ahead, global fungicides market is expected to reach a volume of 2.8 million tonnes by CY2030, exhibiting a CAGR of 2.3% during CY2025-CY2030.

Fungicide prices are expected to rise even as volume growth remains moderate, due to a combination of factors. Higher raw material costs, tighter regulatory requirements, and investments in advanced, more eco-friendly formulations are all pushing up production expenses. Additionally, ongoing inflation and supply chain challenges are adding further cost pressures. These dynamics contribute to price growth, even though sales volume will expand at a slower rate than sales value.

12.1 Market drivers, restraints and success factors of the global fungicide market

12.1.1 Market Drivers in Global Fungicide Market:

The global fungicides market is driven by various growth factors. It is driven mainly by the rising rate of fungal diseases in crops, such as powdery mildew, rust, and blight. These are worsened by climate change and fluctuations in weather conditions, thereby making fungicides essential for crop protection.

- **Rising emphasis on food security**: One in eight people worldwide continues to suffer from chronic hunger in spite of advancements in agriculture production. This highlights the basic job fungicides play in upgrading crop yields by safeguarding against the vast array of pests and diseases that compromise agriculture productivity. According to CropLife India, fungicides are essential for protecting food supply chains from threats posed by over 10,000 insect species, 30,000 weed species, 100,000 plant diseases, and 1,000 nematode species as croplands worldwide expand and populations rise.
- **Technological advancement**- Technological advancements in the application methods of fungicides in the global market have significantly improved the efficiency, precision, and sustainability of fungicide use in agriculture. These advancements are helping farmers to achieve better crop protection while minimizing environmental impact and reducing costs. Here are some key technological developments in fungicide application methods including Precision Agriculture and Smart Farming, electrostatic spraying, Nano-Formulations and Controlled Release Systems, Sensor-Based Application Systems, Robotics and Autonomous Spraying Systems etc.
- **Continuous research and development of new fungicide products:** In order to develop innovative active ingredients that address the advancing resistance of pests and diseases, agrochemical companies frequently make investments in research and development. Notwithstanding the intricacies and increasing difficulties in producing new compounds, major players have effectively introduced new fungicides that have strengthened their market share, especially in developed markets like the US, Canada, Brazil, Japan, and the UK. By meeting the demand for improved agriculture solutions, these innovations not only increase crop protection's effectiveness but also drive revenue growth for businesses. Few examples of recent innovations in the global fungicide market are RNA Interference (RNAi)-Based fungicides, Plant Defense Activators, harnessing the power of Microbial Communities, Green Chemistry and Low-Toxicity Fungicides, Digital Farming Tools for Fungicide Optimization etc.

- **Increase in demand for organic products:** Bio-fungicides and other natural and chemical-free pest control options are in high demand as a result of consumers' growing demand for organic food products, particularly in North America and Europe. The UN Food and Agriculture Organization reports that approximately 187 nations across the globe are presently taking part in organic farming practices, featuring a worldwide shift towards sustainable agriculture. In order to meet the increasing demand, organizations are growing their portfolios to incorporate bio fungicides, like Syngenta's "BotriStop," which was launched in Peru and Mexico in CY2021.
- **Combating malnutrition and food insecurity internationally:** Fungicide use is also being accelerated by international efforts to combat malnutrition and food insecurity. To address food crises, organizations like the World Bank have committed significant resources, such as the $ 30 billion initiative that was announced in May 2022. These initiatives aim to enhance crop yields and the availability of food by enabling farmers to utilize cutting-edge technologies and products and improving agriculture practices.

12.1.2 Threats and challenges for global fungicide market:

The global market for fungicides is constrained by a number of significant obstacles that hinder its expansion and present difficulties for farmers and manufacturers alike.

- **Risk of surpassing Maximum Residue Levels (MRLs):** MRLs denote and monitor the highest amount of pesticide residue that can be permitted legally in food or feed products, guaranteeing food safety. Regulatory bodies like the European Food Safety Authority (EFSA), the United States Environmental Protection Agency (EPA), and India's Food Safety and Standards Authority (FSSAI) set these limits to ensure consumer safety. Non-compliance with MRL regulations can lead to significant financial and legal repercussions for producers, exporters, and businesses.

  Farmers must adhere to these MRL standards as global consumers become more health-conscious and governments tighten regulations, frequently requiring them to invest in technologies and practices that help minimize pesticide residues. This resulted in adoption of Integrated Pest Management (IPM) practices by the farmers, which focuses on controlling fungi infestation while reducing the excessive use of chemical fungicides. The legal MRL in Hong Kong is set at 0.2 ppm (parts per million) and failing to comply with this standard can result in severe financial penalties. For instance, importers or sellers of food that exceeds the MRL can be fined up to $50,000 and face imprisonment for six months upon conviction.
- **Compliance costs**: It has repercussions for business as well as consumer health and safety. Farmers who surpass MRLs may have to deal with large penalties, and their produce might be dismissed by domestic and export markets, affecting their profitability. This economic incentive to stick to MRLs is likewise driving a shift towards more eco-friendly and reasonable farming practices. For example, biological solutions have gained popularity because they help reduce the use of chemical crop protection products and the phytotoxicity and environmental impact of fungicides.
- **Resistance to agrochemicals**: Over the years, the continued use of same type of fungicides has led to an increase in fungal resistance, rendering many traditional chemical solutions less effective. E.g. resistance to Quinone outside inhibitor (QoI) fungicides has been detected in several fungal pathogens. In South Dakota, QoI

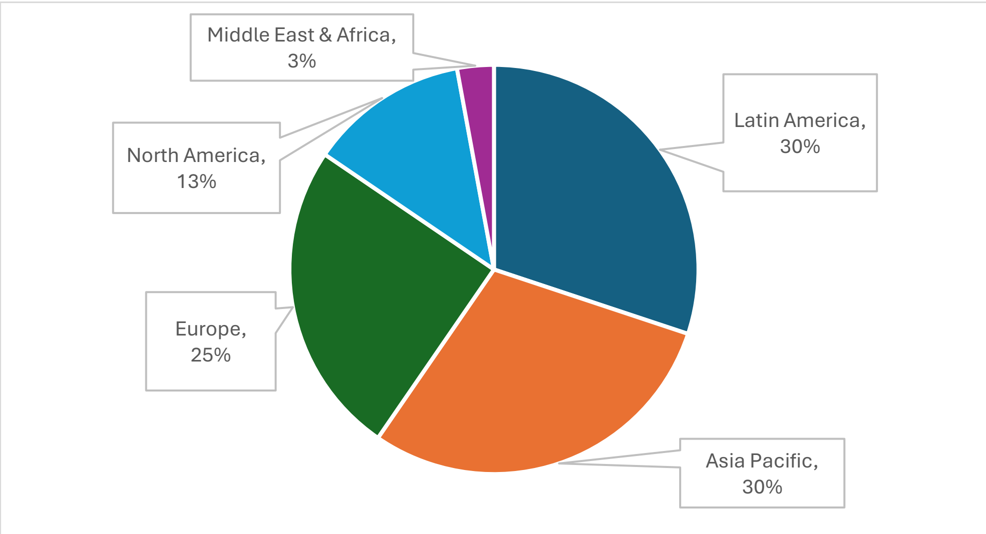
resistance was detected in the frogeye leaf spot pathogen of soybean, Cercospora sojina, in 2019.

Additionally, in Europe and the United States, resistance to QoI and Demethylation inhibitors (DMI) fungicides has been reported in crops like wheat, grapes, and apples, while in Southeast Asia, rice farmers face resistance issues with pathogens such as rice blast, complicating crop management and protection efforts. The rice blast disease caused by the fungus Pyricularia oryzae has become one of the greatest concerns of rice farmers in Vietnam.

- **Reluctance to good agriculture practices:** New variants of the disease that are insensitive to the fungicides have emerged despite years of research and the development of strategies to lessen its impact. Due to economic pressures to maximize short-term profits, some growers are reluctant to fully embrace good agriculture practices like controlled fungicide application within dosage limits and crop rotation

12.2 Global Fungicide Market Breakup by Region (in value terms)

Chart 55: Global fungicides market breakup by region (in %), CY2025 (in terms of consumption)

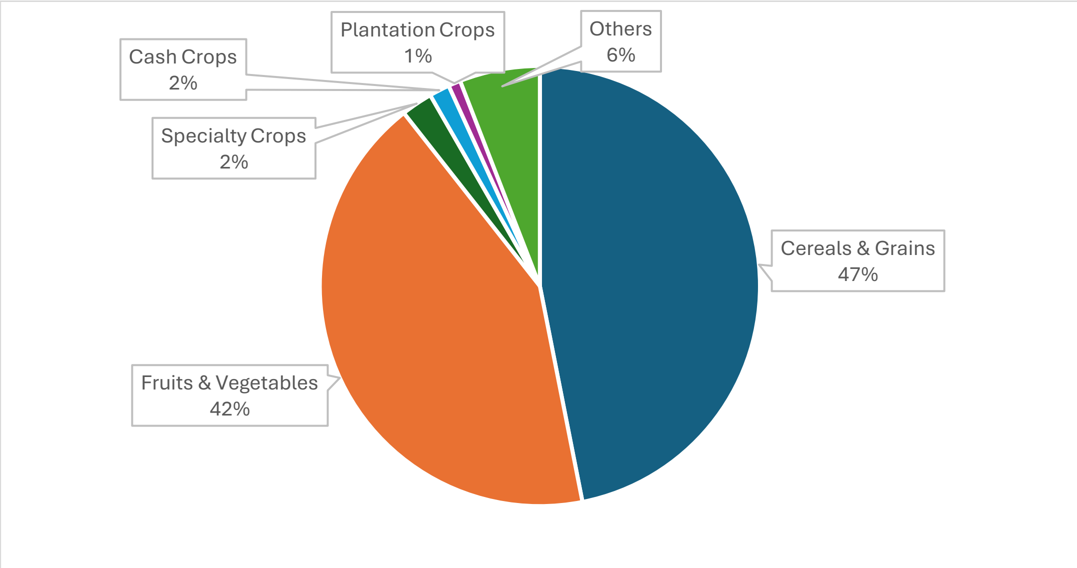


Source: IMARC Group, ICRA Analytics

In CY2025, Latin America represented the largest market for fungicides globally, accounting for a share of ~30% of the total market. Latin America was followed by Asia Pacific at ~30%, Europe at ~25%, North America at ~13%, and Middle East and Africa at ~3%.

12.3 Global Fungicide Market Breakup by Application

Chart 56: Global fungicides market breakup by application (in %), CY2025 (in terms of consumption)

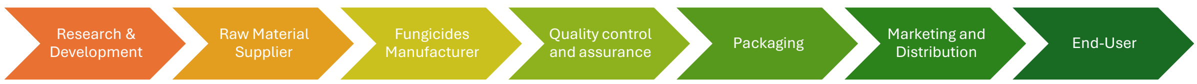


Source: IMARC Group, ICRA Analytics

In CY2025, cereals & grains represented the most popular application for fungicides globally, accounting for a share of ~47% of the total market. Cereals & grains was followed by fruits & vegetables at ~43%, specialty crops ~2%, cash crops at ~2%, plantation crops at ~1% and others at ~6%.

12.4 Global Value Chain Analysis

Value Chain Analysis of Global fungicide market



Product research and development, raw material suppliers, fungicide manufacturers, quality control and assurance, packaging, marketing and distribution, and end users are all parts of the fungicides industry's value chain.

- **Research and development:** It is the most important phase in this industry value chain. It includes broad lab research, field preliminaries, and getting regulatory approvals. R&D Innovations can be used to discover new active ingredients that are less harmful to the environment and more effective against fungi that are resistant.

- **Raw material supplier:** Suppliers of raw materials acquire these essential components from producers and subsequently supply them to manufacturers of fungicides. The process of fungicide production initiates with the sourcing of raw materials, which encompasses a range of chemicals and active ingredients, including sulfur, copper compounds, specialty amines, synthetic chemicals (such as triazoles and strobilurins), as well as natural sources. Prominent chemical companies, including BASF and Bayer, often serve as suppliers due to their substantial production capabilities and extensive supply chains. The procurement process is characterized by stringent quality assessments and the establishment of long-term partnerships with dependable suppliers to ensure a consistent availability of critical ingredients.

