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Cover Story

Seawin has established an innovation system and market structure in the field of specialty fertilizer fertilizer and synergists, and will continue to deepen its efforts in this field, expanding and strengthening specialty fertilizer business!

Industry Insight

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How to Face Industry Challenges in China and International Fertilizer Market

—— Shan Junwei, Chairman of Qingdao Seawin Biotech Group, Talks about Specialty Fertilizer

New synergistic substances and technologies are continuously improving the potential and competitiveness of fertilizers.

Conventional fertilizers ensure essential nutrients, while synergistic ingredients deliver better application results. Using the well-established channel of conventional fertilizers to drive sales of specialty fertilizer, and using the effects of specialty fertilizers to strengthen the brand position of conventional fertilizers, has become the main strategy for fertilizer enterprises in the market.

So, what is the current market status of biostimulants and specialty fertilizers? What are the methods for improving fertilizer efficiency? What is the future potential for biostimulants and biostimulants-based specialty fertilizer? Let's hear from Shan Junwei, Chairman of Qingdao Seawin Biotech Group.

What is your understanding about efficiency enhancing effect of biostimulants for fertilizer?

Any efficiency enhancement must focus on cost-effectiveness.

Efficiency enhancement, as the name suggests, refers to improve the effectiveness of fertilizers. One method of enhancing efficiency of fertilizer is to add additives during the conventional fertilizer manufacturing process to formulate specialty fertilizer, which represents promising development direction for the future of the fertilizer industry. These additives are synergists, including biostimulants.

The fundamental and critical function of biostimulants is to improve the cost-effectiveness of fertilizers, reduce input costs, and achieve higher output.

Biostimulants improve the crop's utilization rate of fertilizers, increase yield, and improve quality. At the same time, they promote eco-friendly co-development between fertilizers, crops, and soil, contributing to environmental protection.

What is the current status of the Biostimulants market?

It is growing rapidly, but products still need market validation.

Currently, China market for synergists is experiencing explosive growth. On the other hand, this also means that the industry has yet to mature and remains in a phase of uncontrolled expansion. Either the industry standard and labeling need to be further standardized. The market for biostimulants is rapidly expanding, with the global

market may reach $4.03 billion in 2024, and expected to grow to around $9.75 billion by 2032. The domestic market for biostimulants has already exceeded 2.5 billion RMB. Globally, Europe remains the largest market for biostimulant products, while the Asia-Pacific region is growing quickly, and China's market potential is immense. Meanwhile, competition in the global agricultural bioproduct sector is intensifying, accompanied by a surge in R&D enthusiasm worldwide.

There is a wide variety of specialty fertilizers on the market, with quality ranging from excellent to poor, requiring scientific identification. For fertilizer manufacturers, it is crucial to have core technologies and key substances include biostimulants to support their products. Ultimately, the effectiveness of the fertilizers will be tested by the market and determined by customers — high-quality products will endure, while inferior ones will be eliminated — this applies to both specialty fertilizers and biostimulants.

What are the main biostimulants offered by Seawin? What are their advantages?

Driving industry development with high-quality products.

Since its establishment in 2000, Seawin has been deeply engaged in the field of biostimulants and functional Specialty Fertilizer. In the early stages, the company invested significant effort and resources in consumer education, promotion, and demonstrations to raise awareness. This allowed the market to understand the biostimulants such as seaweed polysaccharides, alginic acid, fish protein peptides, and chitosan oligosaccharides and in a certain sense, guiding and promoting the development of this industry.

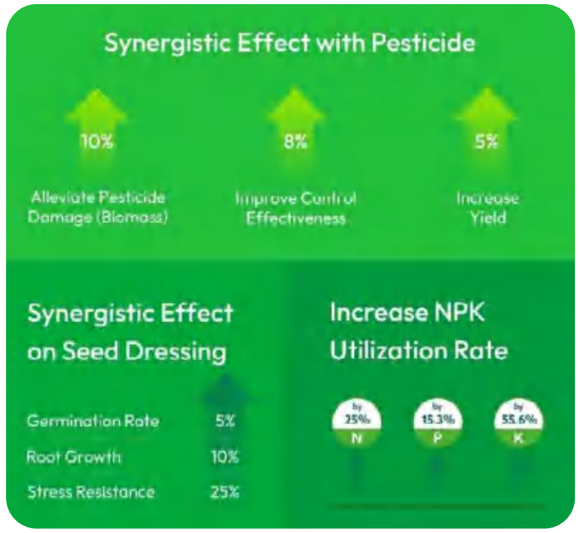
Seawin leverages abundant marine biological resources and leading extraction and biosynthesis technologies to develop a wide range of biostimulants. The Technology Center, through years of applied research, has explored the integration processes and dosage levels of these biostimulants in various types of fertilizers, providing customers with comprehensive product enhancement solutions.

Currently, Seawin has three core synergistic functional factors:

- **SEAD:** Improves the absorption and utilization rate of fertilizers by crops.
- **APAA:** An anti-stress and resistance factor that enhances the crops' tolerance to abiotic stress, promoting growth and stress resistance.
- **GALA:** Primarily targeting cash crops, especially fruits, GALA helps increase sweetness, promote color change, and improve both quality and yield, leading to higher profits.

These prods are not only added to Seawin's specialty fertilizers and sold through distributors, it also involves deep collaboration with well-known industry leaders in China, as well as partnerships with over 60 listed companies, providing product enhancement solutions for more than 200 small and medium-sized enterprises. Over the past decade, the company has driven the production and application of over 10 million tons of specialty fertilizers in the industry, promoting the "dual reduction" of pesticides and chemical fertilizers input, and leading the development of the domestic specialty fertilizer industry. Additionally the products are exported to more than 80 countries and regions worldwide, gaining strong recognition for their efficiency, particularly from leading multinational companies in the industry. As a result, the market share has significantly increased year by year.

These biostimulants are like the "chips" for specialty fertilizers. Seawin uses these "chips" to enhance the effectiveness of partners' products and drive the development of the industry.



How does Seawin develops market and respond to market challenges?

Embracing Market Challenges with Innovation

The method for developing the market is simple: let the product's effectiveness speak for itself. The first step is demonstration, as people need time to accept a new thing. During this process, we consistently use the product for demonstration and follow up with customer visits and technical support. For over 20 years, we have been promoting the products by showcasing its principles, effects, and application demonstrations. We firmly believe that products without effective results have no long-term viability. On the other hand, products that deliver results will always have the power to grow.

At the same time, Seawin focuses on R&D, continuously pursue innovation, and strives to achieve the best product performance, reduce cost to a minimum, and achieve large-scale production. This is the company's approach to responding to market competition.

While these goals sound easy, achieving them requires long-term, substantial investment, making it a very challenging task. Seawin adheres to a long-term perspective and remains persistent in innovation. Seawin's R&D team now exceeds 100 members, including 6 Ph.D.s and over 100 Master's degree holders. The team has established 6 technology platforms and developed 6 core technologies, including the Dual Algae Fermentation and Enzymolysis Coupling Extraction Technology and Core" SE activity product biosynthesis technology.

With 25 years of industry experience, including strengths in innovation, raw material advantage, and intelligent production, we are able to maintain our leadership and growth potential.

In the future, the main innovation and R&D in the synergist industry will focus on the exploration of active substances and the development of synthetic biology, both offering significant room for innovation. Biostimulants are the core of upgrading specialty fertilizers, while synthetic biology serves as the new engine driving innovation and development in the specialty fertilizer sector. Seawin has conducted in-depth research in these two areas. The company leverages the marine biological resources of the Jiaodong Peninsula to develop new extraction products. In synthetic biology, Seawin has also established close collaborations with many experts from academic and research institutions and has already achieved industrial-scale development. For example, Seawin's biosynthetic product, APAA. APAA is a polymerized glutamic acid rhamnolipid prepared using integrated biosynthesis technology. The carboxyl group of glutamic acid reacts in a directional manner with the hydroxyl group at the C-2 or C-3 position of rhamnose sulfate to form an ester bond. It is then polymerized through intermolecular crosslinking to form a novel multi-functional biopolymer with a network macromolecular structure, realizing the integration and enhancement of the functions of algal polysaccharides and polyglutamic acid, resulting in a new generation of marine biostimulants. The product has now reached large-scale production and sales.

Seawin has established an innovation system and market structure in the field of specialty fertilizer fertilizer and synergists, and will continue to deepen its efforts in this field, expanding and strengthening specialty fertilizer business! AP

2024 Global Crop Protection Market Review and 2025 Outlook

By Derek Oliphant
Partner & Senior Crop Protection Analyst, AgbioInvestor

This report provides AgbioInvestor's preliminary assessment of the global crop protection market in 2024. This represents estimated sales of products at the ex-manufacturer level, i.e. product moving from manufacturers into the first stage of distribution, but expressed at the ex-manufacturer value as used on the ground in the specific agricultural year. Unless otherwise specified, values are expressed in US dollars, with currency conversion using average year exchange rates.

Table 1: Global Agrochemical Market Value ($m.)

