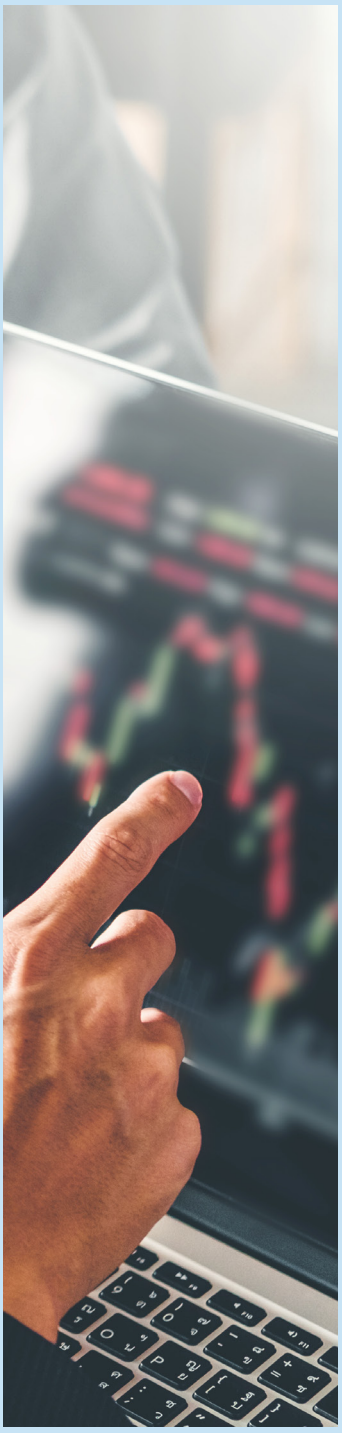
VIEW POINT



AGROCHEMICALS MARKET AND THE STRATEGIC ROLE OF THE R&D FUNCTION

Infosys®
Navigate your next

Table of Contents

Introduction

The demand for food is increasing in tandem with the growth in global population. Agricultural systems need to address several challenges to fulfill the growing demand: limited availability of arable land and water; depletion of natural resources; insect and rodent infestations that cause crop loss; and fungal, bacterial, and viral diseases that deteriorate the nutritional value of produce. Pests and disease account for 20%-40% yield loss, costing the global economy more than US$ 290 billion annually[1].

Agrochemicals, including fertilizers and crop protection products, play a pivotal role in ensuring crop health, increasing yield, and safeguarding crops from weeds, pests, and pathogens. Fertilizers provide essential nutrients to the soil and improve crop health and produce quality. Crop protection products, such as insecticides, fungicides, herbicides, rodenticides, growth regulators, and seed treatment chemicals, protect crops by mitigating stress. Agrochemical products drive food security by boosting crop yield and production and preventing food loss. It is estimated that 78% fruit production, 54% vegetable production, and 32% cereal production is lost when pesticides are not applied[2].

Farmers use a combination of products to protect crops effectively and minimize agriculture's environmental impact. Plant growth regulators are used to modify or control vegetative growth for ensuring optimal yield. Seed treatment chemicals are applied to seeds for protection from pests and diseases and enable healthy germination and plant growth. Biopesticides, derived from natural materials such as animals, plants, bacteria, and minerals, help in targeting specific pests and avoiding chemical residue in food.

Crop protection products increase crop yield by limiting the spread of pests and diseases, preventing crop loss, and controlling the growth of weeds. It also mitigates the impact of adverse weather conditions, ensuring stable crop production across seasons. Notably, improved yield and reduction in crop loss contribute to the economic wellbeing of farmers and growth of the agriculture sector.

Market Overview

Agrochemical industry market insights

The global agrochemical market is predicted to grow from US$ 235+ billion in 2023 to US$ ~297 billion by 2030, at a CAGR of 3.39%[3]. It includes crop protection chemicals, fertilizers, seed, and other products.

The Asia Pacific region plays a pivotal role in global agriculture, accounting for ~27% agrochemical market share in 2023[4] (Figure 1). This region is also the world's largest producer of agrochemicals[5] (Figure 2). India, China, and Japan are the primary contributors to the APAC regional agrochemical market. Europe holds the second position with a 35% share, followed by North America.