- **Fungicides manufacturers:** The manufacturing process entails the procurement of raw materials from suppliers, which are subsequently subjected to a series of procedures to yield final products. This phase of manufacturing focuses on the transformation of raw materials into completed fungicide products through chemical synthesis and formulation into various forms, including liquids, powders, and granules. The procedure involves the combination of active ingredients with inert materials to produce formulations that are both user-friendly and effective in minimal quantities.

- **Quality control & assurance:** Quality control (QC) and quality assurance (QA) are essential elements in the fungicide industry, ensuring that products are both effective and safe while meeting stringent regulatory requirements. QC involves thorough testing of raw materials, in-process materials, and finished products to detect any deviations from established quality standards, such as the FDA's Current Good Manufacturing Practices (cGMPs). This process includes chemical composition analysis, efficacy testing against target fungi, and environmental impact assessments. QA encompasses the systematic procedures and processes that guarantee consistent product quality throughout the manufacturing cycle, including process validation, meticulous documentation, and adherence to Good Manufacturing Practices (GMP).

- **Packaging:** Packaging is a critical aspect of the fungicides market, ensuring the safe transport, storage, and application of products. Effective packaging preserves the chemical stability and integrity of fungicides by protecting them from environmental factors such as moisture, light, and temperature fluctuations. Additionally, packaging must comply with regulatory standards to prevent leaks and contamination, adhering to international standards like Tappi 487-99, AFNOR NF 41-517, and ASTM G 21, to ensure the safety of handlers and users. Liquid fungicides are typically packaged in bottles made from materials like COEX, PET, and aluminium, while solid fungicides are often packaged in bags made from water-soluble materials or aluminium.

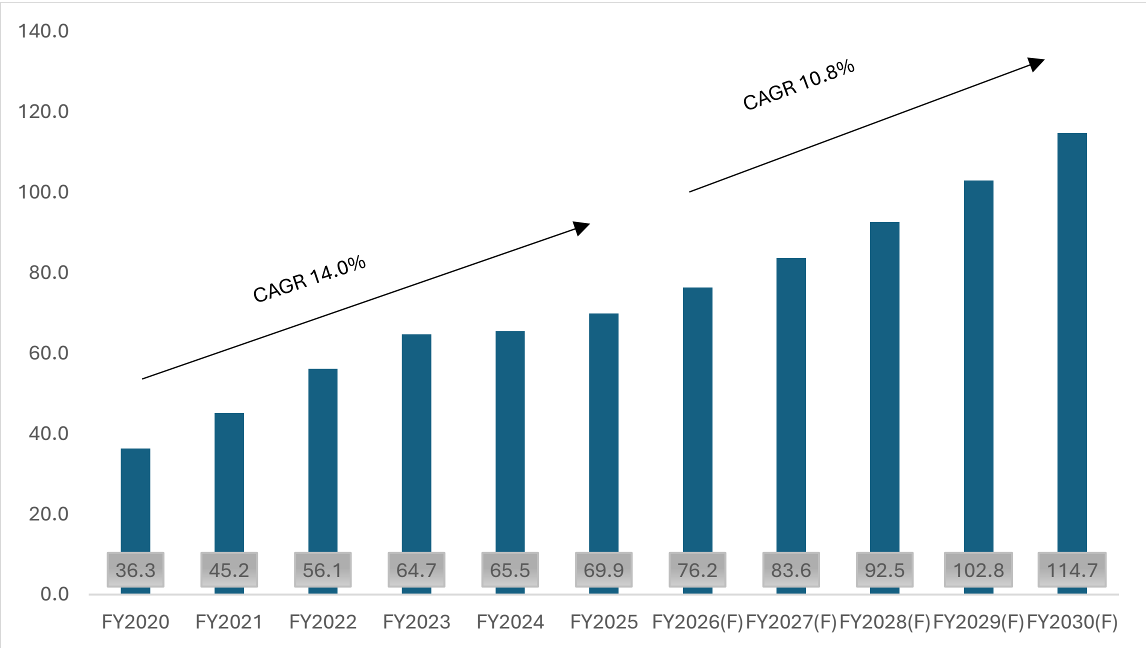
- **Marketing and Distribution:** Marketing strategies encompass a range of activities including advertising, educational programs for farmers, field demonstrations, and promotional sales aimed at showcasing the advantages of specific fungicides. After the production of fungicides, it is essential to distribute them across various markets. This distribution relies on a network comprising distributors, wholesalers, and retailers who facilitate the delivery of products to farmers and agriculture enterprises. Effective management of logistics is vital to preserve product quality and guarantee prompt delivery. Additionally, well-organized transportation networks are necessary to ensure that products reach distributors and retailers in a timely manner. Establishing the appropriate pricing for fungicides is critical for achieving profitability and requires careful consideration of factors such as production expenses, market competition, and the perceived value by customers.

- **End user:** The final segment of the value chain consists of the end users who utilize the product. The primary end users of fungicides are farmers and agriculture enterprises that employ these products to shield crops from fungal infections, thereby promoting robust growth and maximizing yields.

13. Domestic overview:

The fungicide market in India plays a pivotal role in the agriculture landscape, essential for safeguarding crops against fungal diseases and ensuring robust agriculture productivity. As the nation faces the challenge of nourishing a rapidly expanding population, the necessity for effective fungicide solutions has become increasingly urgent. This market has experienced significant growth driven by the demand for enhanced crop yields, a rise in fungal infections, and innovations in crop protection technologies. Key crops, including wheat, rice, pulses, fruits, and vegetables, are particularly susceptible to fungal threats, highlighting the critical role of fungicides in safeguarding these vital food sources.

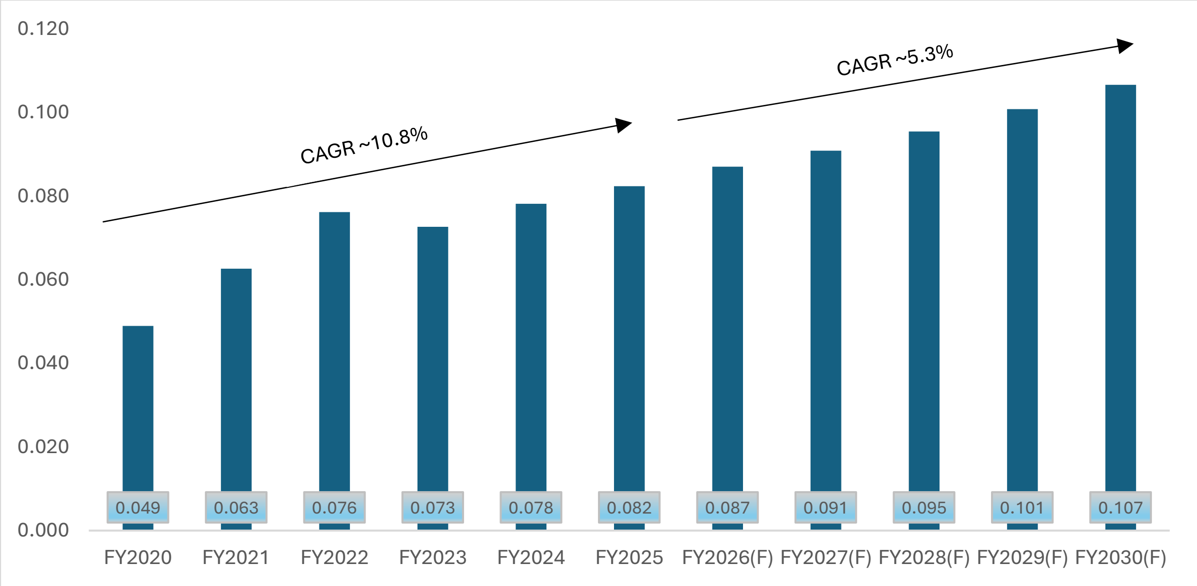
Chart 57: Sales value of Indian Fungicides Market (in Rs. Billion), FY2020-FY2030F



Source: IMARC Group, ICRA Analytics

The India fungicides market reached a value of Rs 69.9 billion in FY2025, growing at CAGR 14.0% of during FY2020-FY2025. Going ahead, the India fungicides market is expected to reach a value of Rs.114.7 billion by FY2030, growing at a CAGR of 10.8% during FY2026-FY2030.

Chart 58: Sales volume of Indian Fungicides Market; in Million Tonnes, FY2020-FY2030F



Source: IMARC Group, ICRA Analytics

The India fungicides market reached a volume of 0.082 million tonnes in FY2025, growing at CAGR 10.8% of during FY2020-FY2025. Going ahead, the India fungicides market is expected to reach a volume of 0.107 million tonnes by FY2030, growing at a CAGR of 5.3x` % during FY2026-FY2030.

Parasitic fungi have the potential to severely harm agriculture, resulting in significant reduction in crop yield, quality, and overall profit. Fungicides are essential tools for managing fungal diseases and ensuring healthy crop production due to their numerous advantages in agriculture.

- **Enhanced crop yields:** Fungicides play a crucial role in preventing and controlling fungal diseases that can drastically reduce crop yields. By safeguarding plants from these diseases, fungicides help ensure higher and more consistent crop production.
- **Improved crop quality:** The use of fungicides effectively maintains and enhances the quality of harvested crops. By preventing diseases that cause blemishes, rot, or other quality issues, fungicides ensure that produce meets market standards, leading to better prices.
- **Economic efficiency:** Fungicides help farmers maximize their return on investment by reducing the impact of fungal diseases. Healthier crops lead to fewer losses and higher revenue, making fungicides a cost-effective tool for disease management.
- **Disease prevention:** Fungicides can be applied as a preventive measure to protect crops before any disease symptoms appear. This proactive strategy helps avoid severe infections and reduces the need for more intensive treatments later on.
- **Wide range of disease control:** Fungicides are effective against a broad spectrum of fungal pathogens, including those that affect fruits, vegetables, grains, and ornamental plants. This versatility makes them essential for managing various plant diseases across different crops and growing conditions.
- **Economic efficiency:** Fungicides aid farmers in maximizing their return on investment by reducing the impact of fungal diseases. Fungicides are a cost-effective method of disease management because healthier crops result in fewer losses and higher profits.

- **Supports IPM:** Fungicides play a crucial role in IPM strategies. When utilized alongside various pest control techniques, they enhance the management of fungal diseases while supporting sustainable agriculture practices.
- **Protection for high-value crops:** Fungicides are essential for safeguarding high-value crops, including grapes, tomatoes, and peppers, as disease outbreaks can result in significant financial losses. The application of fungicides to these crops is vital for preserving their economic viability.

13.1 Market drivers, restraints and opportunities of the Indian fungicide market

13.1.1 Drivers in Indian Fungicides industry:

- **Vulnerability of major crops:** In India, key agriculture products such as rice, wheat, maize, soybeans, and potatoes are particularly prone to a range of fungal diseases. For example, rice is at risk from the rice blast fungus, which can drastically reduce yields if not properly controlled. Likewise, wheat is threatened by stem rust, a disease capable of causing severe crop losses, thereby necessitating prompt fungicide application to safeguard production. Maize is impacted by corn smut, which adversely affects both the quality and yield of the crop, while soybean rust and late blight in potatoes also present considerable dangers. The prevalence of these fungal pathogens highlights the critical role of fungicides in preserving the health and productivity of these vital crops, thereby increasing the demand for effective solutions within the Indian agriculture sector.
- **Weather events:** Climate change is modifying the distribution and behaviour of fungal diseases. Increasing temperatures are prompting fungal pathogens to migrate to higher latitudes, potentially introducing diseases to areas where they were once rare. For instance, diseases that have historically impacted tropical regions may now threaten India's temperate zones. Furthermore, warmer climates promote the development of new fungal strains and the wider dispersal of spores, complicating disease management efforts. This evolving scenario necessitates increasing use of innovative fungicides.
- **Crop Intensification:** In India, the increasing intensity of crop production, spurred by evolving agriculture methods and heightened food demand, has resulted in a notable rise in the annual frequency of cropping cycles. Farmers are adopting practices of repeated cropping and broadening the number of crop cycles, which consequently heightens the risk of disease outbreaks, particularly fungal infections. This intensification not only raises the probability of fungal diseases but also increases the use of fungicides to effectively combat these challenges.