Year	Crop Protection	Non-Crop	Total Agrochemical	Agrochemical YOY Change (%)
2013	58,886	6,404	65,290	6.9
2014	61,885	6,491	68,376	4.7
2015	56,867	6,237	63,104	-7.7
2016	55,869	6,458	62,327	-1.2
2017	56,355	6,568	62,923	1.0
2018	58,165	6,916	65,081	3.4
2019	59,279	7,130	66,409	2.0
2020	60,769	7,191	67,960	2.3
2021	65,775	7,644	73,419	8.0
2022	74,755	8,014	82,769	12.7
2023	74,860	7,985	82,845	0.1
2024P	70,061	7,134	77,195	-6.4

Note: 2024P signifies preliminary market data representing AgbioInvestor's understanding as of January 2025

As shown in table 1, our preliminary view of the global agrochemical market in 2024 reflects a year-on-year decline of 6.4% to $70,061 million, the first year-on-year decline in value terms since 2016. The chart below outlines the impact of volume, price, and currency on market development in recent years:

Crop Protection Market Development: Volume/ Price/Currency Impacts

In 2024, AgbioInvestor estimates that the volume of crop protection products applied declined by 3.4% compared to the prior year, largely impacted by unfavourable weather conditions in certain markets, affecting Asia, parts of South America, and key cereal growing regions of Europe in particular.

Prices declined for the second consecutive year, with low ex-factory prices from China impacting southern hemisphere country markets in this crop year. Generally high inventory levels also had a dampening effect on prices.

The Global Crop Protection Market 2024

The most significant factors which affected crop protection market performance in 2024 were:

- Low agrochemical prices, with significant effects felt in southern hemisphere in 2024 (ag year Jul 2023 – Jun 2024).
- Lower maize areas in the key markets of the US and Brazil.
- Unfavourable ag economics (high cost of borrowing, declining commodity prices, high input costs).
- Unfavourable weather conditions had significant impacts in several key crop and country markets:
  - Winter cereals in Europe.
  - Brazil soybean crop impacted by unfavourable weather conditions in southern regions, delaying harvest.
  - Erratic monsoon in India.
  - Hot and dry conditions in Australia and China.
  - Poor weather in Russia required significant areas to be replanted.
- High inventories in most regions holding back price improvement and affecting producers/suppliers of crop protection products.

Indications from available data suggest that the value of the herbicides market is continuing to be impacted by very low prices for key products, notably the widely used non-selectives glyphosate and glufosinate. These price declines were also felt in the southern hemisphere, where the prior ag year had not been as badly affected due to seasonal timings of application.

For insecticides, low pest pressure in key markets, notably India, is expected to have held back growth; however, pest pressure in China was

Table 2: Regional Crop Protection Market Performance 2024: Preliminary Estimate

Region	2023	2024P	Nominal Change (%)	Constant Dollar Change* (%)
North America	12,379	11,702	−5.5	−5.4
Central & South America	24,995	23,233	−7.0	−8.4
Asia Pacific	20,327	18,916	−6.9	−4.1
Europe	14,433	13,726	−4.9	−4.3
Middle East / Africa	2,673	2,484	−7.1	−0.5
World	**74,807**	70,061	−6.3	−5.7

*2023 baseline

reported at high levels. The higher soybean area in Brazil, a significant market for insecticides, is also expected to have benefited the sector. In Argentina, the confirmed presence of African leafhopper, which can act as a vector for the pathogen responsible for corn stunt disease, may have boosted insecticide use as growers attempt to limit the impacts to yield.

Dry conditions in areas of Brazil are expected to have limited disease pressure, whilst unfavourable weather conditions in much of the key cereal producing regions in Europe is also a negative for the development of the fungicides market.

Crop Protection Overview and 2025 Outlook

The crop protection market experienced a sharp decline in value terms in 2024, impacted by the continuing effects of low agrochemical prices, unfavourable agricultural economics based on low commodity prices and high input costs, lower areas of key crops in certain markets (notably US and Brazil maize), and unfavourable weather conditions in several key regions, including cereal areas in Europe and large parts of Asia Pacific.

However, the market in 2025 can be expected to be more favourable, with agrochemical prices stabilising and improved weather conditions in Europe, Asia, and Brazil. It can be expected that company performance in 2025 will benefit from a more stable inventory situation, with company sales in recent years being hampered by high supplies in many regions.

The key factors behind the assumptions for a more stable market in 2025 are:

- Stable agrochemical prices.
- Improved weather conditions (Europe, Asia, Brazil).
- Higher maize area in US and soybean area in Brazil.
- Normalisation of inventory levels, particularly in North America and Europe.
- Continued growth from recent, novel active ingredient introductions.

North America

- Challenging farm economics
  - Low commodity prices
  - Difficulty in accessing credit
  - High cost of debt
- Improving inventory situation, switch to just-in-time purchasing
- Higher maize, area in US, but reduction for soybean
- Increased wheat area in Canada.
- Expectations for higher canola area in Canada to meet high crushing demand.

Central & South America

- Total planted area in Brazil expected to be up by 1.8%
  - Soybean area up by 2.6%, although slight decline expected for maize.
  - Maize production expected to rebound from effects of delayed safrinha crop last year when weather impacted the soybean harvest.
- Agrochemical pricing remains low, but worst effects of recent declines expected to be over.
- Brazil continues to benefit from position as preferred supplier of key crop commodities to China.

Asia Pacific

- Continuing to be hampered by low agrochemical pricing.
- Improved weather conditions in key markets expected to benefit market, notably India.
- Continued expansion in developing markets.

A recent decision by the European Parliament to reject maximum residue levels for crop protection active ingredients currently banned for use in the EU could also benefit market development in countries where produce is exported to the EU, including in Asia Pacific. This could shift product usage away from older low-cost active ingredients, such as mancozeb and chlorpyrifos, as well as recent examples such as cyproconazole and spirodiclofen, to EU-approved active ingredients, potentially to the overall benefit of market value as it will often be the case that replacement of a banned active ingredient will occur with a newer, typically higher priced, alternative.

Europe

- Improved weather conditions in key cereal growing regions.
- Weather-impacted output in 2024 can be expected to limit crop availability and provide solidity to crop commodity prices going forward.
- Declining agrochemical pricing a negative, although the impacts in Europe are less than in many other regions.
  - Costs in Europe have been affected by a myriad of factors, primarily high energy costs.
- Further growth from new product introductions, including:
  - Bixlozone – novel mode of action for grass weed control in cereals
  - Cinmethylin – novel mode of action for cereals, including control of resistant blackgrass.
  - Mefentrifluconazole – first isopropanol-azole, effective against triazole resistant diseases, including Septoria in wheat.
  - Fenpicoxamid – picolinamide fungicide derived from natural compound, introduced in cereals and fruit & vegetables.

Middle East & Africa

Recent decision by the European Parliament to reject maximum residue levels for crop protection active ingredients currently banned for use in the EU could benefit market development in many African countries, where crop production for export to the EU is widespread. This could shift product usage away from older low-cost active ingredients to EU-approved active ingredients, potentially to the overall benefit of market value. This also makes African markets potential targets for new product introductions, e.g. BASF recently launched the new insecticide Cimegra SC (broflanilide) in Zambia for the control of fall armyworm in maize.

Recently developing La Niña conditions are expected to lead to below-average rainfall in eastern East Africa. Conversely, above-average rainfall would be more likely in Southern Africa. AP

M&As in 2024 Crop Protection Industry: Regional Deep Cultivation, Channel Transformation, and Technological Upgrade

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Editor's Note: M&A in the global crop protection industry in 2024 is characterized by regional market commitment, accelerated channel integration, technological innovation, and upgrading. From a regional layout perspective, the markets of Brazil, Oceania, and Southeast Asia became hot regions of mergers and acquisitions, where a number of blockbuster M&A deals facilitated the reshaping of the market structure. Multinational agrochemical giants continued their intensive market layout via the acquisition of local distributors, whilst local leading companies expanded market share to enhance competitiveness through integration and consolidation. The integration of distribution channels became a focus of mergers and acquisitions, and many companies strengthened the setup of sales networks through acquisition. At the same time, enterprises focused on the enhancement of technological innovation capability through mergers and acquisitions, which helped to gain valuable R&D capability and patent portfolio.

These M&A activities are driving profound changes in the industry landscape, not only increasing market concentration but also facilitating the improvement of service and optimization of the supply chain. Looking ahead, in the circumstances of globalization and regionalization, and while digital and precision farming is emerging, mergers and acquisitions in the crop protection industry are expected to be continuously active. Via mergers and acquisitions, enterprises will gain more technical resources and market share to promote the sustainable development of the industry.

M&A highlights

Distinctive regional deep cultivation

In 2024, agrochemical mergers and acquisitions revealed characteristics of regional deep cultivation, demonstrating a strengthened market layout made by a number of enterprises in key markets via mergers and acquisitions.

As one of the world's largest agrochemical markets, Brazil continued to attract industry giants' M&A investments. Nutrien launched its unified new brand, Agroessence, via the acquisition of two traditional input distributors, Casal and Cultive, having assembled more than 2,500 resellers. This initiative aims to present a nationwide agricultural distribution network to better serve the Brazilian market and promote innovative and sustainable development of the industry.

Syngenta further expanded its presence in Brazil by acquiring an agricultural inputs distributor.This is Syngenta's fourth distributor acquisition in Brazil in three years, demonstrating its continued commitment to the Brazilian market.

In the Ocean market, mergers and acquisitions are occurring at an accelerating pace. The Australian agri-services giant Elders further strengthened its market leadership with the acquisition of Delta Agribusiness, which cost AUD475 million. Delta operates its business through 68 locations, serving approximately 40 independent wholesale customers and having annual revenues of AUD835 million. The acquisition is expected to significantly strengthen the presence of Elders in key regions such as New South Wales and northwestern Victoria.