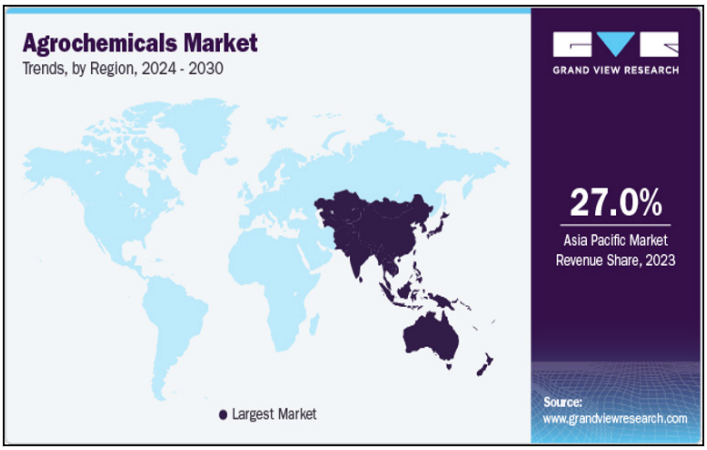


Figure 1: Global agrochemical market

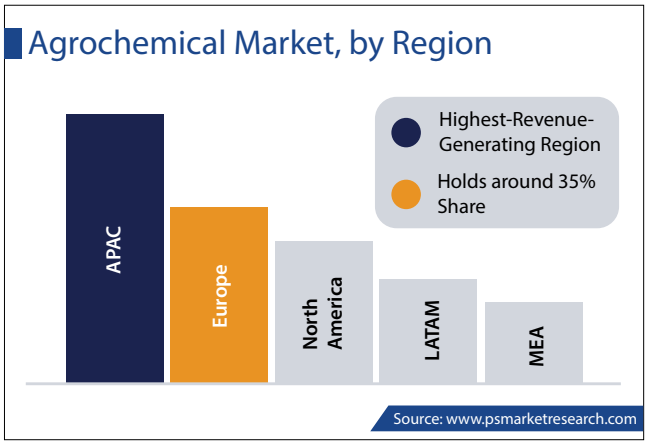


Figure 2: Agrochemical market size

Crop protection industry market insights

The global crop protection market, estimated at US$ 88.2 billion in 2022, is expected to reach US$ 132.4 billion by 2032 growing at a CAGR of 4.2% during the period 2023-2032 (Figure 3)[6]. The primary growth driver for crop protection chemicals is the need to control pests, weeds and diseases that affect crop yield and quality.