13.1.2 Restraints in Indian Fungicide Industry:

- **Environmental pollution and health risks:** The use of fungicides raises significant concerns regarding environmental pollution and health risks. The contamination of water bodies through runoff and leaching from agriculture practices presents a serious environmental challenge. Such contamination can disrupt aquatic ecosystems and potentially harm non-target organisms, including beneficial microbes and wildlife. Furthermore, the presence of fungicides in water sources can lead to broader ecological consequences and health hazards for humans who may be exposed to contaminated water.

- **Fungicide effectiveness:** The inadequate control of diseases using fungicides can arise from various factors that impede their efficacy. Low application rates may fail to offer sufficient protection against fungal pathogens, while certain fungicides may inherently exhibit limited effectiveness against specific pathogens, thereby restricting their overall success. Furthermore, improper timing or application techniques, such as incorrect dosages or insufficient coverage, can result in less than optimal outcomes. Additionally, excessive rainfall can worsen these challenges by washing away fungicides before they can exert their effects, thereby diminishing their effectiveness.
- **Fungicide Resistance:** The emergence of fungicide resistance in plant pathogens is a significant challenge to effective crop protection, affecting the performance of various site-specific fungicide groups. Resistance issues have been documented in several major classes of fungicides, including benzimidazoles, phenylamides, demethylation inhibitors, quinone outside inhibitors (QoIs), and succinate dehydrogenase inhibitors (SDHIs). For example, recent reports from vineyards in Maharashtra highlight a troubling development: resistance QoI fungicides (such as azoxystrobin and kresoxim-methyl) and CAA fungicides (including mandipropamid and dimethomorph), which has been linked to specific genetic mutations.

13.1.3 Opportunities in Indian Fungicide Industry:

- **Government Initiatives:** By providing subsidies, the government has alleviated the financial strain on farmers, thereby making fungicides more accessible and cost-effective. Furthermore, extension services play a crucial role by delivering expert advice and practical assistance regarding the efficient application of fungicides. Few examples of the subsidies in the Indian fungicide market are Subsidized Agriculture Inputs under the National Food Security Mission (NFSM), Pradhan Mantri Krishi Sinchai Yojana (PMKSY), Subsidies for Integrated Pest Management (IPM), National Mission for Sustainable Agriculture (NMSA), Pradhan Mantri Fasal Bima Yojana (PMFBY) etc.
- **Collaborations:** To effectively manage food security and preserve the efficacy of fungicidal treatments, it is crucial to implement reliable local monitoring of resistance and adaptation. Collaborative efforts among companies in India aim to equip the agriculture sector with the necessary tools and expertise to monitor and address resistance issues, thereby ensuring the continued effectiveness of fungicides and promoting sustainable agriculture practices. For example, in 2024, EpiLogic GmbH and Tentamus India have partnered to introduce EpiLogic's acclaimed fungicide resistance monitoring services to the Indian market.

13.2 Domestic Value Chain Analysis

Value Chain Analysis of Indian Fungicide Industry

Research and Development (R&D), registration, manufacturing, formulation, distribution, and end-users make up the fungicides industry's value chain.

- **Research and Development (R&D):** The R&D stage is fundamental to developing new fungicides and refining existing ones. This phase involves extensive scientific research to discover novel active ingredients, improve formulations, and optimize their effectiveness against various fungal pathogens. Agriculture research institutions, universities, and private companies invest heavily in R&D to create fungicides that are both effective and environmentally safe, targeting specific fungal challenges in crops. The R&D process is critical for innovation, ensuring that fungicides meet stringent performance and safety standards.

- **Registration:** After the R&D phase, fungicides must undergo a rigorous registration process to comply with regulatory standards before they can be brought to market. This involves submitting detailed data to regulatory bodies, such as the CIBRC in India. The registration process includes conducting efficacy trials, safety evaluations, and environmental impact assessments. Successfully completing this process ensures that the fungicide is effective, safe for use, and in compliance with legal and environmental regulations.

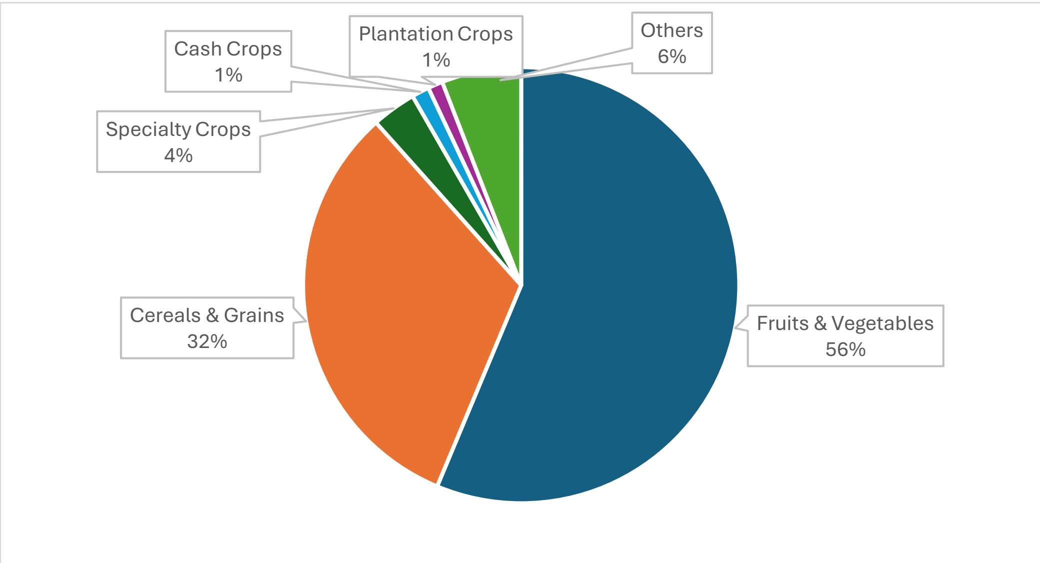
- **Manufacturing:** The manufacturing stage encompasses sourcing the essential chemicals and compounds needed for fungicide production and then producing the final products. Chemical manufacturers supply the active ingredients and other necessary materials for formulation. These ingredients are combined in specialized facilities to produce fungicides in various forms, such as liquids, powders, or granules. Maintaining the quality of raw materials and adhering to strict manufacturing standards are vital for producing fungicides that are both effective and reliable.

- **Formulation:** In the formulation phase, raw materials and active components are combined with carriers, solvents, and stabilizers to create the final fungicide products. A significant number of fungicides are produced as wettable powders, which generally consist of 20%-80% finely milled mineral diluents, including bentonite, talc, or kaolinite. The primary role of these fillers is to inhibit the clumping of fungicide particles during the grinding and storage processes. This function is crucial for preserving the product's effectiveness and ensuring reliable performance upon application. Formulators concentrate on enhancing the product's performance, stability, and ease of use, thereby guaranteeing that the final fungicide effectively targets fungal pathogens and is compatible with various application techniques.

- **Distribution:** The logistics of transporting fungicide products from manufacturing facilities to retailers and end users are managed during the distribution stage. Transportation, inventory management, and storage are all part of this. In order to meet market demand and ensure that fungicides are readily available in various regions, distributors play a crucial role. Maintaining product availability and ensuring farmers timely access require efficient distribution.
- **End Users:** Farmers, as the primary end users, utilize fungicides to combat and manage fungal infections affecting their crops. The successful application of these fungicides is essential for mitigating crop loss and promoting robust plant development. The decisions made by farmers regarding fungicide application are shaped by various factors, including the crop type, the specific fungal pathogens involved, and the overarching disease management approach. Appropriate fungicide usage enhances both crop yield and quality, thereby facilitating favourable agriculture results.

13.3 Indian Fungicide Market Breakup by Application

Chart 59: Indian Fungicide Market Breakup by Application Type (in %), FY2025 (value in terms of consumption)

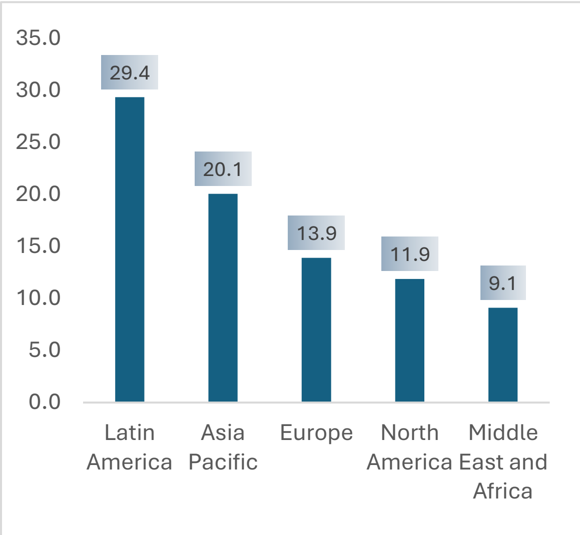


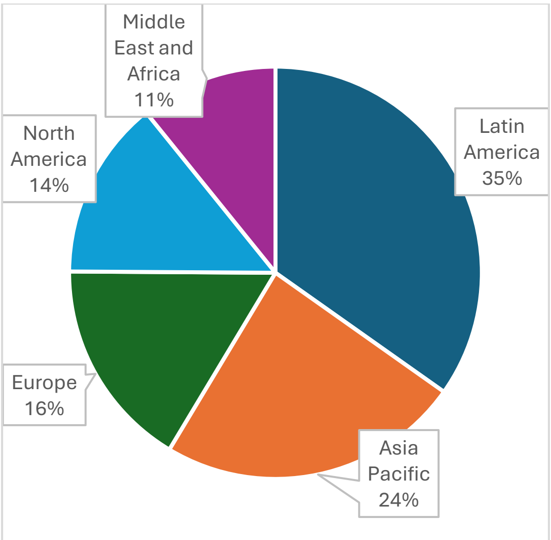
Source: IMARC Group, ICRA Analytics

In FY2025, fruits & vegetables currently dominates as the largest application in term of value, accounting for a share of ~56% of the total market. Fruits & vegetables was followed by cereals & grains at 32%, specialty crops at ~3%, cash crops at ~1%, plantation crops at ~1%, and others at ~6%.

13.4 Indian Fungicide Industry Export market breakup

Chart 60: Indian Fungicides Export Market Breakup by Region (in % & in value terms in Rs. billion), FY2025





Source: IMARC Group, ICRA Analytics

In FY2025, Latin America represented the largest market for exported fungicides from India, accounting for a share of ~35% of the total export in term of value. Latin America was followed by Asia Pacific at ~24%, Europe at ~17%, North America at ~14%, and Middle East and Africa at ~11%.