Also, the market layout in Southeast Asia is constantly being perfected. India's UPL completed the acquisition of the remaining 20% stakes in the Indonesian PT Excel, having achieved complete control of PT Excel. This acquisition enabled UPL's more autonomous operation in Indonesia, which laid a solid foundation for its strategic expansion in Southeast Asia. PT Excel has a broad distribution network in Indonesia, operating in the distribution of agrochemicals, seeds, fumigants, and fertilizers.

Integration of distribution channels becoming a focus of M&A

The integration of distribution channels is another highlight of agrochemical M&A in 2024. Sipcam Oxon's acquisition of New Zealand-based Grosafe Chemicals is a significant expansion of the distribution network in the Asia-Pacific region. For nearly three decades, Grosafe has consistently provided high-value-added solutions to New Zealand agriculture, with a stable customer base and a well-established distribution system. Also, Grupo Duwest's acquisition of Syngenta's GRAMOXONE business is eye-catching, which enabled the acquisition of paraquat-related assets in 11 countries, including Mexico and Guatemala, covering a number of well-known trademarks, registrations, and related intellectual property rights. The acquisition strengthened Grupo Duwest's market leadership in the Central American market.

The consolidation process of local companies is also accelerating. The U.S. agricultural inputs distributor CHS and West Central Ag Services executed an M&A letter of intent, aiming to provide better service to customers with the complementary advantages of each other. This cooperation will help optimize the efficiency of the supply chain and enhance market competitiveness. Another U.S. agri-dealer, GROWMARK, acquired the agrochemical manufacturer AgraForm, gaining expertise in agrochemical processing covering spray drying, grinding, packaging, and storing. This vertical integration is destined to lead to the optimization of GROWMARK'S supply chain management.

Technological innovation and R&D integration

Part of the M&A cases reflected the importance of technological innovation and R&D capability. Best Agrolife acquired the Indian Sudarshan Farm Chemicals, gaining access to the latter's strong R&D capability and extensive intellectual property portfolio. It is worth mentioning that SFCL is an established name in the field of agrochemicals and innovative process chemistries, with an IP portfolio of 10 patents (applied). These technological assets are expected to significantly enhance Best Agrolife's innovation capability.

UPL acquired Corteva Agriscience's global mancozeb business, having obtained a complete regulatory, scientific dossier of mancozeb and the Rainshield™ technology. This acquisition not only expanded UPL's product portfolio but also enhanced the company's multi-site fungicidal technology.

Furthermore, Rainbow completed the acquisition of an agrochemical formulation plant in Texas, USA, which further expanded Rainbow's production layout in the North American market, reflecting its strategic planning of high-end agrochemical formulation production.

Impact of M&As

Further increase in market concentration

M&A in 2024 significantly increased the market concentration of the crop protection industry. Multinational agrochemical giants further strengthened their leadership position in the global market by acquiring regional leaders or emerging high-tech enterprises. For example, UPL's acquisition of PT Excel and Syngenta's acquisition of Produtécnica significantly strengthened corporate competitiveness in the target markets. This kind of increased market concentration helps to optimize resource allocation and improve the overall efficiency of the industry, which, however, may also lead to intensified market competition, causing more significant pressure on the survival of small and medium-sized enterprises.

Acceleration of technological innovation and product upgrading

M&A activities brought new technical resources and innovation impetus to the crop protection industry. By combining the technological strength of both sides, enterprises are able to launch new products more quickly. For example, Best Agrolife acquired 10 patents and a strong R&D capability through the acquisition of Sudarshan Farm Chemicals, which includes the planned development of a more cost-competitive generic molecular technical route. Moreover, Sipcam Oxon could further strengthen

its technological capability in the field of biostimulants and biologics with the acquisition of Grosafe Chemicals. The acceleration of technological innovation and product upgrading are destined to promote the development of the crop protection industry in a more efficient and environment-friendly direction.

Synergistic effect of industry integration and collaboration

The integration and synergy of regional enterprises were another feature of mergers and acquisitions in the field of crop protection in 2024. Through mergers and acquisitions, enterprises can achieve optimal allocation of resources and improve operational efficiency and service capability. For example, Elders' acquisition of Delta Agribusiness not only strengthened its market presence in Australia's agricultural service sector but also further enhanced Elders' service capacity and market competitiveness by integrating the technology and resources of both sides. Industry integration and synergy will help improve the overall efficiency and service quality of the crop protection industry and promote sustainable development.

M&A Trending

Coexistence of globalization and regionalization

In the future, the crop protection industry will continue to exhibit the development trend of globalization and regionalization. Multinational agrochemical giants will continue the expansion of global market share through mergers and acquisitions as well as the establishment of strategic partnerships, especially in emerging markets. For example, UPL's acquisition of PT Excel deepened its strategic presence in the Southeast Asian market. Meanwhile, regional enterprises are prepared to enhance market competitiveness in the local market through consolidation and synergy. For example, Elders acquired Delta Agribusiness to strengthen its leading position in the Australian agricultural service sector further.

Technological innovation and sustainable development

With the increased global attention to environmental protection and sustainable development, the crop protection industry is increasingly targeting technological innovation and sustainable development. To this end, enterprises are obliged to acquire advanced technologies through mergers and acquisitions to develop more environment-friendly and efficient crop protection products. For example, Sipcam Oxon acquired Grosafe Chemicals to strengthen further its technological capability in the field of biostimulants and biologics. Moreover, Rainbow acquired a U.S. formulation plant to further expand its business layout in the North American market, reflecting its strategic planning of manufacturing high-end agrochemical formulations.

Digitalization and precision farming

Digitalization and precision farming have become essential directions for the development of crop protection. Enterprises are bound to acquire advanced digital technology and precision farming solutions through mergers and acquisitions to enhance their core competence in agrotechnology. For example, Elders acquired Delta Agribusiness to further strengthen its capabilities in agrotechnology and precision farming. Also, via the merger of Casal and Cultive, Nutrien launched the Agroessence brand, which is meant to bring advanced agricultural technologies to farmers across the country, especially to small and medium-sized growers, to ensure their access to professional technical aid. AP

M&As in 2024 Biological Industry: Empowering Industry Upgrading and Reshaping

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Editor's Note: Mergers and acquisitions (M&As) in the agricultural biological industry in 2024 were exciting, revealing diverse and distinct trends. These M&As not only profoundly impact the involved companies but also bring about strong momentum for the development of the whole industry. Through technological innovation, market expansion, resource integration, and sustainable development, agricultural biological is moving towards a more efficient, environment-friendly, and innovative direction of growth.

With the industry's continuous development, M&As are expected to continue to be an essential driver of enterprises' strategic development and promotion of industry transformation, which will create more opportunities for the sustainable development of global agriculture. This article analyzes the typical M&A cases in 2024 to explore their highlights, their positive role in promoting growth, and the future trends of agricultural biological.

M&A highlights: Multi-dimensional perspectives, such as technological innovation, market expansion, industry chain synergy, and strategic layout

Technological innovation and resource integration: Key driver to industry upgrading

Technological innovation and resource integration became key drivers for mergers and acquisitions in the agricultural biological market in 2024. For example, the agricultural humic solutions leader, Huma®, Inc., acquired the granular fertilizer company Gro-Power, Inc. The acquisition not only led to the integration of granular fertilizer and soil conditioner products but also resulted in an increase in soil fertility and crop health via the Micro Carbon Technology®. Similarly, Lesaffre, a key global player in the field of fermentation and microorganisms, acquired Altar, a French start-up specializing in Adaptive Laboratory Evolution (ALE), boosting Lesaffre's capacity for innovation in fermentation and microorganisms.

Certis Biologicals acquired multiple assets from AgBiome, including consequential and market-tested fungicides Howler® and Theia®. The acquisition is not only a complementation to the product portfolio of Certis Biologicals to expand the provision of total solutions to greenhouse, specialty, and large-acreage crops but is also an enhancement of the company's innovation capability for agriculture. Furthermore, Ginkgo Bioworks acquired AgBiome's platform assets, including over 115,000 fully sequenced and isolated strains and over 500 million unique gene sequences. These assets further expanded Ginkgo's innovation capability in the development of agricultural biotechnology, which not only accelerates the process of new product development but also provides a rich resource for the development of AI models for biological R&D.

These M&A cases indicate that through M&As, enterprises can quickly acquire key technologies and speed up technological innovation to provide customers with more efficient and environment-friendly total solutions.

Market expansion and regional layout: Speeding up global market penetration

Market expansion and regional layout became important means for enterprises to enhance core competence. Israel Chemical (ICL) acquired Nitro 1000, a Brazilian biological manufacturer, developer, and provider. The acquisition further strengthened ICL's market position in South America and reinforced its market presence in Brazil, as supported by the Nitro 1000 product portfolio. Andermatt Group, a biocontrol company, accelerated its global market expansion and regional presence through a series of strategic acquisitions, having successively acquired BioTEPP in Canada, 80% stakes in the Argentinian biocontrol and agrotechnology provider Agricheck Srl and Entocare C.V., a Dutch natural enemy beneficial insect company, so as to accelerate the global market expansion. These acquisitions consolidated Andermatt's leading position in biological crop protection and expanded its biocontrol technologies and services. Andermatt stresses that building a complementary product system covering the entire life cycle of pests and diseases will help growers achieve sustainable, high-standard control and high return on investment.