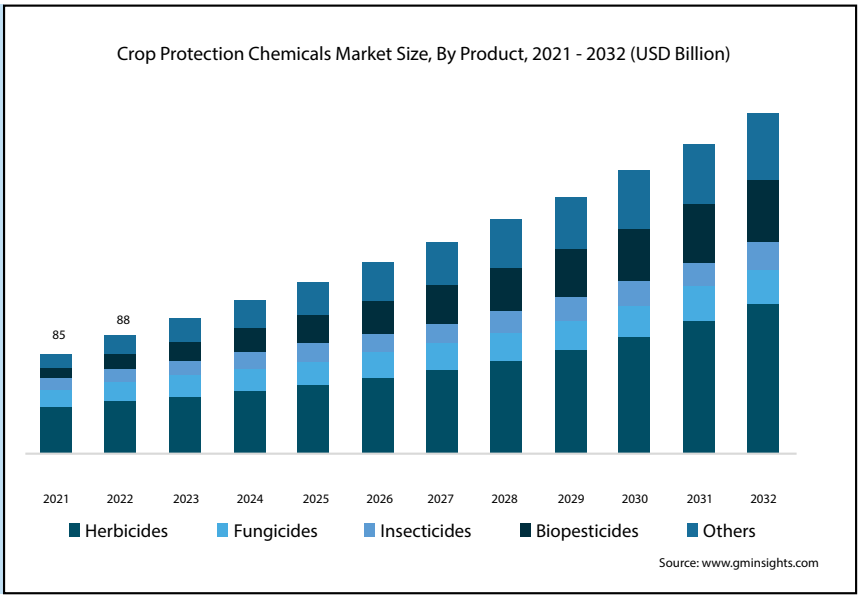


Figure 3: Global crop protection market

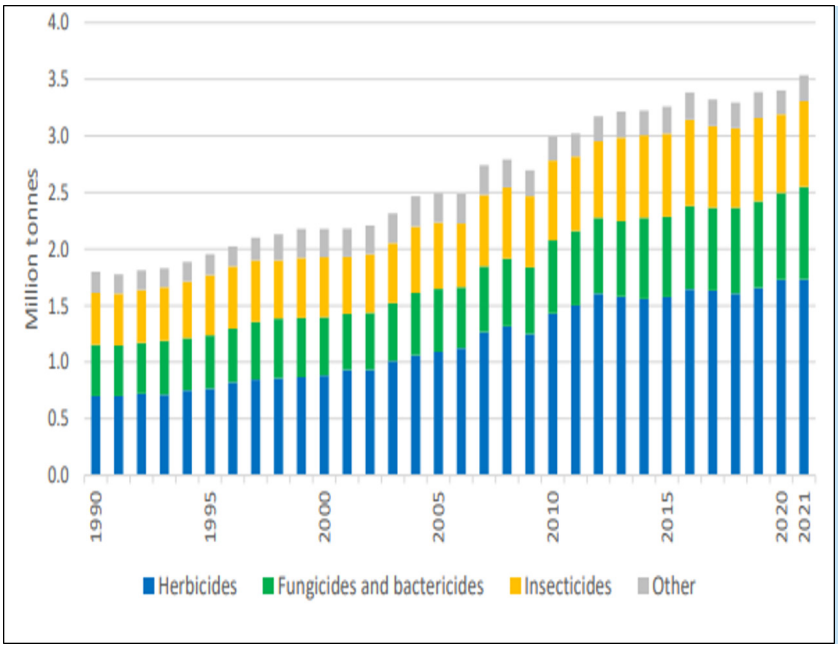


Figure 4: Global pesticide consumption by type

Global crop protection products consumption by type

Pesticide consumption has doubled since 1990. Total pesticide usage in agriculture reached 3.54 million tons of active ingredients in 2021 – a 4% increase from 2020 and 11% increase in the decade of 2011 to 2021, according to a Food and Agriculture Organization of the United Nations (FAO) report[7]. The use of herbicides grew globally by 53%, fungicides and bactericides by 111%, and insecticides by 44% between 1990 and 2021, according to FAO (Figure 4)[8].

Global crop protection products consumption by region

The Americas consumed more than half of the pesticides produced in 2021, while Asia and Europe consumed 27.7% and 14.3% respectively (Figure 5)[9]. Notably, the use of pesticides has increased consistently. Pesticide consumption in the Americas registered a 2% increase between 2020 and 2021, and 191% growth over the period of 1990 to 2021 (Figure 6). The increase in pesticide consumption was 8% in Asia and 4% in Europe during 2020-20217.[7]

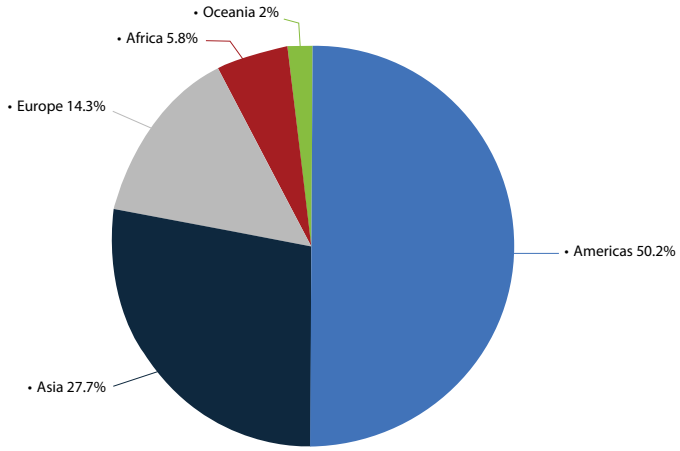


Figure 5: Distribution of pesticide consumption worldwide in 2021, by region

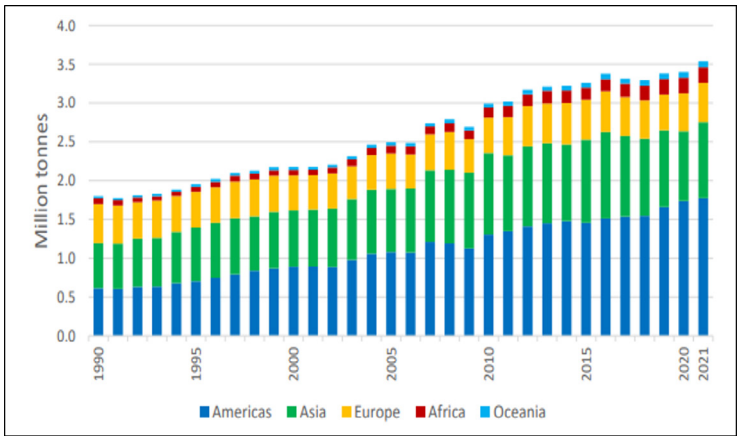


Figure 6: Total crop protection products consumption by region from 1990-2021

Global crop protection products consumption by country

Global consumption of pesticides reached 3.53 million in 2021 – increasing by 96% between 1990 and 2021[10]. In 2021, Brazil was the largest market for pesticides, with a consumption of 719.51 thousand metric ton, followed by USA with 457.39 thousand metric ton (Figure 7). Demand for crop protection solutions was high in Indonesia, Argentina, and China.