Plant Growth Regulator (PGR) market

14. Global PGR market:

PGRs are chemicals that are naturally produced by plants and are essential for regulating their growth and development. Commonly referred to as phytohormones or plant hormones, these substances operate effectively at minimal concentrations and have a significant impact on various physiological functions within plants. In addition to the naturally occurring regulators, there are synthetic versions created to replicate or enhance the effects of these natural plant hormones. PGRs exhibit a wide range of chemical structures, which can include gases such as ethylene, terpenes like gibberellic acid, and carotenoid derivatives such as abscisic acid. Each category of plant hormone possesses a distinct chemical configuration, leading to specific physiological outcomes on plant growth and development. The primary groups of PGR consumed in fruit crops consist of:

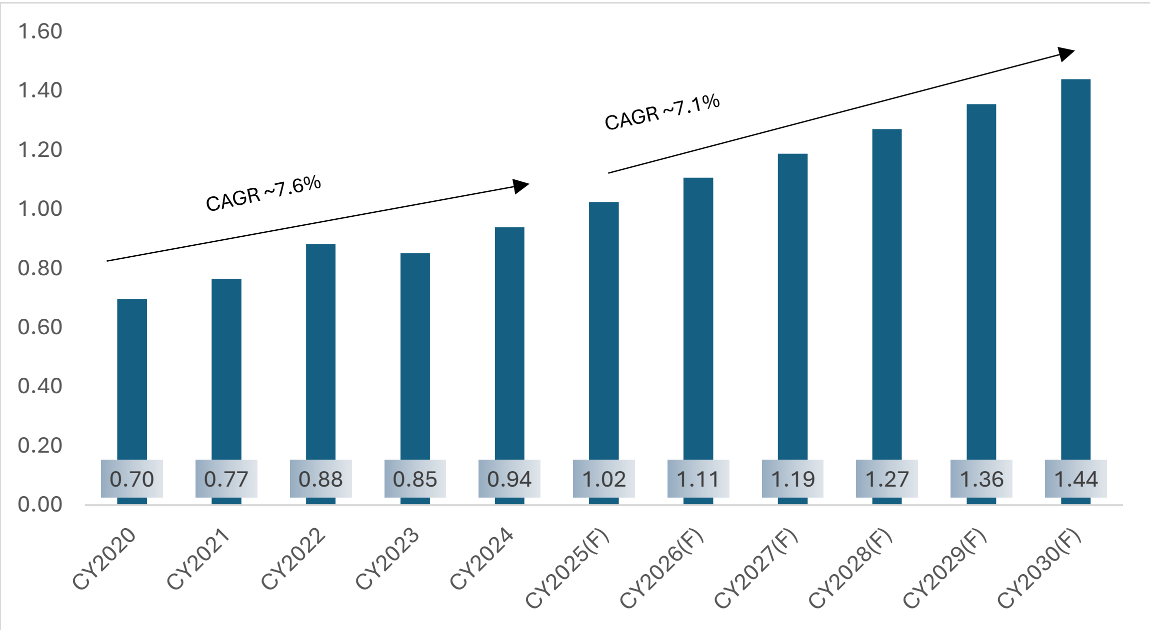
Major Classes of PGR:

- **Auxins:** Auxins are essential for promoting cell elongation and division, influencing the overall shape and growth of plant tissues. They play a key role in apical dominance, root initiation, and fruit development. Common examples include Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA), and Naphthalene acetic acid (NAA).
- **Gibberellins:** Gibberellins are responsible for promoting stem elongation, seed germination, and flowering. They are particularly effective in breaking seed dormancy and stimulating enzyme production, which helps in nutrient mobilization during seed germination. Examples include Gibberellic acid (GA3), GA1, and GA4.

- **Cytokinins:** Cytokinins are plant hormones that facilitate cell division and growth, enhance nutrient mobilization, and postpone leaf aging. They function in conjunction with auxins to regulate a variety of growth mechanisms. Notable examples include Zeatin, Kinetin, and Benzylaminopurine (BAP).
- **Abscisic Acid (ABA)**: It serves a key role in inducing dormancy, stomatal closure, and enhancing stress resilience in plants. It functions as a growth suppressor by decelerating metabolic activities.
- **Ethylene:** It is a gaseous hormone and is integral to processes such as fruit ripening, leaf abscission, and responses to physical stress. It is essential for the plant life cycle, influencing numerous physiological functions.

These PGR are integral to the management of fruit crops, influencing everything from seed germination to fruit ripening, and are widely used to optimize agriculture productivity. The PGR market reached a market value of $ 0.94 billion in CY2024, representing a CAGR of 7.6% during CY2020-CY2024. Going forward, the growth of the same is expected to reach a value of $1.44 billion by CY2030, exhibiting a CAGR of 7.1% during CY2025-CY2030.

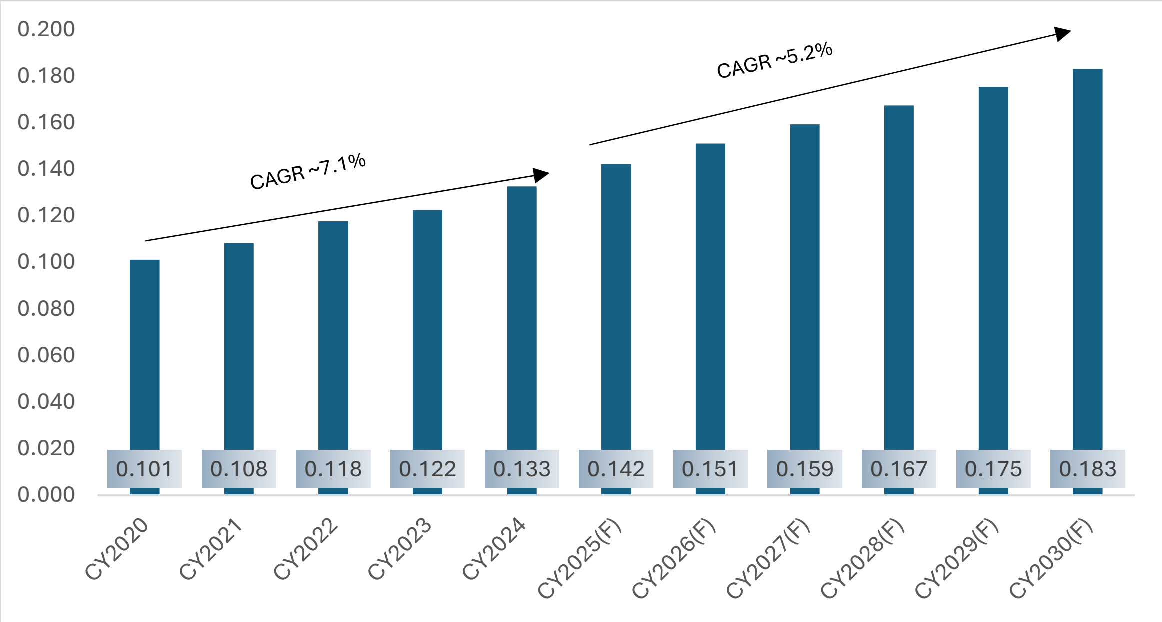
Chart 61: PGR Market: Sales value (in $ Billion), CY2020-CY2030



Source: IMARC Group, ICRA Analytics

In terms of volume, the global PGR market reached a volume of 0.133 million tonnes in CY2024, representing a CAGR of 7.1 % during CY2020-CY2024. Looking forward, global PGR market is expected to reach a volume of 0.183 million tonnes by CY2030 to grow at a CAGR of 5.2% during CY2025-CY2030.

Chart 62: PGR Market: Sales volume (in Million Tonnes), CY2020-CY2030



Source: FAO, IMARC Group, ICRA Analytics

14.1 Market drivers, restraints and success factors of the PGR market

14.1.1 Market drivers of the PGR market:

The market for PGR is currently on a notable upward trend, influenced by a variety of factors that are projected to enhance its expansion in the coming years.

- **Increasing focus on natural and sustainable agriculture methods:** Increasing demand for high-value crops is driving the adoption of PGR, as farmers are progressively pursuing natural and sustainable agriculture methods. The growing interest in organic farming, influenced by evolving dietary choices and focus on sustainability, is anticipated to further enhance the market. As a larger number of consumers choose organic products, the requirement for natural PGR that correspond with these preferences will considerably contribute to market expansion. This trend is especially evident in areas such as Oceania and Europe, where the proportion of organic agriculture land is significantly up, thereby increasing the demand for PGRs that facilitate sustainable farming practices.
- **Trend of rising global trade and production of fruits:** Leading fruit-producing nations, such as Australia and Japan, are experiencing an increased demand for PGR, particularly fuelled by the thriving avocado sector in Australia. Additionally, countries within the European Union, including Spain, are at the forefront of summer fruit production, such as watermelons and muskmelons, making the role of PGRs essential for improving both fruit quality and yield. These trends are expected to drive the market forward as PGR companies strategically focus on these profitable regions to enhance their profit margins.
- **Cytokins & Auxins:** Among the various types of growth regulators, cytokinins and auxins are expected to experience robust growth. Cytokinins, known for their role in enhancing stress tolerance and promoting protein synthesis, are emerging as a key segment in the PGR market, especially in regions experiencing climatic variability. Similarly, auxins are expected to see increased demand, driven by the growing interest in medicinal plants and landscaping. The rising demand for PGRs across various crop types, including cereals, oilseeds, fruits, and vegetables, is anticipated to further propel the market, underscoring the versatile applications of these regulators in modern agriculture.

- **Increasing resistance towards traditional pesticides:** The increasing resistance of pest and insect populations to traditional pesticides is prompting a significant shift towards alternative methods, including the use of PGRs. The excessive dependence on pesticides has resulted in the rise of resistant species, creating considerable obstacles for effective crop protection. Consequently, the incorporation of PGRs into farming practices has become essential to bolster plant resilience, enhance flowering rates, promote growth, and boost crop yields.
- **Strategic collaborations and product innovations**: Strategic collaborations and product innovations are poised to drive market expansion. For example, partnerships like the extended distribution agreement between Valent Canada Inc. and Nufarm Agriculture Inc. highlight the potential for growth through collaborative efforts. On June 14, 2022, Valent Canada Inc. and Nufarm Agriculture Inc. extended their distribution partnership in Canada for another five years. This collaboration, ongoing since 2011, focuses on offering a broad range of herbicides, insecticides, fungicides, and seed treatments, including products like Valtera and Fierce for improved weed management. The partnership aims to continue delivering tailored agronomic solutions for Canadian agriculture, leveraging the strengths of both companies.

  Such alliances are expected to accelerate the availability and adoption of PGRs across different regions, contributing to the market's expansion. Moreover, the approval of new PGR products, such as Sumitomo Chemical's Accede™, reflects the ongoing innovation within the sector. These developments indicate a strong pipeline of solutions that are likely to enhance the market's growth trajectory by offering growers more effective and sustainable options for crop management.

14.1.2 Restraints witnessed in the PGR market:

The market for PGR encounters following constraints that hinder its expansion and broader acceptance.

- **Rigorous regulatory framework**: A significant obstacle is the lengthy approval process for new products, which arises from the comprehensive regulatory requirements for multi-site field trials and the assessment of residual impacts, especially concerning synthetic variants. This rigorous regulatory environment results in extended timelines, frequently surpassing ten years, and demands considerable financial resources, occasionally exceeding USD 100 million, to launch a new crop protection product. Even generic products encounter significant challenges, with registration timelines extending up to five years. These difficulties result in delays in product registration and present considerable barriers for companies seeking to launch new PGR products in the market.

  While patent protection and market exclusivity are vital for recovering research and development expenditures, the rising costs linked to product development and the protracted approval process lead to increased retail prices. These heightened expenses ultimately reduce net profit margins for growers, thus obstructing the growth of PGR in the global agrochemicals sector.
- **Lack of awareness:** A significant barrier to the adoption of PGRs is the lack of awareness among growers about their benefits. Many farmers are uninformed about the types, correct application methods, and cost-saving advantages of PGRs, leading to their underutilization. This knowledge gap is particularly pronounced in developing regions

such as Southeast Asia, Sub-Saharan Africa, and Latin America, where there is limited knowledge exchange about organic farming and sustainable PGR use.

Additionally, the prevalence of substitute products like fertilizers, coupled with the persistence of conventional farming practices, especially in Asian markets, hinders the broader adoption of PGRs. Educational campaigns and targeted marketing are crucial to overcoming these challenges.

14.1.3 Success factors in the PGR market:

The market for PGR is set for substantial growth, fuelled by a variety of emerging opportunities linked to the increasing demand for improved crop productivity and the rising global consumption of agriculture products.

- **Government initiatives to satisfy growing population:** A significant driver of this expansion is the increasing necessity for greater crop yields, which is further reinforced by governmental initiatives focused on ensuring food security and safety. Prominent cereal-producing countries, including China, India, the United States, Russia, Brazil, Argentina, Indonesia, and France, have witnessed a notable increase in cereal production. This growth can be largely attributed to advancements in crop production techniques and the introduction of high-yielding cereal varieties. For example, the Department of Agriculture and Farmers Welfare reported that India's food grain production reached 330.1 Million tonnesduring FY2022-FY2023 period, reflecting an increase of 14 million tonnes compared to the previous year, which represents a 4.2% increase.

The ongoing support from governments around the globe, combined with the necessity to satisfy the needs of a growing population and evolving consumer preferences, is anticipated to enhance the adoption of PGRs, thereby propelling market growth.