The French Eléphant Vert acquired all shares of BIO3G, demonstrating its strategy to accelerate global market penetration. With this acquisition, Eléphant Vert could utilize its essential market in Africa and BIO3G's network in Europe to complement its product portfolio and geographic region, thus further expanding its market influence in the biological market of Europe and Africa.

Moreover, Indian PI Industries acquired Plant Health Care (PHC), a novel hairpin-derived peptide high-tech enterprise, to accelerate global market expansion. The acquisition enables PI Industries to combine PHC's core expertise in plant immune induction to promote the integrated development of biologicals and innovative chemicals while providing PHC with broader distribution channels and approaches to business expansion.

Industry chain integration and synergy: Enhancing comprehensive service capability

The integration and synergy of the industry chain became a key factor in the promotion of corporate development. MustGrow Biological acquired NexusBioAg, a Canadian biological supplier. Upon completion of the acquisition, MustGrow will become a fully integrated provider of biological and regenerative agriculture

solutions with a sales, marketing, and distribution division in Canada. The NexusBioAg sales and marketing team would bring extensive experience in the biological and regenerative agriculture sector to facilitate the marketing of MustGrows products and third parties while reducing the cost of distribution, which enables the achievement of a synergistic effect.

Nutrien Ag Solutions acquired Suncor Energy's biocontrol technology, which not only enriches its product portfolio but also enhances, via technical collaboration, its competitiveness and service capability in the biocontrol sector.

Furthermore, Sustainable Agro Solutions acquired Pevesa Agroscience, a plant-based biostimulant and fertilizer producer, to achieve vertical integration of a strategic raw material (natural plant-derived amino acids), further enhancing its competitiveness in the biostimulant sector. These cases revealed the importance of mergers and acquisitions to allow enterprises to consolidate the upstream and downstream industry chain, which optimizes resource allocation and improves operational efficiency to provide customers with more comprehensive solutions.

Corporate strategy and long-term development: Paving the way for future growth

Corporate strategy and long-term development became important considerations in mergers and acquisitions. Ginkgo Bioworks' acquisition of AgBiome's platform assets not only gave it access to a wealth of strain and gene sequence resources but also significantly enhanced its competitiveness in agricultural biotechnology via the integration of its R&D capabilities. PI Industries acquired PHC to further improve its business presence in the biopesticide sector via the integration of PHC's peptide technology.

These cases demonstrate that M&A is not only an enterprise's short-term strategy but also an important measure to lay the foundation for long-term future development. By integrating resources and technologies, enterprises are better positioned to respond to future market challenges and achieve sustainable growth.

Impact of M&As: Injecting new vigor into the biological industry and starting up a new engine of development

M&A has a positive impact on the agriculture biological industry in many ways. First, by integrating technical resources and increasing R&D spending, enterprises can accelerate technological innovation and new product development, improving the industry's overall technical level. For instance, Ginkgo Bioworks' acquisition of AgBiome's assets could provide abundant data and strains for AI model development, which is expected to achieve major technical breakthroughs.

Secondly, mergers and acquisitions can optimize the market structure and resource allocation, helping enterprises achieve scale expansion, eliminate outdated production capacity, and regulate market operation in a more orderly manner while improving the efficiency of resource utilization and promoting the healthy development of the industry. In addition, many M&A cases focused on the development of environment-friendly and sustainable agricultural biological, which facilitate the green transformation of agricultural production to meet consumer demand for healthy food and the requirement of protection of the ecological environment.

Lastly, through the integration of technology, markets, and resources, enterprises are continuously improving their comprehensive strength, optimizing products and services, and strengthening brand development. Thus, production efficiency, product quality, and service within the entire industry are improving, which helps enhance global competitiveness.

M&A trending: Reshaping industry future via technological innovation, diversified layout, and sustainable development

From the M&A cases at present, it is not difficult to find that most companies have been accelerating development and transformation via various strategic initiatives. On the one hand, enterprises can achieve diversification of product portfolio and expansion of the market through mergers and acquisitions, which are brought into new markets or new market segments using the competitive market channel and customer resources of the acquired company. Meanwhile, on the other hand, technology-driven innovation becomes a new driver to future development, where enterprises consolidate technical resources to accelerate research and development of new products so as to promote technological innovation and technical breakthroughs within the industry.

The idea of sustainable development prevails over the whole process of mergers and acquisitions when enterprises follow the global trend of sustainable agriculture, develop environment-friendly biologicals, and reduce the use of chemical pesticides to contribute to the achievement of ecological balance and soil health. Besides, there is a noticeable trend of integration of the industry chain, where enterprises are optimizing the production processes through vertical integration, cost reduction, and improvement of supply stability to enhance their voice and competitiveness in the industry chain.

These M&A trends have not only promoted the development of an enterprise itself but have also enhanced the competitiveness and sustainable development capacity of the entire industry, paving the way for reshaping the market structure in the future. AP

Collaborations in 2024 Crop Protection Industry: Multi-dimensional Collaborations, Leading New Trends of Technology, Market and Green Development

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Editor's Note: In 2024, collaboration in the crop protection industry showed multidimensional trends of development, such as technological innovation, market expansion, green crop protection, and sustainable development, intensified strategic alliance and resource integration, digital transformation, and intelligent services.

The collaboration promotes the upgrading of crop protection technology and global market layout and injects new impetus into the sustainable development of the crop protection industry.

In the future, with the further development of technology and the changes in market demand, collaboration within the crop protection industry will become more intensified, and the mode of cooperation become more diversified. Enterprises ought to seize the opportunities to enhance competitiveness and tackle the challenges facing global agriculture via strategic collaboration and resource integration.

Diversified mode of collaboration

Collaboration in technological research and innovation

In 2024, collaboration in technological innovation in the agrochemical industry showed a satisfactory and accelerated development trend. Through in-depth collaboration with technology companies, biotechnology enterprises, and scientific research institutions, agrochemical enterprises could significantly accelerate the research, development, and application of novel crop protection products.

Syngenta's partnership with Enko, an AI-powered crop health company, has dramatically shortened the cycle of the development of novel herbicides with the help of AI and machine learning. This mode of collaboration not only improves R&D efficiency but also reduces R&D costs, enabling companies to bring innovative products to markets faster. Also, Evogene, a leading computational biology company, reached a collaboration with Google Cloud to develop a cutting-edge foundation model for generative small molecules. Evogene is planning the use of the ChemPass AI tech engine to develop novel compounds for drug development, sustainable crop protection, and other innovative products across a wide range of life-science industries.

AgPlenus, a subsidiary of Evogene, signed a collaboration agreement with Bayer to develop a novel sustainable herbicide that targets APTH1 protein using the ChemPass AI platform, where Bayer is responsible for product testing and optimization, as backed up by its exclusive license for commercialization. Working together, the two sides are committed to accelerated delivery of economical and

sustainable solutions to farmers. In addition, AgPlenus collaborated with Corteva to develop a new molecule with the brand-new herbicidal mechanism APCO-1, aiming to fix the issue of weed resistance and provide innovative solutions to global agricultural production. The collaboration between British Moa Technology and Nufarm has focused on the co-development of herbicides of a new mode of action, opening up a new approach to solving the problem of weed resistance.

The above shows that the application of AI, machine learning, and biotechnology not only significantly improves the efficiency of R&D but also provides new ideas for solving problems in conventional crop protection. This trend indicates that technological innovation will become the crop protection industry's core competence in the future. At the same time, cross-industry collaboration is undoubtedly the key path to achieving core competence.

Market expansion and channel collaboration

In the global crop protection industry, market expansion and channel collaboration have become key strategies for enterprises to enhance competitiveness and expand market share. By establishing cooperative relationships with professional partners or local companies, enterprises will not only quickly access new target markets or expand their influence in target markets but also optimize product layout, improve market penetration, and achieve mutual benefit on a win-win basis, with the help of partners' resources and channel advantage.

Sipcam Nichino Brazil formed a partnership with the Brazilian market access specialist M2M Agro to strengthen its market access strategy for products such as herbicides, fungicides, and pesticides for sugarcane. Sino-Agri has become Nanjing Redsun's exclusive agent for the distribution of diquat dibromide in the Brazilian market. The two sides are deepening their collaboration to grow the Brazilian market and establish a standardized channel system.

Belchim Crop Protection USA and Sipcam Agro USA announced a partnership, which enables Belchim USA to exclusively acquire and sell Sipcam Agro's fungicide Minerva in the US market to promote the product for application to the U.S. sugar beet. The U.S. agrochemical company ExcelAg and Caribbean Chemicals, a Caribbean-based agricultural input distributor, reached a partnership to provide Caribbean agriculture with more innovative and environment-friendly planting solutions, which will enhance the sustainability of local agriculture.

The British Pangaea Biosciences announced an exclusive agreement with MILAGRO sp. z o.o. to distribute Booster™ in Poland; soon afterward, Pangaea Biosciences signed a new exclusive agreement with ODOX EU, JSC, under which ODOX EU, JSC is designated to sell all its products, including Booster™, in the Baltic and Scandinavia.

UPL's partnership with Nantong CAC International enabled the promotion of cyproflanilide to more than 40 countries, which has optimized its product portfolio. This collaboration combines the product and technology strengths of both sides, leading to the achievement of mutual benefit via a synergistic effect. UPL has become an exclusive distributor of Synthesia Chemi for distribution in the Russian market, which is a consolidation of its product portfolio, optimization of product range, and marketing in the Russian agrochemical market.