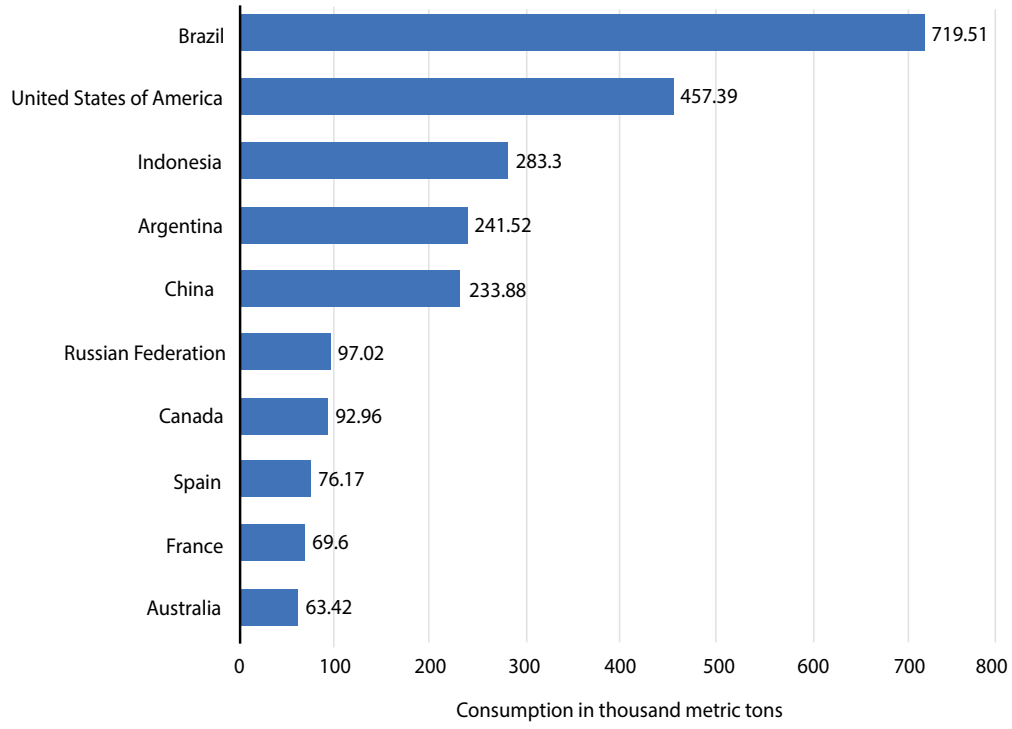


Figure 7: Total pesticide consumption by country

Market leaders and annual sales

Table 1 depicts the top 20 crop protection product companies based on annual sales in 2022 and 2021. The combined sales of these top 20 global agrochemical companies was US$ 85.762 billion[11], an annual increase of 18.18% from US$ 72.569 billion in 2021.

Table 1: Annual sales of top 20 crop protection product companies

Ranking	Company name	FY 2022 (Bn US$)	FY 2021 (Bn US$)
1	Syngenta	15.969	13.301
2	Bayer Crop Science	13.875	11.436
3	BASF	8.851	7.713
4	Corteva Agriscience	8.476	7.253
5	UPL	5.881	5.556
6	FMC Corporation	5.396	5.045
7	ADAMA	5.020	4.389
8	Sumitomo Chemical	3.594	3.495
9	Nufarm	2.620	2.087
10	Jiangsu Yangnong Chemical	2.312	1.815
11	Rainbow	2.129	1.518
12	Sino-Agri Leading Biosciences	1.737	-
13	Lianyungang Liben Crop Science	1.559	1.178
14	Wynca Chemicals	1.427	1.184
15	Lier Chemical	1.370	0.930
16	Hubei Xingfa Chemicals	1.289	1.170
17	Nutrichem	1.189	1.135
18	Fuhua Tongda Agrochemical Technology Co	1.100	1.003
19	Zhejiang Zhongshan Chemical	1.021	-
20	Nanjing Red Sun	0.947	0.724

1. ADAMA became part of Syngenta group in 2020

2. Wynca Chemicals was at rank 12th in 2021

3. Sales exclude fertilizers, digital agriculture, seeds, intermediates, etc.

The top four agrochemical companies (Syngenta, Bayer Crop Science, BASF, and Corteva Agriscience) collectively accounted for 55% of total sales. Companies with sales between US$ 5 billion and $1 billion were dominated by generic manufacturers except Sumitomo Chemical, which invests significantly in the research and development pipeline. Notably, Chinese companies earned 43% of total sales. China is a major manufacturer of active chemicals, which are used as raw material to synthesis pesticides. China is also the largest manufacturer and exporter of crop protection products.

The growth of the top 11 pesticide companies in terms of sales over the period 2018 to 2022 is shown in Figure 8 [11,12]. These companies have retained their industry rankings for five consecutive years, which is indicative of their core strengths and stable operations.