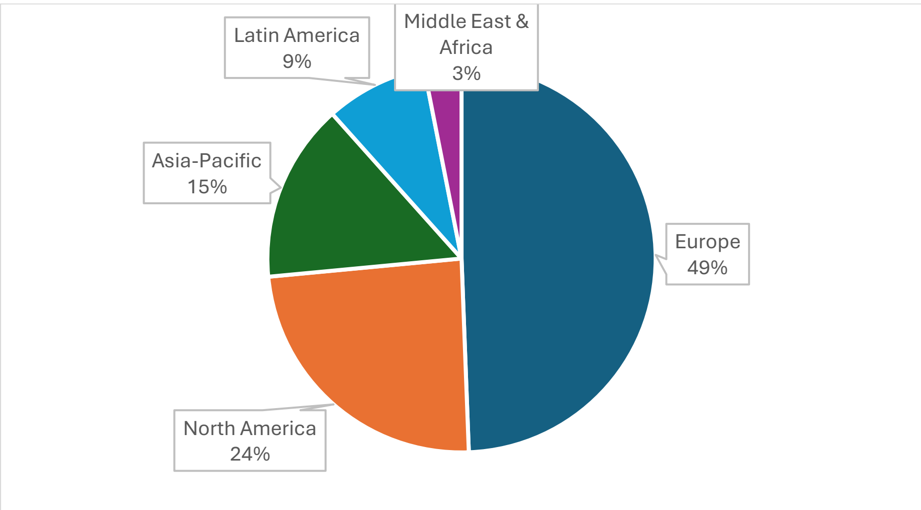
- **Increasing global fruit trade and production:** The PGR market has significant growth potential due to the increasing global fruit trade and production. With the total exports of $4.3 billion (2.2 million tonnes in volume terms) in CY2023, the U.S. remains a top fruit exporter, and despite challenges like adverse weather reducing citrus production by 12% in CY2022-CY2023, PGRs are crucial in mitigating stress and boosting yields. India also offers substantial opportunities with its strong fruit production base, exporting to key markets such as the U.K., UAE, and others.
- **Enhanced production needs:** The potential for enhanced production and yield of diverse crops offers a favorable pathway for the expansion of the PGR market. In light of the challenges posed by limited arable land and resources, along with erratic weather patterns, the emphasis has transitioned towards maximizing crop yields instead of increasing the area under cultivation.

  The Organisation for Economic Cooperation and Development (OECD) has forecasted considerable growth in crop yields, especially for wheat, oilseeds, and sugarcane. This transition is anticipated to strengthen the PGR market, as these regulators promote crop health, in contrast to conventional fertilizers that may disrupt soil equilibrium and lead to toxicity. The OECD-FAO Agriculture Outlook CY2020-2029 forecasts an increase in global soybean oilseed production by ~11% over a span of 8 years from 0.000367 million tonnes in CY2021 to an estimated 0.000406 million tonnes by CY2029. This growth is largely driven by the rising demand for protein meals, particularly in China, which is expected to gain momentum, thereby improving economic conditions for farmers.

- **Strategic actions by key industry players**: Strategic moves by key players in the industry are poised to significantly boost the PGR market. In March 2023, Corteva Agriscience, a leader in the fast-growing biologicals sector, completed the acquisitions of Symborg, a specialist in microbiological technologies, and Stoller, a prominent independent Biologicals company. These acquisitions are expected to strengthen Corteva's market presence and expand its PGR portfolio, positioning the company to capture a substantial share of the market. Corteva's collaboration with NEVONEX, powered by Bosch, in December 2022, is set to revolutionize the precision application of crop protection products using advanced data analytics and cutting-edge equipment. This initiative is projected to drive the PGR market forward by providing added value to farmers, enhancing client retention, and improving the overall effectiveness of crop production practices. These strategic developments highlight the dynamic growth potential within the PGR market, driven by innovation and industry collaboration.

14.2 Market Breakup by Region

Chart 63: PGR Market: Breakup by Region (in %), CY2025 (value in terms of consumption)

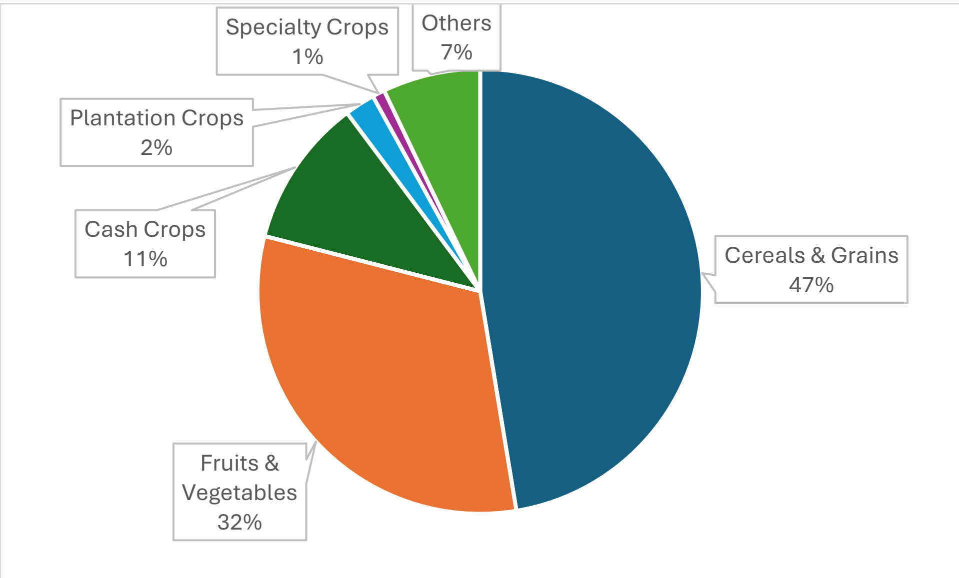


Source: IMARC Group, ICRA Analytics

During CY2025, Europe represented the largest market for PGR globally, accounting for a share of 49% of the total market. Europe was followed by North America at ~24%, Asia Pacific at ~15%, Latin America at ~9% and Middle East and Africa at ~3%.

14.3 Market Breakup by Application

Chart 64: PGR Market: Breakup by Application (in %), CY2025 (value in terms of consumption)



Source: IMARC Group, ICRA Analytics

During CY2025, the most popular application for PGR globally, accounting for a share of ~47% of the total market was the cereals & grains segment. This was followed by fruits & vegetables at ~32%, cash crops at ~11%, plantation crops at ~2%, specialty crops at ~1% and others at ~7%.

14.4 Value Chain Analysis

Global PGR Market: Value Chain Analysis

The value chain of the PGR industry involves product research & development, raw material suppliers, PGR manufacturers, quality control & assurance, packaging, marketing & distribution, and end-users.

Research and development: R&D is fundamental to the PGR industry, focusing on discovering new compounds that influence plant growth. Researchers from chemical companies, research institutions, and universities study these compound's effects on plant physiology. Field research and development (FRD) is essential for assessing the efficacy and safety of PGRs across various crops and environmental conditions. Agrochemical companies source new PGR compounds both internally and externally. Internally developed compounds offer easier control and management, while externally sourced compounds require evaluation for licensing or purchase opportunities.

Raw Material Suppliers: The procurement of raw materials constitutes a crucial component in the value chain of PGR. This process entails the identification of dependable suppliers capable of delivering high-quality active ingredients, chemical intermediates, and other essential components. These materials may encompass a variety of chemical compositions, including gases such as ethylene, terpenes like gibberellic acid, or carotenoid derivatives such as abscisic acid. The procurement process encompasses contract negotiations, logistics management, and the maintenance of a consistent supply chain to prevent production interruptions. Additionally, this stage requires strategic sourcing decisions that balance cost efficiency with quality and reliability, thereby ensuring that the performance of the final product remains uncompromised.

PGR Manufacturers: The third stage of the value chain involves the production of PGRs by specialized chemical manufacturers. This process takes place in dedicated production facilities where active ingredients are combined with other components to create formulations that enhance the delivery and effectiveness of PGRs. These plant hormones, typically produced at the tips of stems and roots, are then transported to other parts of the plant.

PGRs can be derived from both natural and synthetic sources. Before commercialization, manufacturers must navigate a regulatory approval process. For example, registering a PGR as a biopesticide in the U.S. requires approval from the Environmental Protection Agency's (EPA) Biopesticides and Pollution Prevention Division (BPPD), similar to the process for other pesticides. Additionally, separate pesticide registrations are required at the state level.

Quality Control & Assurance: Due to the potent effects of PGRs on plant growth, rigorous quality control and assurance measures are essential. These processes include comprehensive testing at multiple stages of production, starting from the sourcing of raw materials to the final packaging of the products. Quality assurance systems, such as ISO certification, ensure compliance with international standards. Additionally, residue analysis is vital for monitoring environmental impact and ensuring food safety.

Packaging: In the PGR industry, packaging is critical for maintaining product stability, efficacy, and user convenience. Effective packaging solutions are designed to preserve the chemical integrity of PGRs, facilitate easy application, and provide clear usage instructions. Packaging design must also consider factors such as product concentration, target crop, and application method. Sustainable packaging options are increasingly popular to reduce environmental impact. PGR products are offered in various packaging types, including HDPE bottles, drums, and others.

Marketing and Distribution: This segment of the supply chain focuses on the introduction of products to the market. It encompasses all activities undertaken by a company to facilitate the sale of PGR. This phase includes conducting market analysis to identify trends, customer preferences, and competitive landscapes. Informed by this analysis, marketing strategies and promotional initiatives are crafted to emphasize the advantages and appropriate application of PGR products.

Additionally, the distribution aspect entails the transportation of PGR products from production sites to various global markets. Distributors, wholesalers, and logistics providers are integral to this process. Establishing and sustaining a strong distribution network is essential for ensuring the widespread availability of PGR products, thereby catering to diverse agriculture markets across multiple regions.

End-user: The final segment of the value chain is represented by the end users who utilize the product. In agriculture contexts, PGR products serve as the ultimate application. The primary consumers of PGRs include farmers, horticulturists, and landscapers, who implement these products on crops, plants, and fields following established guidelines. The end-use phase is where the tangible advantages of PGRs become evident, marking it as a crucial juncture in the value chain.

Additionally, within the value chain analysis of the PGR market, post-market surveillance is incorporated into the comprehensive framework of product lifecycle management. This surveillance is imperative for assessing the safety and effectiveness of PGRs once they are available in the market. It entails the collection and analysis of data regarding product performance, adverse incidents, and environmental effects. Surveillance efforts encompass product recall protocols, management of customer complaints, and ongoing evaluation of product performance in real-world scenarios.

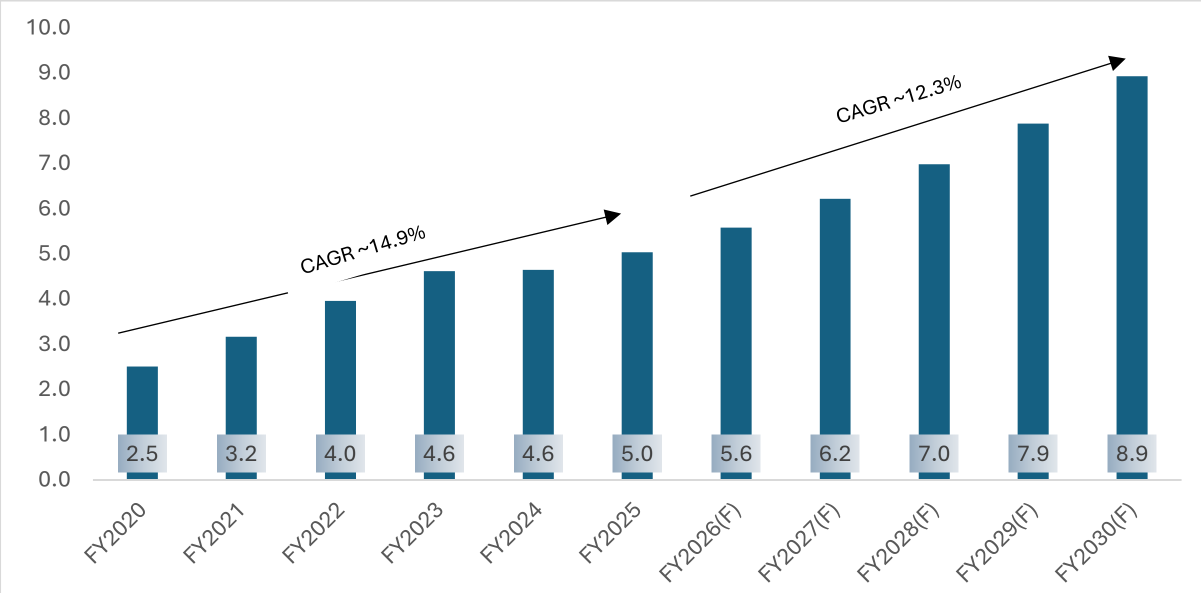
15. India Plant Growth Regulator (PGR) market:

The plant growth regulator market in India has emerged as a significant component of the agriculture sector, underscoring its essential function in enhancing crop growth and boosting agriculture efficiency. As the nation grapples with the dual task of sustaining a rapidly growing population while addressing the constraints on its agriculture resources, the importance of PGRs becomes increasingly evident. This market has experienced considerable expansion, propelled by the demand for improved crop yields, effective growth management, and the integration of modern agriculture techniques. Innovations in formulations are tailored to meet the specific challenges faced by Indian agriculture, thereby improving productivity.