Sino-Agri reached a strategic collaboration with KingAgroot to launch the patented novel herbicide Jingjinkaili. The partnership integrates the superior resources of both parties, bringing about mutual benefit and a win-win result.

The US Aqua-Yield has partnered with WestLink Ag Group to distribute all company products through WestLink's 42 retail outlets, expanding market coverage and increasing product credibility.

In the future, with the further integration of the global market, crop protection companies ought to optimize worldwide resource allocation and enhance market competitiveness to cope with the increasingly intensified market competition.

Corporate strategy and resource integration

Through strategic collaboration and resource integration, enterprises are optimizing supply chain management to enhance market competitiveness. For example, UPL has partnered with Aarti Industries to set up a joint venture for the supply of specialty chemicals, supported by the two parties' combined strengths in product and technology. This collaboration not only optimizes the allocation of resources but also enables mutual benefit and win-win results through synergies.

Similarly, Nichino America signed a cross-licensing agreement with Sipcam Agro, whereby Nichino obtained the distribution rights for Sipcam's fungicide Eject® while Sipcam obtained early access to Nichino's acaricide/insecticide Fenpyroximate 5SC/5EC (fenpyroximate). The cross-licensing allows the two parties to optimize their product portfolio and enhance market competitiveness. This kind of collaboration not only optimizes the two parties' product portfolios but also enhances their market competitiveness.

In Brazil, UPL and Bungay established the joint venture Sinova, a new agricultural materials distributor. This initiative fully reflects the importance of corporate strategy development and resource integration, aiming to optimize the operation process and further enhance market competitiveness via resource integration and strategic adjustment.

In addition, Clariant's collaboration with Red River Specialties and Ferrar Quimica expanded its distribution network in the American agricultural sector. By partnering with local distributors, Clariant is able to better serve the American market and improve customer satisfaction.

Emerging technologies and collaboration with research institutions

In 2024, the mode of collaboration in the crop protection industry continued to be innovative, expanding from conventional to emerging technologies and industry partnerships. In-depth collaboration between enterprises and scientific research institutions has become a new driving force for promoting industry development.

For example, Binnong Technology and BASF collaborate in various fields, including technology research and development, market development, and supply chain management. This kind of collaboration enhances the technical strength of the enterprises, optimizes the market layout, and enhances their overall competitiveness.

Syngenta reached a strategic partnership with the Hunan Academy of Agricultural Sciences on the research and development of tetflupyrolimet, which is of help to the promotion of the sustainable development of modern agriculture in China. Furthermore, Pilarquim has cooperated with Nankai University in the development of nano-pesticide technology, which improves the efficiency and environmental benefit of pesticide applications by reducing use amount and increasing efficiency. The application of this technology not only promotes the green transformation of crop protection but also creates a new source of growth for the industry.

These modes of collaboration demonstrate that integrating enterprises with scientific research institutions will facilitate the acceleration of technological innovation and market expansion, optimization of product portfolio, and enhancement of market competitiveness of enterprises. Going forward, with the deepening of collaboration between agrochemical enterprises and scientific research institutions, the crop protection industry is expected to usher in more opportunities for development.

Green crop protection and sustainable development

With the worldwide concern and emphasis on environmental protection and sustainable development, green crop protection technology has become an important direction of development of the crop protection industry. For example, Syngenta has partnered with Chengdu New Sun to promote the novel biological-chemical integrated crop protection technology, having developed the environment-friendly natural brassin lactone – Yishiban, etc. This collaboration not only falls in line with the sustainable development trend of global agriculture but also provides a new direction for the development of the crop protection industry.

Furthermore, MagrowTec has collaborated with Certis Belchim to combine precision spraying technology with biological products, promoting sustainable agriculture development. This mode of collaboration not only improves the efficiency of pesticide use but also reduces the impact on the environment. Going forward, green crop protection and sustainable development are sure to become essential trends in the crop protection industry, which will promote the industry's growth in a more environmentally friendly and efficient way.

Impact of collaboration and future trends

In 2024, the multidimensional collaboration model in the crop protection industry had a far-reaching impact. It greatly promoted technological innovation, market expansion, green transformation, and resource integration, injecting new impetus into the industry's sustainable development.

Technological innovation and cross-industry integration

The collaboration has significantly improved the R&D efficiency and innovation ability of the crop protection industry. The wide application of AI, big data, and biotechnology has extensively promoted the development of pest and disease prediction, precision farming, and green crop protection technologies. Through in-depth collaboration with technology companies, biotech companies, and scientific research institutions, the agrochemical enterprises have not only accelerated the process of product research and development but have also reduced the cost of operation, which is a contribution to the promotion of the green transformation of the industry.

Going forward, AI and big data technologies will play a more significant role in pest and disease prediction, precision farming, and product optimization. Biotechnologies such as gene editing and microbiomes are expected to facilitate the development of more environment-friendly and efficient crop protection products. The cross-industry collaboration will be further deepened as crop protection enterprises are prepared to cooperate with companies in material science, agricultural science, and technology to consolidate resources and accelerate research and innovation.

Importance of globalization and localization

Collaboration for globalization has optimized the market layout of agrochemical enterprises and enhanced their influence in emerging markets. Through collaboration with local companies, agrochemical enterprises are able to better adapt to local market demand, develop products that fit local regions, and enhance market competitiveness.

In the future, the trend of globalization will accelerate, and cross-border collaboration and resource integration will enable further optimization of the global market layout. Emerging markets, such as Brazil, China, India, and Southeast Asia, will become important drivers of the growth of the industry. At the same time, the importance of localization-oriented collaboration will become more prominent, whereby enterprises will be in a better position to serve local markets through localized research and production.

Strategic alliance and intensification of resource integration

Strategic alliances and resource integration have significantly improved enterprises' operation efficiency and market competitiveness. Through collaboration with upstream and downstream industry players, scientific research institutions, and high-tech companies, agrochemical enterprises can optimize resource allocation to accelerate technological innovation and market expansion.

Going forward, the strategic alliance is bound to become more diversified, with well-established inter-company cooperative relationships among peers, upstream and downstream companies, scientific research institutions, and technology companies. Resource integration will be further deepened through acquisitions and collaboration, and enterprises will consolidate global resources to enhance market competitiveness.

Digital transformation and smart service

The application of digital technology in the crop protection industry has improved the operational efficiency and supply chain management of enterprises. Intelligent services have promoted the development of precision crop protection via the use of drones and sensors, which reduce resource waste and improve the sustainability of agricultural production.

Going forward, digital technology will play a greater role in crop protection. Blockchain, the Internet of Things, and big data technologies will facilitate the optimization of supply chain management and the improvement of product quality and safety; intelligent services will become an important direction of the industry's development, where drones, sensors, and intelligent agricultural equipment will promote precision crop protection and improve service efficiency and accuracy.

Green crop protection and sustainable development

Promoting green crop protection technology enhances enterprises' market competitiveness and reflects their responsibility for sustainable development. By developing eco-friendly products and promoting green technologies, agrochemical enterprises can fulfill the market demand for sustainable agriculture while enhancing their social image.

In the days to come, with the global concern and emphasis on environmental protection and sustainable development, green crop protection technology will also become an important direction of the development of the industry; the development of green technology, such as nano pesticides, biologics, and precision spraying, will accelerate; the policy support of all governments to the sustainable development of agriculture will facilitate the further promotion and application of green crop protection technology. AP

Collaborations in 2024 biological industry: How Enterprises Lead an Industry Revolution through Multi-Dimensional Industry Chain Collaboration

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Editor's Note: In 2024, the mode of collaboration in the biological industry was much diversified, which included collaboration in technology research and development, marketing, and manufacturing, having injected strong impetus into the development of the industry. The collaboration not only promoted technological innovation and expanded market channels but also promoted the sustainable development of agriculture. Looking ahead, the deepening of cross-industry collaboration, the strengthening of globalized collaboration, and the intensification of industry-school-institution collaboration will bring more development and innovation opportunities to the biological industry to help the industry achieve technical breakthrough and market expansion, contributing to the global agricultural development and environmental protection.

Mode of collaboration

Collaboration in technological research and development

Technology R&D collaboration is one of the key modes of innovation in the biological industry. Close collaboration among enterprises, between enterprises and universities, and between enterprises and research institutions can accelerate the development and application of new technologies, promoting the rapid development of the industry.

1. R&D collaboration among enterprises

R&D collaboration among enterprises has greatly accelerated the biological research process by integrating the technological and resource advantages of all parties. For example, Syngenta's partnership with Lavie Bio is a good example, where Syngenta leveraged its global R&D and commercialization capabilities, combined with Lavie Bio's unique technology platform, thus rapidly identifying and optimizing biopesticide candidates in support of the co-development of novel biopesticides. This collaboration not only addresses the problem of pest resistance but also significantly shortens the research cycle and improves the market competitiveness of the product.

Syngenta's partnership with Ginkgo Bioworks is a typical demonstration of the potential of joint research and development among enterprises. By developing and optimizing microbial strains, the two parties could accelerate the time to market of biological products. This mode of collaboration not only promotes the development of sustainable agricultural solutions but also significantly improves enterprises' innovation ability and market responsiveness, providing strong support to the green transformation and sustainable development of agriculture.