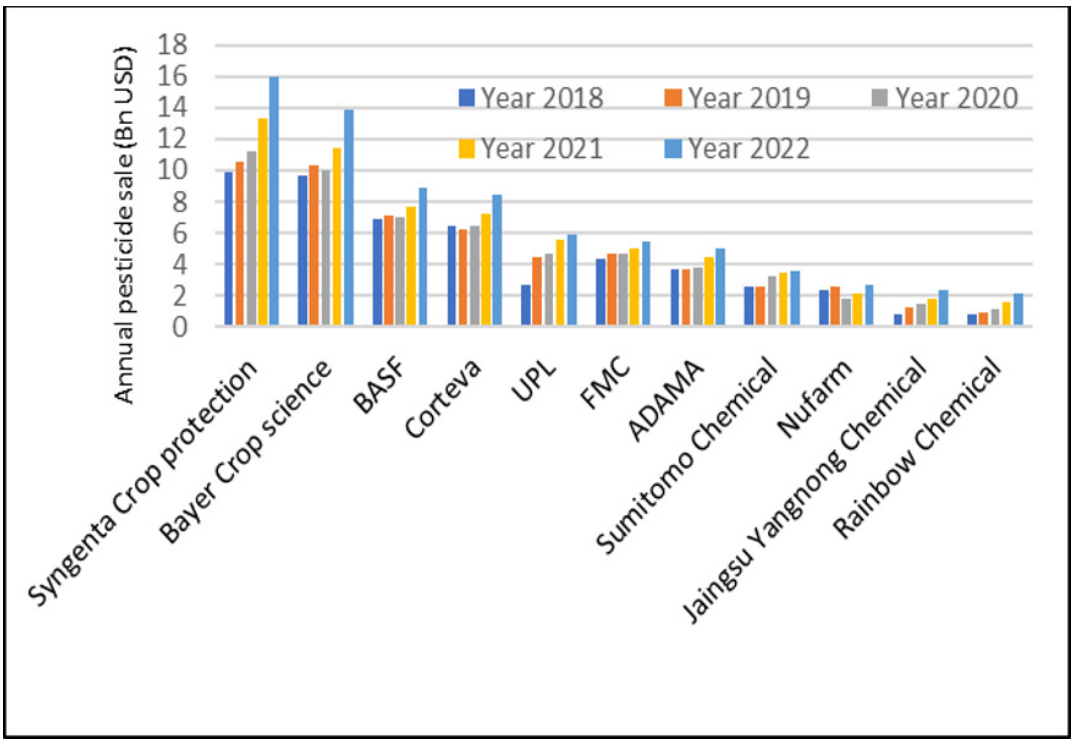


Figure 8: Annual sales of leading pesticide companies

Growth drivers of the industry

The application of fertilizers and pesticides to improve crop production and comply with regulatory guidelines for agriculture stimulates the demand for agrochemicals. The need to produce more food in terms of quality and quantity for the growing global population with the limited arable land is another growth factor. Other aspects spurring demand are discussed in Table 2[13].

Table 2: Growth drivers of the agrochemical industry

Growth driver	Description
Global food demand	Increasing global population demands higher agricultural productivity and more nutritious food.
Crop yield enhancement	Better agrochemicals are needed for yield improvement and crop protection.
Climate change	Changing climate patterns and increased prevalence of pests / diseases require innovative crop protection products.
Sustainable agriculture	Net zero goals can be achieved only by minimizing the environmental impact of operations and reducing chemical residues.
Crop diversification	Cultivation of a wide variety of crops requires specialized agrochemicals to address specific requirements.
Organic farming	Bio-based alternatives are needed to realize organic farming.
Government policies	Emerging safety regulations can be better addressed by developing new chemicals.
Industrialized agriculture	Industrial-scale agriculture operations, especially in emerging economies, is increasing agrochemical consumption.
Genetically modified crops	GM crops, engineered for resistance to pests, etc., increase demand for corresponding crop protection products.
Emerging markets	The adoption of modern farming practices in place of conventional farming drives demand for agrochemicals.
Trading regulations	Global trade in agricultural commodities necessitates the use of agrochemicals that meet quality and yield standards for export.

Given the substantial value of crop protection products in ensuring global food security, there is a need for new crop protection compounds with enhanced properties (the ability to address pesticide resistance, improve yield, and reduce environmental impact). It underscores the pressing need for research and development (R&D) and innovative crop protection measures. It is worth noting that R&D companies, Syngenta, and Bayer Crop Sciences, were in the leaderboard of the crop protection industry in 2021 and 2022 (Table 1). The growth of these enterprises can be attributed to the increased focus on R&D, digital agriculture, and sustainable growth practices.