The market's emphasis on integrated plant growth management (IPM) strategies, which merge chemical and biological approaches, highlights a commitment to sustainable agriculture practices. Furthermore, advancements in PGR application technologies, such as precision agriculture, play a crucial role in maximizing efficacy and minimizing the environmental impact of these products. It is vital to educate farmers on the advantages and correct application of PGRs to enhance adoption rates and ensure successful implementation. As the PGR market continues to develop, prioritizing innovation, sustainability, and farmer education will be key to overcoming challenges, boosting crop productivity, and fostering the overall progress of Indian agriculture.

The India plant growth regulator market reached a value of Rs 5.0 billion during FY2025, growing at CAGR 14.9% of during FY2020-FY2025. Looking forward, the India PGR market is expected to reach a value of Rs 8.9 billion by FY2030, exhibiting a CAGR of 12.3% during FY2026-FY2030.

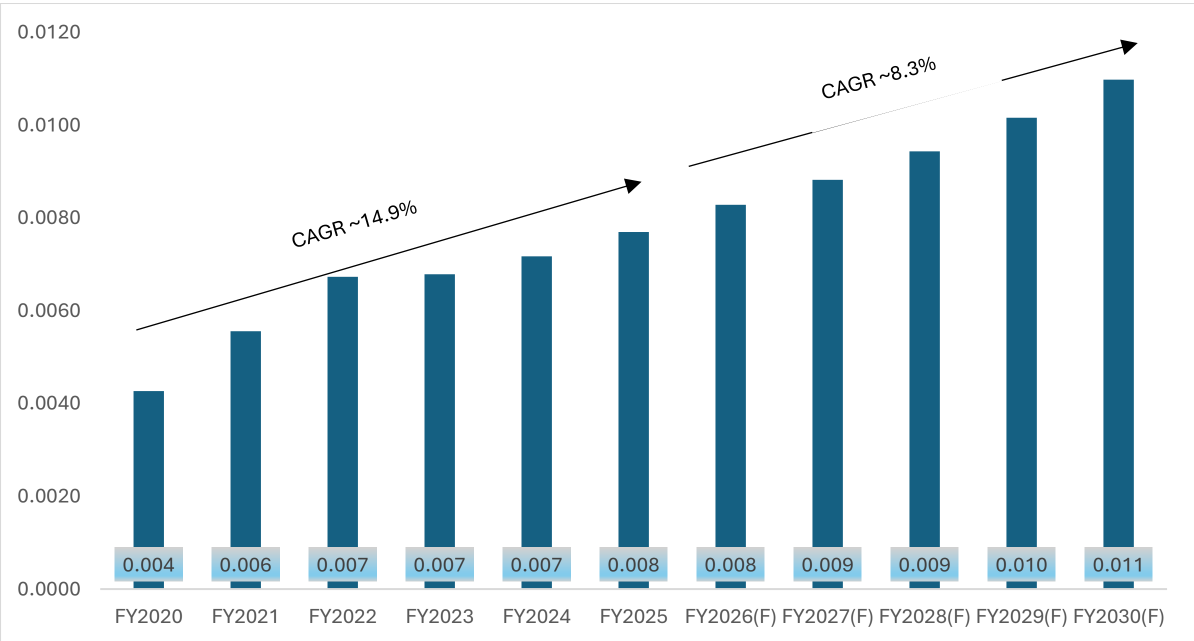
Chart 65: India PGR Market: Sales value (in Rs billion), FY2020-FY2030



Source: IMARC Group, ICRA Analytics

The India PGR market reached a volume of 0.008 million tonnes in FY2025, growing at CAGR 14.9% of during FY2020-FY2025. Going forward, the market size is expected to reach a volume of 0.011 million tonnes by FY2030, growing at a CAGR of 8.3% during FY2026-FY2030.

Chart 66: India PGR Market: Sales volume (in Million Tonnes), FY2020-FY2030



Source: IMARC Group, ICRA Analytics

15.1 Market Drivers, Restraints, and Opportunities of the India PGR market:

15.1.1 Market drivers:

- **Increase in pest resistance:** The rise in the development of resistance among pest and insect populations is a significant factor contributing to the expansion of the PGR market. As these pests and insects become more resistant to standard pesticides, farmers encounter considerable difficulties in preserving crop health and productivity. This issue of resistance highlights the pressing need for alternative approaches that can either supplement or substitute traditional pest control methods.

PGRs present a viable solution by enhancing plant growth and improving stress resilience, thereby bolstering crop defense against pests and diseases. By decreasing dependence on chemical pesticides and prioritizing plant health and development, PGRs aid in reducing environmental harm and fostering sustainable agriculture practices.

- **Better agriculture productivity:** PGRs provide numerous benefits that significantly boost agriculture efficiency and productivity. By affecting various aspects of plant growth, PGRs help optimize crop yields and enhance fruit quality, making them indispensable in modern farming. They allow for precise control over plant development, including increasing branching, suppressing unwanted shoot growth, and regulating flowering and fruiting times. This precision helps farmers achieve greater uniformity and higher quality in their produce. Moreover, PGRs can improve a plant's ability to tolerate stress, enabling crops to better withstand adverse environmental conditions such as drought or extreme temperatures.
- **Government initiatives:** The Indian government's focus on agriculture modernization is driving significant growth in the PGR market through a range of supportive measures. Initiatives such as subsidies, grants, and research funding are making PGRs more accessible and affordable for farmers, encouraging their widespread adoption. For instance, the Department of Agriculture & Cooperation, in collaboration with the Directorate of Plant Protection, plays a vital role in promoting the effective use of PGRs. They provide detailed guidelines on application methods, including timing, dosage, and other essential parameters for approved PGRs. These efforts are designed to raise awareness and ensure that farmers use PGRs effectively, ultimately improving crop productivity and sustainability.
- **Integration with Conservation Agriculture (CA):** The synergy between PGRs and Conservation Agriculture (CA) represents a pivotal factor in the expansion of the PGR market. CA aims at sustainable agriculture practices by reducing soil disturbance through methods such as zero tillage, prudent application of chemical inputs, and careful management of residues and waste. This methodology not only improves soil health and crop yields but also enhances biodiversity and conserves natural resources.

  Within this context, PGRs are essential as they optimize plant growth and enhance resilience. They assist in alleviating the impacts of both biotic and abiotic stresses, thereby boosting crop performance and maintaining yields within the CA framework. By adhering to the principles of CA, PGRs facilitate efficient resource utilization and promote sustainable farming practices, contributing to their growing adoption and market growth.

15.1.2 Restraints of the India PGR market:

- **Insufficient awareness among Indian farmers:** A major obstacle to the advancement of the PGR market in India is the prevalent lack of awareness among farmers, especially those residing in rural regions. Numerous farmers are not informed about the different types of PGRs available and the advantages they can offer. This deficiency in knowledge also includes the cost-effectiveness and efficiency enhancements linked to these growth regulators.

  Consequently, many farmers continue to depend on traditional farming methods, opting for conventional chemicals and fertilizers instead of embracing innovative PGR solutions.

The existing gap in awareness regarding modern technologies and products hinders the adoption of PGRs, thereby stifling market expansion. Educational programs, training sessions, and outreach initiatives can bridge this gap and fully realize the potential of PGRs in improving agriculture productivity and sustainability.

- **Residual toxicity:** The presence of PGR residues can lead to environmental contamination and pose risks of foodborne illness. To enhance agriculture output while mitigating adverse impacts on the environment and public health, it is essential to consistently monitor and regulate the application of PGR in agriculture practices.

15.1.3 Opportunities tapped in the India PGR market:

- **Improving crop yield and quality:** Given the constraints of limited arable land and finite resources, the enhancement of crop yield and quality through the use of PGRs is essential to satisfy the increasing global food demand. As agriculture practices adapt to these challenges, PGRs are integral in boosting productivity and operational efficiency. The anticipated rise in oilseed crop production, spurred by heightened demand across the food, feed, and fuel sectors, underscores a significant opportunity for PGRs to exert a meaningful influence. By facilitating optimal plant growth and enhancing resilience to stressors, PGRs can significantly elevate both the yield and quality of oilseed crops, thereby promoting agriculture sustainability.

  This approach not only addresses the escalating market requirements but also encourages economic growth for farmers and other stakeholders. Consequently, the utilization of PGRs in the growth of crop production is vital for fulfilling both agriculture and economic objectives.
- **Advancements in PGR Technology:** Recent advancements in PGR technology are focused on significantly enhancing the efficiency and effectiveness of PGR applications. Key areas of innovation include the development of new formulations and delivery systems that improve the absorption and impact of PGRs. For instance, the application of nanotechnology in PGR formulations can increase the stability and bioavailability of these substances, enabling precise and targeted delivery to specific plant tissues. These technological advancements ensure that PGRs are more effective and efficient in promoting plant growth, thereby optimizing agriculture outcomes.

15.2 Value Chain Analysis

India: Plant Growth Regulator Industry: Value Chain Analysis

The value chain of the plant growth regulator industry in India encompasses several key stages which are highlighted in detail below:

Research and Development (R&D): The R&D phase serves as the foundation for the creation of novel PGRs and the enhancement of existing formulations. This phase encompasses scientific investigations aimed at discovering new compounds and analysing their impacts on plant growth, development, and overall productivity. Such research is undertaken by agriculture research organizations, academic institutions, and private enterprises focused on plant science and biotechnology. Advancements in R&D contribute to the formulation of PGRs that can boost crop yields, enhance quality, and mitigate plant stress.

Registration: The registration phase, which follows the research and development stage, is vital for confirming that new PGRs comply with regulatory requirements prior to their market introduction. This phase necessitates the submission of comprehensive data regarding the PGR's effectiveness, safety, and environmental implications to regulatory authorities, such as the Central Insecticides Board & Registration Committee (CIB&RC) in India. The registration process entails thorough evaluations, which include toxicological assessments, environmental impact studies, and formulation analyses.

Technical manufacturing: This phase encompasses the procurement of essential chemicals and compounds necessary for the production of PGRs and their conversion into final products. Chemical manufacturers provide the active ingredients and other components required for PGR formulation. During the manufacturing process, these ingredients are combined with carriers and additives to produce PGRs. It is advisable to manufacture or formulate PGRs using dedicated equipment that is not utilized for herbicides, rather than sharing production facilities. This practice, adopted by numerous CropLife International member companies, significantly mitigates the risk of herbicide contamination in PGR production environments.

Formulation: The term formulation in relation to a PGR pertains to the medium in which it is contained and the concentration of the active ingredient within that medium. This process encompasses the development of herbicides in multiple forms, including liquids, powders, granules, and emulsifiable concentrates. The selection of a specific formulation is influenced by the intended application and target audience. Major manufacturers often employ in-house formulators dedicated to the innovation and enhancement of these formulations.