Similarly, the collaboration between Israel Chemical (ICL) and Lavie Bio demonstrated the great potential of digital tools in R&D of biological. The two parties used artificial intelligence technology to develop novel biostimulants, successfully screening a variety of highly efficient microbial candidates. This kind of collaboration not only significantly shortens the R&D cycle but also improves the accuracy and efficiency of R&D through digital means.

The collaboration between BASF and AgroSpheres also demonstrated the advantages of joint R&D activities among enterprises. BASF leveraged its technological strength to develop broad-spectrum biopesticides in combination with AgroSpheres' AgriCell technology. This collaboration not only improved the product's performance but also accelerated its time to market, providing farmers with a more effective pest control solution.

Furthermore, BASF has partnered with the French Elicit Plant to jointly develop and promote the drought-resistant biostimulants EliSun-a and EliGrain-a, which aim to enhance the resilience of sunflower and cereal crops via the natural property of phytosterols, thus increasing yield and promoting the sustainability of agricultural production. BASF reached a strategic partnership with Huaheng Biological in the joint development of biostimulants and the establishment of a crop nutrition research institute, aiming to improve crop yield and quality, enhance stress resistance, and promote the sustainable development of Chinese agriculture.

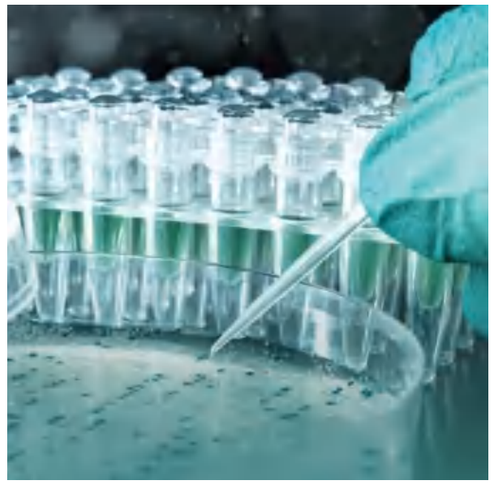
The collaboration between FMC and AgroSpheres has accelerated the development and launch of RNAi biopesticides, as supported by the integration of AgroSpheres' manufacturing and formulation technologies with FMC's strength in high-throughput testing, evaluation, and marketing. This mode of collaboration not only improves the efficiency of product development but also accelerates the process of product commercialization through the integration of market resources.

2. Collaboration between enterprises and research institutions

The mode of collaboration between enterprises and research institutions fully exploits the research strengths of universities and research institutions, which can accelerate the industrialization and marketing of new technologies generated in laboratories. This mode of collaboration not only improves the technical level of enterprises but also promotes the achievement of technical breakthroughs in the biological industry through the professional competence of research institutions.

For example, SugaROx's collaboration with the Institute of Lausanne and the University of Oxford in the UK has accelerated the development and commercialization of the T6P biostimulant. By combining SugaROx's technological advantages with the research resources of research institutions, the collaboration has significantly improved the efficiency of product development and provided new solutions for sustainable agricultural development.

The collaboration between Beijing Multigrass Formulation and Henan Agricultural University reflects the



key advantages of collaboration between enterprises and universities. The two parties jointly launched the RNAi biopesticide project, aiming to provide innovative green solutions for the prevention and control of wheat scabs. This collaboration not only promotes the development of biopesticides in China but also offers strong support for the green transformation of agriculture.

Overall, the collaboration of enterprise-to-enterprise and enterprise-to-research institutions has played an essential role in the development of the biological industry. By integrating the technological and resource advantages of all parties, the collaboration not only accelerated the development and application of new technologies but also promoted the rapid development of the industry, providing strong support to the green transformation and sustainable development of agriculture.

Collaboration in marketing and distribution

Marketing and distribution collaboration is an essential means of growing the biological market. By partnering with local and international agricultural retailers and distributors, biological enterprises could quickly expand their product market coverage and enhance market competitiveness.

In Asia, collaboration in marketing and distribution is characterized by a high-degree resource integration and rapid market penetration. For instance, Insecticides (India) Limited (IIL) has signed a memorandum of understanding (MoU) with BioPrime Agro Solutions to bring the environment-friendly biostimulant Relieve to the Indian market, which was quickly promoted to the Indian market via IIL's market influence Krishak Bharati Cooperative Limited (KRIBHCO), an Indian fertilizer-producing cooperative, has partnered with Novonesis to launch the advanced Mycorrhizal Biofertilizer product – KRIBHCO Rhizosuper, which could rapidly cover the Indian agricultural

market via KRIBHCO's market network; Phytochrome Japan cooperated with Azotic to bring Azotic's nitrogen-fixing product N-Catch to the Japanese market, which quickly landed in the Japanese market via Phytochrome's channel advantage. These cases of collaboration demonstrated the high efficiency of Asian companies in rapid promotion of biological using local market resources.

In the Americas, especially in the United States and Brazil, the mode of collaboration in marketing is very impressive. Pivot Bio partnered with Hefty Seed to bring the nitrogen-fixing agent PROVEN 40 to the US market through Hefty Seed's sales network, which quickly covered the corn growing regions; the US GROWMARK has partnered with Indigo Ag to bring biological to the US market through GROWMARK's network of cooperatives, leveraging its sales network in more than 15 states and provinces across North America to rapidly expand market share; FMC and Novonesis have expanded their strategic partnership to become the exclusive distributor of Novonesis' improved biological in Canada beginning from the 2025 growing season, which will further enrich its product portfolio and provide Canadian growers with proven biological solutions to promote development of the sustainable agriculture; Acadian Plant Health announced a new strategic distribution partnership with Koppert USA to market biostimulants in a number of states in the United States, providing Acadian's US customers with increased ease of access to products and local technical expertise, via Koppert's logistics and local technical support; Lavie Bio and Ceres Global Ag Corp have collaborated to include Yalos™ bio-inoculant, in regenerative agriculture initiatives in the US and Canada, aiming to increase farmer productivity and agricultural sustainability by improving the availability and efficiency of nutrient use; MustGrow Biological Corp recently announced an exclusive distribution agreement with G.S. Long for distribution of MustGrow's TerraSante™ biofertility product in Oregon and Washington State, which is a collaboration using G.S. Long's local market resource to bring MustGrow's products quickly into the US market; Seipasa, a Spanish developer of biopesticides and biostimulants, has partnered with the Guatemalan distributor Agrovalsa, enabling registration and launch of its product to the market, marking the beginning of Seipasa's strategic market expansion in Central America.

AgriLife Solutions in Brazil has partnered with Fyteko in Belgium to introduce the drought-resistant biostimulant to the Brazilian market, leveraging AgriLife Solutions' market resources to gain farmer acceptance quickly. Also, FMC partnered with the Brazilian Ballagro to bring biological to the Brazilian market, via FMC's local presence to rapidly expand its market coverage. These cases of collaboration reflect enterprises' utilization of strong sales networks to rapidly market biological.

The European marketing collaboration mode focuses more on the in-depth combination of technology and marketing. For example, Eden Research in the United Kingdom partnered with Sumi Agro Europe to bring the biofungicide Mevalone to the Austrian market, leveraging Sumi Agro Europe's market resource to quickly gain recognition from local growers. Moreover, BASF has partnered with Acadian to bring seaweed biostimulants to the global market, using BASF's global sales network to rapidly increase the international recognition of the product. These cases demonstrate the high efficiency of European enterprises in global deployment utilizing technological advantages and market resources.

In other regions, such as Africa and the Middle East, the marketing collaboration brings about an intense market penetration. For example, Fresh Energy in Egypt has partnered with Koppert to introduce a number of integrated pest management (IPM) programs to the Egyptian market, leveraging Fresh Energy's local market resource to rapidly expand the scope of product application.

Indigo Ag has expanded collaboration with Galeri Ziraat, a leading crop input distributor in Turkey, to bring its innovative biological seed coating agents to the national market, which significantly improved crop yield and grower profitability. In contrast, further market expansion is being planned to cover the rest of the European countries. These cases of collaboration demonstrate the flexibility and efficiency of enterprises in utilizing local market resources and technological innovation to rapidly promote sales of biological.

New Zealand-based H&T (Hodder and Taylors Ltd) will introduce BioConsortia's FixiN 33 microbial seed treatment during the 2024/2025 season. This partnership leverages H&T's market resources in New Zealand to help BioConsortia's products quickly enter the New Zealand market.

Overall, the mode of marketing and distribution collaboration in the biological industry in 2024 is characterized by worldwide high-degree resource integration and rapid market penetration. Whether in Asia, the Americas, Europe, or elsewhere, biological enterprises worked closely with local and international partners to quickly bring innovative products to market, which significantly increased market reach and brand influence. This kind of collaboration not only accelerates the commercialization of biological products but also provides strong support for the sustainable development of agriculture.

Collaboration in production and manufacturing

The mode of collaboration in production and manufacturing enables the realization of the large-scale output and effective promotion of biological products by integrating the advantages of all parties in technology research and development, production facilities, and market channels. This not only improves the product capacity and reduces the cost of production and logistics but also ensures the implementation of high-quality standards and enhances the competitiveness of enterprises.