Agrochemical R&D Overview

The emergence of new insects and diseases, climate change, and pest resistance make existing crop protection products less effective. The discovery of new compounds and formulations is quintessential to profitable crop production and sustainable growth of agrochemical manufacturers.

Figure 9 depicts the agrochemical R&D value chain comprising four broad phases - lead generation, lead optimization, development, and launch. Lead generation and lead optimization are often combined and called the discovery phase.

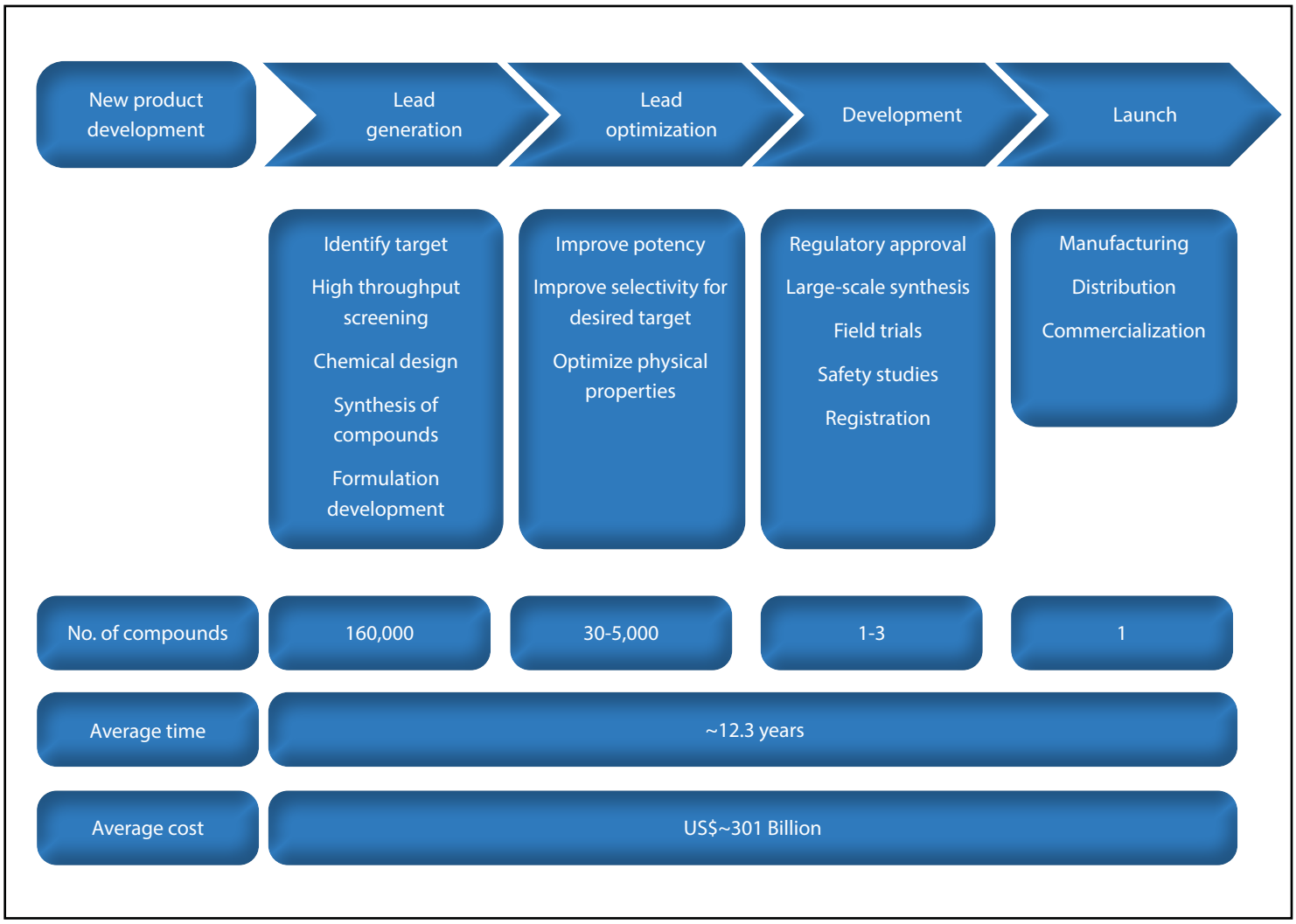


Figure 9: Agrochemical R&D value chain

The discovery and development of agrochemical compounds involves the identification and development of new chemicals that protect crops from various bio-stress factors such as pests, disease, and weeds. This process includes safety, biological, and formulation research. The results of these parallel studies are analyzed prior to regulatory approval for field trials. A compound is registered as an agrochemical only after successful trials and statutory approval. The probability of launching a new product after due clearance is only one in approximately 160,000 compounds.