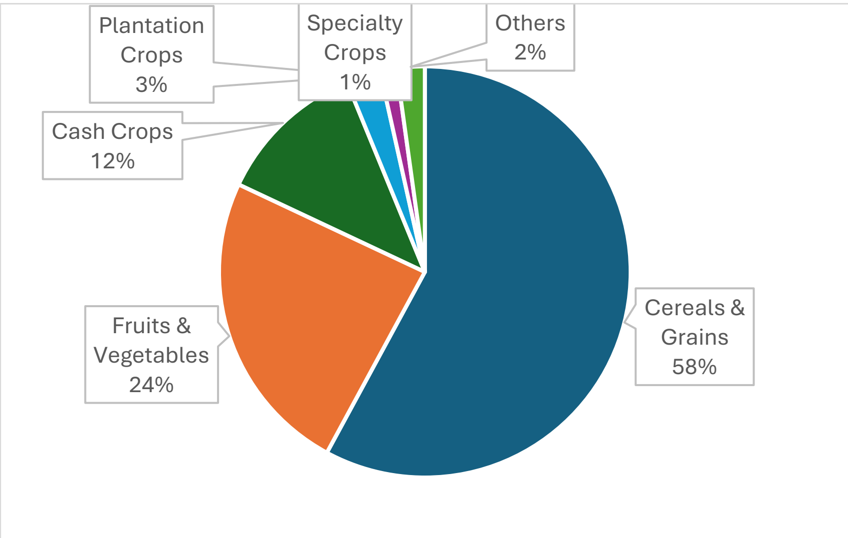
Distribution: The distribution phase emphasizes the logistical aspects of moving PGR products from manufacturers and formulators to retailers and end-users. This encompasses warehousing, inventory oversight, and transportation logistics. Distributors are essential in ensuring the availability of PGRs across different regions and in maintaining a seamless supply chain to satisfy market demand.

Retail: The retail aspect of the PGR market involves promoting and selling PGR products through various channels. This includes participating in agriculture fairs, running advertisements, and executing direct marketing campaigns. Products are distributed through a network of agrochemical retailers, cooperatives, and direct sales to farmers, ensuring that PGRs are accessible to those who need them.

End Users: The primary end users of PGRs are farmers who apply these regulators to enhance plant growth, manage stress, and improve crop yields. Farmers' decisions to use PGRs are influenced by factors such as the type of crop, growing conditions, and specific growth objectives. When applied effectively, PGRs can lead to more efficient and productive farming practices, helping farmers achieve better results.

15.3 Market Breakup by Application (Value Wise)

Chart 67: India PGR Market: Breakup by Application Type (in %) during FY2025 (in terms of consumption)



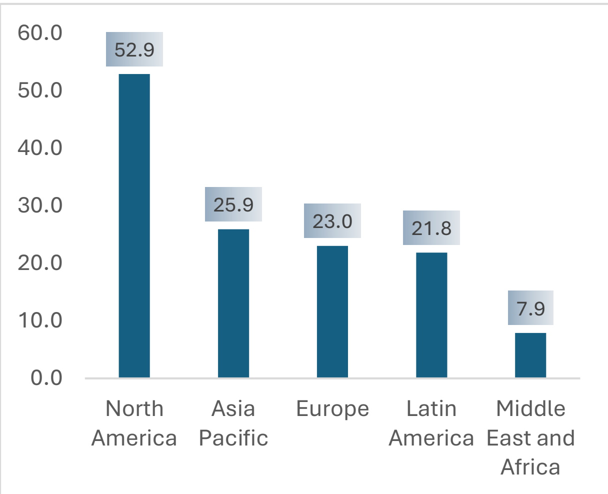
Source: IMARC Group, ICRA Analytics

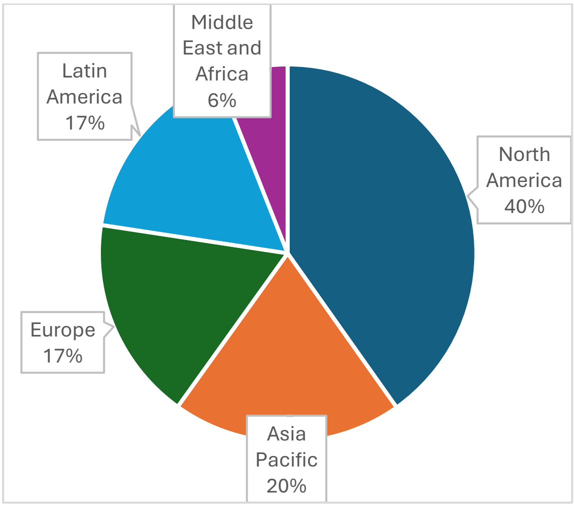
During FY2025, cereals & grains currently dominates as the largest application in term of value, accounting for a share of 58% of the total market.

Cereals & grains was followed by fruits & vegetables at ~24%, cash crops at~12%, plantation crops at ~3%, specialty crops at ~1% and others at ~2%.

15.4 Export Market Breakup by Region (Value Wise)

Chart 68: India: Herbicides, Anti-sprouting Products and PGR Export Market: Breakup by Region (in % terms and value in Rs billion) during FY2025





Source: Department of Commerce, IMARC Group, ICRA Analytics
Note: The export value includes herbicides as well as anti-sprouting products since there is no separate HS code allocated for PGR

During FY2025, North America represented the largest market for exported herbicides, anti-sprouting products and PGR from India, accounting for a share of 40.2% out of the total export in terms of value at Rs. 131.6 billion. North America was followed by Asia Pacific at ~20%, Europe at ~18%, Latin America at ~17% and Middle East and Africa at ~6%.

16. Competitive Landscape

16.1 Brief Profile of GSP Crop Science Limited and its peer companies

1. **GSP Crop Science Limited**

GSP Crop Science was ranked among the Top 10 Indian applicants for patents from Scientific and Research & Development Organizations in Fiscal Year 2017.Rajdhani Petrochemicals Private Limited, a subsidiary of GSP Crop Science, was also ranked among the Top 10 Indian applicants for Patent Cooperation Treaty filings (RO/IN) in Fiscal Year 2022.

The Company has a proven track record of introducing Formulations and Technicals to the Indian agrochemicals market, as demonstrated by the following examples:

a) It is among the first indigenous manufacturers and sellers with exclusive patents for the following Formulations:

Table 9: List of GSP Crop Science exclusive patented Formulations

Sr No	Formulations	Brands	Category	Relevant Crop	Usage
1	Pendimethalin 35% + Metribuzin 3.5% SE	Platform	Herbicide	Wheat	Control of canary grass, wild oat, lamb's quarters, field bindweed, swine cress & bermuda grass
2	Pyraclostrobin 3.5% + Thiram 15% + Clothianidin 22.5% FS	PCT 410	Fungicide + Insecticide	Groundnut	Control of collar rot, stem rot, aphid, jassid, termite & white grub
3	Tolfenpyrad 15% + Bifenthrin 7.5% SE	Raavan	Insecticide	Rice	Control of brown plant hopper, green leaf hopper, stem borer and leaf folder
4	Pymetrozine 25.0% + Thiamethoxam 17.5% + Hexaconazole 12.5% WG	Afford	Insecticide + Fungicide	Rice	Control of insect pests viz., brown plant hopper, white backed plant hopper, green leaf hopper, yellow stem borer, and leaf folder and diseases of sheath blight and leaf blast
5	Thiocyclam Hydrogen Oxalate 3.0 % + Clothianidin 1.2% GR	Aurthor	Insecticide	Rice	Control of larvae of mosquito
6	Thiafluzamide 15% + Difenoconazole 20% SC	Element	Fungicide	Rice	Control of sheath blight, brown spot, false smut and grain discolouration disease
7	Methoxyfenozide 20% + Chlorantraniliprole 5% SC	Liger	Insecticide	Groundnut	Control of tobacco caterpillar, american bollworm and groundnut leaf miner

Sr No	Formulations	Brands	Category	Relevant Crop	Usage
8	Pendimethalin 15% + Pyrazosufuron Ethyl 0.15% GR	All Rounder	Herbicide	Transplanted Rice	Control of susceptible annual grasses, sedges and broad leaf weeds
9	Pymetrozine 30.0% + Tebuconazole 37.0% WG	Runway	Insecticide	Rice	Control of BPH, sheath blight, brown spot, blast and grain discoloration
10	Methoxyfenozide 18% +Emamectin Benzoate 1.8% SC	Fighter	Insecticide	Chilli	Control of fruit borer, thrips and mite

Source: Ministry of Agriculture & Farmers Welfare, ICRA Analytics

b) It is also among the first indigenous manufacturers of the following Technicals, which are used in the manufacturing of its approved Formulations:

Table 10: List of GSP Crop Science technicals

Sr No	Technicals	Category
1	Chlorantraniliprole Technical 96.00% w/w Min	Insecticide
2	Clothianidin Technical 98.00% w/w Min	Insecticide
3	Pymetrozine Technical 98.00 % w/w Min	Insecticide
4	Azoxystrobin Technical 95 % w/w Min	Fungicide
5	Diafenthiuron Technical 96% Min	Insecticide
6	Pyraclostrobin Technical 96.00% w/w Min	Fungicide
7	Methoxyfenozide Technical 97% w/w Min	Insecticide

Source: Ministry of Agriculture & Farmers Welfare, ICRA Analytics

c) It holds the following exclusive process patents for technicals:

Table 11: List of GSP Crop Science process patents for technicals

Sr No.	Process Patent	Technical Name	Category
1.	Novel process for preparation of 1-tert-butyl-3-(2,6-di-isopropyl-4-phenoxyphenyl) thiourea	Diafenthiuron	Insecticide
2.	Improved process for the preparation of n-(3-methyl-1,3,5-oxadiazinan-4-ylidene) nitramide	Thiamethoxam	Insecticide
3.	Improved process for the preparation of azoxystrobin	Azoxystrobin	Fungicide
4.	Novel process for the preparation of trifloxystrobin	Trifloxystrobin	Fungicide

Sr No.	Process Patent	Technical Name	Category
5.	Novel crystalline modification of pymetrozine and process for preparation thereof	Pymetrozine	Insecticide
6.	Improved and efficient process for the synthesis of 2-[2-(1-chlorocyclopropyl)-3-(2-chlorophenyl)-2-hydroxypropyl]-2,4-dihydro-3h-1,2,4-triazole-3-thione (prothioconazole) and its intermediates	Prothioconazole	Fungicide
7.	Improved process for the preparation of pyraclostrobin	Pyraclostrobin	Fungicide
8.	Improved process for the preparation of azoxystrobin	Azoxystrobin	Fungicide
9.	Improved process for the preparation of pyraclostrobin (USA)	Pyraclostrobin	Fungicide
10.	Efficient process for the synthesis of 2-[2-(1-chlorocyclopropyl)-3-(2-chlorophenyl)-2-hydroxypropyl]-2,4-dihydro-3h-1,2,4-triazole-3-thione (prothioconazole) and its intermediates (USA)	Prothioconazole	Fungicide

Source: Indian Patent Office, ICRA Analytics

2. **PI Industries Limited (Year of incorporation- 1946)**
    a. **About the company –** PI Industries Ltd operates in the agro-chemicals space having presence in both Domestic and Export markets.
    b. **Manufacturing locations –** The company has five manufacturing units in Gujarat (3 in Panoli and 2 in Jambusar) and one R&D centre each at Hyderabad and Udaipur.
    c. **Product Offering –** Key products offered by the company include custom synthesis manufacturing, herbicides, insecticides, fungicides, biostimulants.
    d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

3. **Sumitomo Chemical India (Year of incorporation- 2000)**
    a. **About the company –** Sumitomo Chemical India Ltd. (SCIL) is a subsidiary of Japanese chemical major, Sumitomo Chemical Company Limited Japan (SCCL). The Company is known for domestic marketing of proprietary products of its Japanese parent (SCCL). It is engaged in the manufacturing and marketing of crop protection formulations based on the active ingredients procured from SCCL and third parties. SCIL has also marked its presence in Africa and several other geographies of the world.
    b. **Manufacturing locations –** The company has five manufacturing units at Gajod, Vapi, Bhavnagar (Gujarat), Silvassa, Tarapur (Maharashtra).
    c. **Product Offering –** Key products offered by the company include Herbicides, insecticides, fungicides, fumigants, and plant growth regulators.

d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

4. **Dhanuka Agritech Limited (Year of incorporation- 1985)**
   a. **About the company –** Dhanuka Agritech Limited is in the Agrochemical industry in India providing its products only to domestic market.
   b. **Manufacturing locations –** The company has four manufacturing units located at Dahej (Gujarat), Sanand (Gujarat), Udhampur (J&K), Keshwana (Rajasthan).
   c. **Product Offering –** Key products offered by the company include Herbicides, insecticides, fungicides, plant growth regulators, biologicals.
   d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