Vestaron has entered into a strategic partnership with ADM to use ADM's manufacturing facilities and key expertise to expand the peptide pesticide production capacity to meet the global demand for environment-friendly crop protection solutions to the benefit of the promotion of sustainable agriculture; Novonesis and Biotalys have partnered to manufacture, supply and commercialize the biofungicide EVOCA NG to help global fruit and vegetable growers control gray mold and powdery mildew, via the optimized production process and the expanded production capacity, driving the development of biocontrol market; Scheffer has entered into a strategic partnership with Andermatt Brasil to localize the production of Phosbac®, a bio-input developed by ABiTEP, at the Scheffer plant in Sapezal, Brazil, so as to reduce lead time and improve efficiency while further expanding the Brazilian market and promoting sustainable agriculture.

Impact of collaboration on biological industry

Promotion of technological innovation

1. Acceleration of novel product research and development: Through joint R&D collaboration between enterprises and enterprises, enterprises and research institutions, the advantages of technology, talent, and resources of all parties are integrated, which would significantly accelerate the process of research and development of novel biological.

2. Promotion of technology convergence and innovation: Collaboration enables the convergence of technologies from different fields to create innovative solutions for the biological industry.

Market channel extension

1. Increase of product market share: By partnering with distributors and other companies, biological enterprises can bring their products to broader markets and increase their market share.

2. Exploration of new market areas: Collaboration helps enterprises explore new market areas to achieve diversified market development.

Promotion of sustainable development

1. Reduced use of chemical pesticides: Promotion and application of biological help to minimize the use of chemical pesticides, reducing environmental pollution caused by agricultural production.

2. Promotion of sustainable development of agriculture: Collaboration promotes the application of biological in agriculture, promoting sustainable development of agriculture.

Future trend of collaboration

Intensification of cross-industry collaboration to continue

1. Integration of biotechnology with information technology: In the future, the integration of biotechnology and information technology will become a significant trend, such as the use of artificial intelligence and big data for screening of microbial strains, optimization of biological formulations, and accurate prediction of market demand. The biological enterprises may establish more complete

microbial databases and use AI algorithms to quickly screen out microorganisms with potential application value so as to improve R&D efficiency.

2. Cross-industry collaboration between the biological industry and other industry sectors: Cross-industry collaboration between the biological industry and other industry sectors will continue to increase, such as the development of novel biodegradable formulation carriers in conjunction with materials science or the collaboration with the energy industry to improve the production efficiency of biomass energy.

Collaboration for globalization to intensify

1. Increased collaboration among international companies: As global markets integrate, collaboration among international companies will become more popular. Multinational enterprises will continue to seek partners around the world to integrate resources and enhance competitiveness.

2. Emerging market to become a hotspot for collaboration: The emerging market will become a hotspot for the development of the biological industry, attributable to its vast development potential. In some countries and regions in Africa, Asia, and South America, agriculture has been growing rapidly, but the biological market has not yet fully developed. The biological enterprises are expected to increase collaboration in these regions to establish production bases, R&D centers, and sales networks.

Industry-University-Institution collaboration to move closer

1. Underlining of the function of universities and research institutions: Universities and research institutions will play an essential role in agricultural biological innovation. In the future, industry-school-institution collaboration will move closer, where universities and research institutions will continue to deliver their cutting-edge research results and professional talents while enterprises provide financing and market channels, thus facilitating accelerated commercialization of research results.

2. Establishment of a long-term and stable mechanism of collaboration: In order to ensure the efficiency and sustainability of industry-school-institution collaboration, the parties to collaboration are bound to establish a more long-term and stable mechanism of collaboration, which will strengthen the communication and affiliation among enterprises, universities, and research institutions via execution of long-term collaboration agreements and joint establishment of R&D platforms. AP

2024 Overview of Globally Registered, Launched Pesticides and Analysis of High-value Product Varieties, 10+ Innovation Directions and Future Trends to Reshape Future of Agrochemical Industry

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Editor's Note: In 2024, the global agrochemical industry has progressed remarkably in technological innovation, product diversification, and sustainability. In the face of increasingly complex agricultural challenges, multinational companies launched a series of innovative herbicides, insecticides, and fungicides through the exploration of novel modes of action, optimization of mixing technology, improvement of formulation performance, and implementation of precision development strategy. These new products not only exhibit outstanding performance in problem-solving, efficacy, and safety improvement but also provide strong support to the sustainable development of global agriculture. In the future, the pesticide industry is expected to continuously move forward in the direction of green, precise, mixture, intelligent, biological, and regulation-guided development, which will be a significant contribution to the accomplishment of global food security and environmental protection.

This article presents a comprehensive and in-depth analysis of the pesticide registrations/launches of global agrochemical giants in 2024, examining multiple dimensions such as innovation direction, product features, and future trends. This analysis gives insight into the innovation strategy and future trends of global agrochemical production.

Innovation Direction: Multi-field Breakthroughs to Tackle Challenges

Exploration of a new mode of action: Tackling the challenge of resistance

With the worldwide growing resistance to pesticides, their development with new modes of action has become a top priority among pesticide manufacturers. In the field of insecticides, BASF's innovative insecticide Cimegra® (Broflanilide) and Efficon® (Dimpropyridaz) demonstrated a new mode of action, respectively, against diamondback moth and sucking pests, without cross-resistance to the existing products, being deemed as an ideal tool for insecticide resistance management; Syngenta's PLINAZOLIN® technology (Isocycloseram) and Verdavis® (Isocycloseram + Lambda-cyhalothrin) can control the most resistant and difficult-to-control insect pests, via unique mode of action. These new products provide new tools for pest management and pave the way for the sustainable development of the pesticide industry.

In the field of herbicides, FMC's novel herbicide Isoflex® active (Bixlozone), classified as HRAC Group 13, which is granted registration in Brazil, the United Kingdom, Argentina, Australia, China, and India, has become a new herbicidal solution for application to various crops; Corteva's novagraz™ (2,4-D + Florpyrauxifen-benzyl) has become the first herbicidal product for protection of both white clover and annual lespedeza while providing a broad-spectrum weed control solution, thus solving the long-standing problem existing in the livestock industry. The achievement of this kind of selective control effect stands for the beginning of a refined development of herbicides.

Constant optimization of mixing technology: Overall improvement of product performance

Globally, prime companies have continued innovation in product mixing. This innovation is not only reflected in the selection and ratio of a mixture of active ingredients. Still, it is also reflected in the synergistic effect and the improvement of the overall performance of mixture products. Through mixing, not only is a synergistic effect achieved, but the emergence of resistance is put off.

In the fungicide sector, Syngenta launched its Miravis® Duo (Pydiflumetofen+Difenoconazole) and Reflect® Top (Difenoconazole+Isopyrazam), which, through the reasonable mix design, not only expands the control spectrum but also improves the long-lasting effect. In particular, Miravis® Duo shows strong efficacy and long-lasting impact in the control of powdery mildew, anthracnose, and leaf spot, which significantly reduces the number of pesticide applications. Also, BASF expanded its product portfolio with Aramax™ Intrinsic® (Pyraclostrobin+Triticonazole), Melyra® (Mefentrifluconazole+Pyraclostrobin), Keyra® (Fenpropimorph+Mefentrifluconazole). Through mixing of active ingredients of different modes of action, these products can improve the efficacy of control while reducing the risk of resistance.

In the field of herbicides, innovative mixing technologies are appealing. Syngenta launched in Canada its novel cereal herbicide Axial® Maxx (Pinoxaden + Fluroxypyr + Bromoxynil + Bicyclopyrone) against weed resistance; Bayer's herbicide Vios™ FX (Fluroxypyr-meptyl + Thiencarbazone-methyl) is an effective product for control of a wide range of tough weeds, including resistant wild oat and foxtail, via mixing of ingredients of two kinds

of mode of action; Corteva's herbicide Resicore® REV (Acetochlor + Mesotrione + Clopyralid mea salt), through the synergistic effect of three ingredients, can effectively control more than 75 kinds of tough weeds. In addition, the mixing technology takes into account the needs of product compatibility and ease of application, such as Bayer's Vios™ FX, which provides a satisfactory tank-mix flexibility and enhanced user experience.

Innovative formulation technology: Improvement of product performance and user experience

The innovation of formulation technology is particularly attractive, which is a means for prime companies to improve product performance and user experience. In this regard, ADAMA's independently developed Asorbital® formulation technology, which is a good example of ADAMA's innovation capability, is applicable to a wide range of products, including Maxentis®, Forapro®, Maganic®, and Avastel®. The key advantage of this technology lies in its significant improvement of absorption and delivery of the product inside plants.

Syngenta launched its novel insecticide INZAK® ZEON (Acetamiprid + Lambda-cyhalothrin) in Brazil, using the innovative ZEON® microencapsulation technology, having realized continuous release of active ingredients through sustained-release technology, which has both rapid effect and long-lasting efficacy to meet the needs of sustainable agricultural development and effective control of sucking pests on soybean, corn, and cotton, etc.

BASF launched its novel corn herbicide Surtain™ (Saflufenacil+ Pyroxasulfone) in Canada. This is a first-of-its-kind solid-encapsulated herbicidal technology that delivers residual endurance in the field to provide broad-spectrum control of key broadleaf and grassy weeds, including resistant biotypes.

UPL's herbicide BATALIUM® is a successful and perfect mixture of four active ingredients (Flucarbazone-sodium + Fluroxypyr-meptyl + MCPA-2-ethylhexyl + Bromoxynil octanoate), which not only assures the synergy of the ingredients but also ensures the stability and convenience of the use of the product.