The cost and time required to develop a crop protection product are increasing year-on-year. The discovery cost for a compound was US$ 152 million in 1995, and time taken was 8.3 years. In 2010-2014, the expense increased to US$ 286 million and time to 11.3 years. The latest survey indicated between 2014 and 2019, the costs associated to bring a new product to markets had increased to US$ 301 million and time taken is 12.3 years.[14] Moreover, the cost of environmental and toxicity studies and field trials in development stage are also increasing.

Challenges in R&D for crop protection

Various aspects increase R&D costs and time-to-market for agrochemical compounds:

Pest resistance

Repeated use of a class of pesticides develops resistance in pests and insects. Over time, the resistant population becomes dominant, which decreases the efficacy of pesticides. It leads to crop damage and yield loss. R&D effort is required to combat resistance, discover novel crop protection molecules and formulations, and develop different modes of action.

Sustainable products

Some agrochemicals used for crop protection and yield enhancement are toxic. The environmental risk of these products should be minimized. Similarly, there is a need to develop pesticides that are effective in extremely low doses. R&D is essential for discovering novel products that reduce environmental burden and promote sustainable agriculture.

Crop protection and yield improvement

R&D investment is essential to introduce new products and improve farming methods to feed the growing human population, which is estimated to be US$ 9.5 billion by 2050.

Regulatory compliance

Stringent safety regulations for both crop and environment management require manufacturers to conduct extensive testing and generate reliable data for regulatory approval of new products. This mandatory process is time- and cost-intensive.

The discovery journey begins with screening of thousands of chemical compounds. Screening helps in identifying potential compounds with the desired pesticidal activity and eliminating those with negative effects. The selection of a compound is made based on various studies such as efficacy testing, toxicological testing, ecotoxicity studies, mode of action, metabolism, formulation, resistance management, and environmental impact assessment. This process is iterative and repeated until compounds with the desired profile are obtained. The effort is discontinued when several iterative cycles turn unsuccessful. The selection process often narrows down to a few or single compound, which is combined with the formulation to form the pesticide formula.

The development phase involves approximately 150 tests[15] to evaluate toxicity in humans, wildlife, and the environment by following procedures defined by regulatory authorities. If any negative effects are observed during the testing process, the formula is either rejected or revised. A pesticide that meets the desired criteria for efficacy, safety and environmental impact is submitted for regulatory approval along with supporting data. After regulatory approval, the pesticide is launched in the market for use in fields. Ten years after market launch, the compound is reevaluated to determine adverse effects on human / animal health or the environment. During this time, agrochemical companies continue to discover more effective and less toxic compounds than its predecessors.

R&D expenditure at leading agrochemical companies

Leading agrochemical companies make huge R&D investments to discover more effective and sustainable products and remain competitive. Crop protection companies invest 7-10% of their annual sales revenue in research and development focused on innovation and product discovery.[16,17] Simultaneously, agrochemical companies are adopting technology solutions to address challenges in R&D – from screening chemical compounds for identifying potential candidates to processing complex data for gleaning insights and making informed decisions.

Harnessing Technology for Crop Protection Product Discovery

Advanced technologies such as data science, artificial intelligence and predictive analytics enable scientists to design compounds, predict efficacy and toxicity, and boost innovation. These technologies accelerate the discovery of novel and effective compounds, while reducing development timelines and costs. Let us understand how the top three agrochemical companies are utilizing emerging technologies in day-to-day research:

Bayer Crop Science

CropKey is a Bayer initiative to transform crop protection R&D by integrating data analytics, artificial intelligence (AI), and computational science[18]. CropKey enhances the identification of target proteins by utilizing computational tools, systems biology, and machine learning / AI algorithms.

In contrast to traditional methods of screening thousands of molecules, CropKey focuses on designing molecules with highly specific properties and safety profiles. These molecules are designed to minimize off-target activity. It ensures sustainability and minimizes the cost of production by leveraging computational tools and AI. Feasibility of synthesis, indication, efficacy, and human safety are considered while designing molecules.

The initiative represents a fundamental change in Bayer's crop protection R&D landscape. Precision molecule design reduces development cost and time-to-market. CropKey has delivered more than 30 molecular targets, out of which 10 are in early-stage research. In addition, five novel modes of action (MoAs) and screening technologies are in an advanced stage of research[19].

Bayer Crop Science is also collaborating with Iktos (a company specialized in artificial intelligence for drug discovery) to expand the use of AI in the discovery and development of new sustainable crop protection products. Bayer is deploying Makya, Iktos' de novo generative design software, to accelerate design of novel molecules with pre-defined profiles, expedited lead generation, and optimized processes[20].