5. **Rallis India Limited (Year of incorporation- 1948)**
   a. **About the company –** Rallis India is a subsidiary of Tata Chemicals Limited. It manufactures and markets a range of agri-inputs, which include pesticides, fungicides, insecticides, seeds, and plant growth nutrients. Rallis is also in the business of contract manufacturing for global corporations.
   b. **Manufacturing locations –** The company has manufacturing units at Akola and Lote (Maharashtra), Ankleshwar and Dahej (Gujarat), GP Pally, Kokkonda and Medchal (Telangana).
   c. **Product Offering –** Key products offered by the company include Herbicides, insecticides, fungicides, seeds, crop nutrition products.
   d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

6. **Bharat Rasayan Limited (Year of incorporation- 1989)**
   a. **About the company –** Bharat Rasayan Ltd is the group company of Bharat group. The company has presence in diverse product segments of the agrochemical industry including insecticides, herbicides, fungicides, their formulations & intermediates.
   b. **Manufacturing locations –** The company has two manufacturing units at Rohtak (Haryana) and Dahej (Gujarat).
   c. **Product Offering –** Key products offered by the company include Insecticides, Herbicides, Fungicides, their formulations & intermediates.
   d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

7. **India Pesticides Limited (Year of incorporation- 1984)**
   a. **About the company –** India Pesticides Limited operates in the manufacturing of both Technicals & Formulations in Agro-Chemicals and Active Pharma Ingredients for Pharma industry. The company exports its products to more than 40 countries across the globe at regulated markets in US, Australia, Europe, Africa, South America and Asia.
   b. **Manufacturing Plants –** The company has two active manufacturing facilities in Lucknow & Hardoi districts in Uttar Pradesh.

c. **Products offered –** Company offers 27 technical and 207 formulations for the domestic market and 32 technical and 41 formulations for the export market across Herbicides, insecticides, fungicides, and intermediates. Further, the company offers two APIs i.e Anti-Fungal Drugs and Anti-Scabies Drugs.
d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

8. **Excel Industries Limited (Year of incorporation- 1960)**
    a. **About the company –** Excel Industries Limited has presence in the chemical industry through Company's indigenous chemical technology. Company is specialised in producing Agrochemical Intermediates, Specialty Chemicals, Polymer Inputs, Pharmaceutical Intermediates, and Active Pharmaceutical Ingredients (APIs).
    b. **Manufacturing locations –** The company has three manufacturing units at Roha (Maharashtra), Lote (Maharashtra), Vishakapatnam (Andra Pradesh).
    c. **Product Offering –** Key products offered by the company include Agrochemical intermediates, Speciality Chemicals, Polymer Additives, Pharma Intermediates & API, Integrated MSW, Excel OWC, Sanitreat, Bioculum.
    d. **End-user industries served –** Industries served by the company includes Agrochemical Intermediates, Corrosion Inhibitors & Chelating Agents, Pharma & Veterinary, Polymer Aids and Property modifiers.

9. **Heranba Industries Ltd (Year of incorporation- 1994)**
    a. **About the company –** Heranba Industries Ltd is engaged in the manufacturing of a diverse range of agrochemicals such as insecticides, herbicides, fungicides and public health products for pest control
    b. **Manufacturing locations –** The company has 3 manufacturing units at GIDC Vapi (Gujarat) and 1 unit at Sarigaon (Gujarat)
    c. **Product Offering –** Key products offered by the company include Insecticides, herbicides, fungicides, and public health product
    d. **End-user industries served –** Industries served by the company includes Agriculture, public health and pest control services.

10. **Crystal Crop Protection Limited (Year of incorporation- 1994)**
    a. **About the company –** Crystal Crop Protection limited is R&D based crop protection manufacturing and marketing company. Crystal's products cater to the entire lifecycle of crops, from sowing to harvesting. Crystal and its subsidiaries, Modern Papers and Nexus Crop Science Pvt Ltd engage in the technical manufacturing, formulation, and marketing of agrochemical products.
    b. **Manufacturing locations –** The company has manufacturing units at Jammu(J&K), Sonepat (Haryana), Anand (Gujarat), Dahej (Gujarat), Nagpur (Maharahtra), Hyderabad
    c. **Product Offering –** Key products offered by the company include Insecticides, Fungicides, Herbicides, Plant Growth Regulators.
    d. **End-user industries served –** Industries served by the company includes Agriculture and pest control services.

11. **Tagros Chemicals India Private Limited (Year of incorporation- 1992)**

   a. **About the company –** Tagros manufacturers agrochemicals with an international reputation in crop protection and other allied segments.

   b. **Manufacturing locations –** The company has manufacturing units at Dahej, Panoli (Gujarat), Cuddalore (Tamil Nadu)

   c. **Product Offering –** Key products offered by the company include Insecticides, Fungicides, Herbicides, Synergists.

   d. **End-user industries served –** Industries served by the company includes Agriculture and pest control services.

16.2 Financial benchmarking of key peers in the sector

16.2.1 Financial benchmarking of key peer companies for the Financial Year 2025

Table 12: Financial benchmarking of key peer companies for the Financial Year 2025

Particulars	For period ended March 31, 2025								
	GSP Crop Science	PI Industries Limited	Sumitomo Chemical Limited	Dhanuka Agritech Limited	Rallis India Limited	Bharat Rasayan Limited	India Pesticides Limited	Excel Industries Limited	Heranba Industries Limited
Revenue from Operations (Rs. million)	12,874	79,778	31,485	20,352	26,629	11,730	8,286	9,781	14,097
Growth in Revenue from Operations (%)	11.74%	4.07%	10.71%	15.73%	0.55%	12.29%	21.78%	18.39%	12.14%
EBITDA (Rs. million)	1,640	25,275	7,522	4,527	3,185	2,167	1,344	1,494	1,055
EBITDA Margin (%)	12.74%	31.68%	23.89%	22.24%	11.96%	18.48%	16.22%	15.27%	7.48%
Profit/(Loss) for the Year/Period (Rs. million)	814	16,602	5,064	2,970	1,251	1,409	822	853	23
PAT Margin (%)	6.26%	19.95%	15.49%	14.34%	4.64%	11.75%	9.74%	8.46%	0.16%
Return on Equity (%)	18.38%	16.35%	17.42%	21.18%	6.61%	12.47%	9.15%	5.37%	0.37%
Return on Capital Employed (%)	19.80%	23.54%	24.12%	30.83%	11.92%	15.42%	12.03%	6.76%	4.16%
Net Fixed Assets Turnover Ratio (times)	4.87x	1.68x	5.38x	4.09x	2.79x	4.79x	2.15x	2.15x	1.93x
Net Working Capital Days (No. of days)	117	54	116	129	103	177	206	65	105

Source: Company Financial Statements, ICRA Analytics

16.2.2 Financial benchmarking of key peer companies for the Financial Year 2024

Table 13: Financial benchmarking of key peer companies for the Financial Year 2024

Particulars	For period ended March 31, 2024								
	GSP Crop Science	PI Industries Limited	Sumitomo Chemical Limited	Dhanuka Agritech Limited	Rallis India Limited	Bharat Rasayan Limited	India Pesticides Limited	Excel Industries Limited	Heranba Industries Limited
Revenue from Operations (Rs. million)	11,522	76,658	28,439	17,585	26,484	10,446	6,804	8,261	12,571
Growth in Revenue from Operations (%)	-4.25%	18.08%	-19.00%	3.43%	-10.74%	-15.37%	-23.11%	-24.19%	-4.68%
EBITDA (Rs. million)	1,304	22,329	5,702	3,624	3,268	1,521	1,018	560	907
EBITDA Margin (%)	11.32%	29.13%	20.05%	20.61%	12.34%	14.56%	14.95%	6.77%	7.22%
Profit/(Loss) for the Year/Period (Rs. million)	555	16,815	3,697	2,391	1,479	955	602	170	345
PAT Margin (%)	4.80%	21.36%	12.58%	13.33%	5.55%	8.96%	8.65%	1.98%	2.71%
Return on Equity (%)	15.00%	19.26%	15.14%	19.04%	8.08%	9.67%	7.29%	1.19%	4.14%
Return on Capital Employed (%)	18.91%	23.61%	21.34%	25.53%	13.54%	11.70%	10.10%	1.57%	6.47%
Net Fixed Assets Turnover Ratio (times)	5.06x	2.01x	4.86x	5.02x	2.48x	4.42x	2.02x	1.86x	2.16x
Net Working Capital Days (No. of days)	101	47	115	128	108	205	189	47	131

Source: Company Financial Statements, ICRA Analytics

16.2.3 Financial benchmarking of key peer companies for the Financial Year 2023

Table 14: Financial benchmarking of key peer companies for the Financial Year 2023

Particulars	For period ended March 31, 2023										
	GSP Crop Science	PI Industries Limited	Sumitomo Chemical Limited	Dhanuka Agritech Limited	Rallis India Limited	Bharat Rasayan Limited	India Pesticides Limited	Excel Industries Limited	Heranba Industries Limited	Crystal Crop Protection Limited	Tagros Chemicals India Private Limited
Revenue from Operations (Rs. million)	12,033	64,920	35,110	17,002	29,670	12,343	8,849	10,898	13,188	24,970	25,230
Growth in Revenue from Operations (%)	1.01%	22.50%	14.69%	15.05%	13.94%	-5.13%	23.57%	-7.49%	-9.07%	11.44%	0.89%
EBITDA (Rs. million)	813	17,079	7,114	3,234	2,310	2,102	2,102	1,393	1,683	2,507	4,590
EBITDA Margin (%)	6.75%	26.31%	20.26%	19.02%	7.79%	17.03%	23.75%	12.78%	12.76%	10.04%	18.19%
Profit/(Loss) for the Year/Period (Rs. million)	176	12,295	5,022	2,335	919	1,246	1,432	799	1,044	761	1,203
PAT Margin (%)	1.46%	18.49%	14.12%	13.38%	3.09%	9.94%	15.95%	7.25%	7.84%	3.02%	4.71%
Return on Equity (%)	4.79%	17.08%	21.09%	22.00%	5.31%	13.95%	18.53%	6.44%	12.88%	6.08%	8.17%
Return on Capital Employed (%)	9.00%	21.05%	27.78%	28.68%	8.83%	19.81%	25.27%	8.08%	16.32%	10.12%	7.99%
Net Fixed Assets Turnover Ratio (times)	6.51x	2.37x	7.01x	5.35x	2.98x	5.25x	3.21x	2.44x	4.71x	3.73x	1.74x
Net Working Capital Days (No of days)	126	75	140	109	87	170	158	61	139	165	79

Source: Company Financial Statements, ICRA Analytics

Table 15: List of Formulas used for the key peer comparison

SR. No.	Formula
1	The KPIs for GSP Crop Science have been calculated considering only the continuing operations
2	Growth in Revenue from Operations is calculated as a percentage of Revenue from operations of the relevant year/period less Revenue from operations of the preceding year/period, divided by Revenue from operations of the preceding year/period
3	EBITDA is calculated as Profit/(Loss) for the year/period less Exceptional items add Finance costs, Depreciation and amortisation expense, and Total income tax expenses
4	EBITDA Margin is calculated as EBITDA divided by Revenue from operations
5	PAT Margin is calculated as Profit/(Loss) for the year/period divided by Total income
6	Return on Equity is calculated as Profit/(Loss) for the year/period (Excluding share of minority in profits) divided by Total equity (Excluding non-controlling interest).
7	Return on Equity for GSP Crop Science is calculated as Restated profit for the period/year from continuing operations attributable to equity shareholders of the parent divided by Net Worth. Net Worth is calculated as Total Equity less non-controlling interest and Capital Reserve.
8	Return on Capital Employed is calculated as EBIT divided by Capital employed. Capital employed is calculated as the sum of Tangible net worth (i.e. Total assets excluding Goodwill, Other intangible assets and Intangible assets under development reduced by total liabilities), non-current borrowings and Current borrowings less Deferred tax asset (net)
9	Net Fixed Assets Turnover Ratio is calculated as Revenue from operations for the year/period divided by Net Property, plant and equipment, Capital work-in-progress, Goodwill, Other Intangible assets, Intangible assets under development & Right-of-use assets
10	Net Working Capital Days is calculated as Net Working Capital divided by Revenue from operations multiplied by 365 (for full Fiscal)/182 (for the six months period ended September 30, 2024). Net Working Capital is calculated as Inventories add Trade Receivables less Trade Payables (micro and small enterprises and other than micro and small enterprises)
11	NA for Industry Peers refers to information not publicly available

Source: Company Financial Statements, ICRA Analytics