Syngenta

Syngenta Crop Protection is leveraging AI for quicker, economical, and more effective discovery of crop protection and pharmaceutical molecules. Syngenta has entered a multi-year collaboration with Insilico Medicine, a world leader in using AI and deep learning to produce precise chemistry in the pharmaceutical and biotechnology sectors. It will advance the discovery of new crop protection solutions that safeguard crops from diseases, weeds, and pests, while enhancing the ecosystem. This strategic alliance helps Syngenta discover and design molecules while focusing on sustainability[21,22].

BASF

BASF has partnered with Dotmatics to enhance R&D IT infrastructure[23] via the 'Data to Value' project. It applies a 3-step approach to manage data across experiment planning, sample generation, testing, and analysis. The streamlined R&D data management system offers a user-friendly interface for bench chemists and lab technicians to capture data, which improves accessibility to experiment results. At the same time, it allows data scientists to leverage advanced analytics and high-quality data for extracting insights and making decisions.

BASF is collaborating with TECNALIA, a European benchmark research and technological development center, to accelerate R&D in new crop protection products[24].

Conclusion

Emerging technologies empower agrochemical manufacturers to pivot to a design-first discovery approach. Digital solutions address R&D challenges and accelerate the discovery and development of sustainable crop protection products. Robust data management, analytics, computational chemistry, and predictive modeling reduce time-to-market while rationalizing development costs.

Infosys Agrochemical R&D Center of Excellence (CoE)

Infosys has established an Agrochemical R&D CoE to address challenges in the discovery and development of crop protection chemicals. Our solutions optimize research processes, streamline data management, and expedite discovery by capitalizing on predictive analytics, artificial intelligence, simulation, and other advanced technologies. The Infosys CoE offers:

Domain expertise and thought leadership

- Market scan of technology trends in agrochemical R&D
- Collaterals on insights and best practices through publications
- A pool of Subject Matter Experts (SMEs)

Solutions

- Technology-led innovation ideas and conceptual frameworks
- Proof of concept and working model for illustration

Partner ecosystem

- A robust partner ecosystem, including industry partners, start-ups and academia

About the Authors

Aditi Agarwal

Ph.D,

Principal Consultant, Manufacturing Domain Consulting Group, Infosys

Ganesh Shankar

M.Pharm,

Lead Consultant, Manufacturing Domain Consulting Group, Infosys

Manoj Kumar Gupta

Ph.D,

Principal Consultant, Manufacturing Domain Consulting Group, Infosys

Acknowledgements

Kanikka Wadhwa, Lead Consultant, Manufacturing Domain Consulting Group, Infosys

Ashish Thomas, Principal Consultant, Manufacturing Domain Consulting Group, Infosys

References

1. https://www.fao.org/plant-production-protection/about/en
2. Agriculture Development, Pesticide Application and Its Impact on the Environment - PMC (nih.gov)
3. Agrochemical Market Size, Share, Scope, Trends And Forecast 2030 (verifiedmarketreports.com)
4. Agrochemicals Market Size, Share & Growth Report, 2030 (grandviewresearch.com)
5. Agrochemical Market – Growth Potential Forecast, 2023-2030 (psmarketresearch.com)
6. Crop Protection Chemicals Market Size & Industry Share -2032 (gminsights.com)
7. Pesticides use and trade 1990–2021 (fao.org)
8. http://www.fao.org/faostat/en/#data/RP
9. Global pesticide consumption share by region | Statista
10. Pesticide consumption worldwide 2022 | Statista
11. Crop protection companies global revenue ranking | Statista
12. AgroPages-Rankings of Global Top 20 Agrochemical Companies in FY2022-Agricultural news
13. (2) Agrochemical Market Size, Evaluating Share, Trends, and Emerging Growth for 2023-2030 | LinkedIn
14. Time-and-Cost-To-Market-CP-2024.pdf (croplife.org)
15. The Science Behind Pesticide Development - Pesticide Facts
16. Corteva 2023 R&D Innovation Update Highlights and Analysis (upstream.ag)
17. financial-report-2022.pdf (syngenta.com)
18. *Product Development Report.pdf (bayer.com)
19. Highlights and Analysis for the Broader Industry of Bayer's Crop Protection Product Development Report (upstream.ag)
20. Bayer, Iktos Form Collaboration to Expand the Use of AI to Design New Sustainable Crop Protection Solutions - AgriBusiness Global
21. Artificial Intelligence | Syngenta
22. Syngenta Crop Protection and Insilico Medicine to harness artificial intelligence to transform sustainable product innovation | Syngenta
23. Basf-sustainable-agriculture-casestudy.pdf (ctfassets.net)
24. BASF and TECNALIA accelerate R&D of new crop protection products through digitalization

For more information, contact askus@infosys.com

Infosys®
Navigate your next