Corteva's herbicide Linear® (Picloram + Triclopyr-butotyl + Aminopyralid) is made using a new formulation technology which can maintain a stable effect under different ways of application. In addition, the new formulation technology focuses on the reduction of toxicity and environmental impact. For instance, Corteva's nematicide Salibro® (Fluazaindolizine) has little effect on the soil ecosystem, which is a reflection of the trend of environment-friendly development.

Regionalization strategy: Fulfilling specific market needs, taking into account local conditions

Prime companies have been developing and promoting products that consider the crop structure, diseases, pests, weeds, and climatic conditions in different regions.

In the Asian market, especially in India, several companies launched highly targeted products. BASF's Efficon® (Dimpropyridaz) targets specifically sucking pests in India; Corteva's Salibro® (Fluazaindolizine) filled the gap in the nematicide market in India; Syngenta's Miravis® Duo (Pydiflumetofen + Difenoconazole) launched in India, aims to control powdery mildew, anthracnose and leaf spot on crops such as tomato, chili, peanut and grape. Furthermore, Syngenta's Reflect® Top (Difenoconazole + Isopyrazam), launched in India, is a fungicide specially designed for rice to effectively control rice blasts over a long period.

In the South American market, especially Brazil, product innovation is concentrated on major cash crops such as soybean and sugarcane. Corteva's Linear® (Picloram + Triclopyr-butotyl + Aminopyralid) specifically addresses the issue of weed control in sugarcane in Brazil; UPL launched in Brazil the unique herbicide Eximia (Asulam), which is specifically designed for application to sugarcane to combat the difficult-to-control weeds; UPL's Prez (Acetamiprid + Bifenthrin) addresses the problem of deois flavopicta in a Brazilian ranch; ADAMA's Gales® (Imidacloprid + Bifenthrin) is specially designed for control of sugarcane weevil (Sphenophorus levis). These products are developed with full consideration of local planting needs and the occurrence of insect pests and diseases.

In the European market, product innovation appears more environment-friendly and sustainable. ADAMA's series of grain fungicides launched in Europe and Corteva's proclova® (Florpyrauxifen-benzyl + Amidosulfuro) in Germany have all reflected full consideration of reducing environmental impact.

Improvement of safety and environmental friendliness: Green development practices

With increased attention to environmental protection and food safety, the development of pesticides with low toxicity, low residue, and low environmental impact has become an inevitable choice. In general, product innovation in 2024 showed considerations for environmental friendliness, which is reflected in many aspects such as product design, formulation optimization, and application techniques.

Corteva's novel nematicide Salibro® (Fluazaindolizine) is designed with full environmental consideration, which has a low impact on the soil ecosystem and can coexist in harmony with beneficial soil organisms and large soil fauna; ADAMA's herbicide EDAPTIS® (Pinoxaden + Mesosulfuron-methyl) is formulated using refined rapeseed oil to form an oil dispersion formulation, which not only improves product performance but also reduces the environmental burden; several of Syngenta's novel products lay stress on low-dosage and high-efficiency application, such as Miravis® Duo (Pydiflumetofen + Difenoconazole) which has the potential to reduce the number of sprays due to its high efficiency, thus saving resources and reducing environmental impact.

BASF's new products are focused on environmental friendliness, such as Cimegra® (Broflanilide), launched in Australia, which stresses the product property of being free of cross-resistance with the existing products, being a benefit to sustainable applications. Bayer's acaricide Interrupt 240 SC (Spiromesifen) is formulated in an environmentally friendly manner to reduce the environmental impact. Moreover, novel active ingredients have been developed with great attention to environmental friendliness, such as Sumitomo Chemical's herbicide Epyrifenacil, which has attracted market attention due to its high efficiency and low toxicity.

Digital and intelligent integration: Opening up innovation boundaries

Digital technologies are reshaping the agrochemical product development model. From molecular design and formulation optimization to application planning, digital technologies have been improving the efficiency of innovation and expanding its boundaries. New R&D models such as significant data-based targeted discovery, AI-assisted formulation design, and intelligent efficacy evaluation are accelerating the digital transformation of the agrochemical industry.

Besides, prime companies are increasingly designing products in conjunction with digital solutions, such as smart spraying and precision application technologies. This trend suggests that pesticide development in the future will prioritize integration with digital farming technologies.

These innovative breakthroughs demonstrate the systematic progress in technological innovation in the agrochemical industry. Through multi-dimensional collaboration and innovation, the agrochemical industry is speedily moving forward towards a more efficient, safer, and more sustainable direction of development, providing solid technical support to the green growth of global agriculture.

Product Features: Efficient, Precise and Sustainable

Innovative herbicides: High efficiency, long-lasting, selective, and environment-friendliness

In 2024, all multinational companies launched a number of innovative herbicides, which performed outstandingly in terms of efficiency, durability, selectivity, and environmental friendliness, resulting in breakthroughs in agricultural weed management.

1. High efficiency and durability, reducing the number of pesticide applications

In general, novel herbicides would go after rapid and long-lasting herbicidal effects to reduce the number of pesticide applications and improve agricultural production efficiency. For example, BASF launched its herbicide Voraxor® (Saflufenacil + Trifludimoxazin), which is fit to a wide range of crops, showing the rapid and long-lasting effect of weed control; Corteva's launch of herbicide Linear® (Picloram + Triclopyr-butotyl + Aminopyralid) in Brazil provides a year-round weed management solution against tough weeds in sugarcane field; Bayer's novel herbicide Vios™ FX (Fluroxypyr-meptyl + Thiencarbazone-methyl) is effective in tackling a wide range of tough weeds including resistant weeds, having demonstrated excellent weeding results; Syngenta's novel cereal herbicide Axial® Maxx (Pinoxaden + Fluroxypyr + Bromoxynil + bicyclopyrone) in India provides high-effective and broad-spectrum herbicidal effect, with control of resistant weeds.

2. Selectivity and crop safety

Herbicide selectivity and crop safety are the key considerations in the course of product development. In order to improve the safety of specific crops, novel herbicides are made to achieve higher selectivity and better effect of crop protection by optimization of formulation and addition of safeners. For example, Corteva launched in the Spanish market its herbicide Hector® (Nicosulfuron + Rimsulfuron + Dicamba + Isoxadifen) added with the safener ethyl bisbenzoxazolerate, which significantly enhances the selectivity of the product while effectively protecting corn from phytotoxicity. In addition, Corteva launched in Canada its herbicide Extinguish™ XL (Halauxifen-methyl + 2,4-D-2-ethylhexyl ester), which is specifically targeted at broadleaf weeds in wheat and barley fields, with a broad period of application and stable herbicidal activity to ensure the safety of crops throughout the entire growth cycle.

3. Resistance management

Resistance management is one of the key future directions in herbicide development. For example, Corteva's novel herbicide Tolvera™ (Tolpyralate + Bromoxynil) can effectively control resistant weeds and provide growers with a reliable resistance management

solution; FMC's Isoflex® active (Bixlozone) has been granted registration in several countries, where, with its unique mode of action, the product provides growers with a new resistance management tool capable of effective control of annual grassy weeds and broadleaf weeds. Furthermore, FMC launched its wheat herbicide Ambriva® (Bixlozone + Metribuzin) in India that is specifically designed against Phalaris minor, which is resistant to a variety of chemical herbicides, thus offering Indian farmers an innovative solution to tackle the challenge of resistant weeds.

4. Environment friendliness

Novel herbicides appear more environmentally friendly. For example, Corteva's herbicidal Enversa™ (Acetochlor) was launched in the U.S. market using encapsulated acetochlor technology, which effectively controls weeds while ensuring crop safety and environment friendliness. In addition, Sumitomo Chemical's herbicide Epyrifenacil, launched in the Argentinian market, reduces environmental impact due to its high efficiency and low toxicity.

Novel insecticides: New mode of action, versatility and environment friendliness

In 2024, multinational companies launched several innovative insecticide products that exhibit excellent performance in mode of action, versatility, and environmental friendliness.

1. New mode of action to tackle the challenge of resistance

In general, novel insecticides are developed with a unique mode of action to address the growing issue of resistance. BASF's innovative insecticide Cimegra® (Broflanilide) and Efficon® (Dimpropyridaz) demonstrated a new mode of action against diamondback moth and sucking pests, without cross-resistance to the existing products, which is deemed as an ideal tool for insecticide resistance management. Syngenta's PLINZOLIN technology (Isocycloseram) and Verdavis® (Isocycloseram + Lambda-cyhalothrin) can also effectively tackle the challenge of resistance through its unique mode of action.

2. Multi-functional design to achieve enhanced efficiency and effect of control

Versatility becomes the focus of pesticide product design. For example, Syngenta's Verdavis® (Isocycloseram + Lambda-cyhalothrin) not only possesses the function of foliar spray but also contains a "resistance-breaker," which can control the most resistant and difficult-to-control pests. Also, BASF's Cimegra® (Broflanilide) demonstrated high efficiency and long-lasting effect, making it an ideal tool for pesticide resistance management.

3. Highly-targeted insecticides, being environment friendly

Novel insecticides are developed with more emphasis on environmental friendliness while maintaining a high effect of control. For example, Corteva's novel nematicide Salibro® (Fluazaindolizine), launched in the Indian market, has a low impact on the soil ecosystem and is compatible with beneficial soil organisms. Syngenta's novel insecticide INZAK® ZEON launched in India (Acetamiprid + Lambda-cyhalothrin) is developed using the innovative ZEON® microencapsulation technology, having achieved the continuous release of active ingredients through the sustained-release technique, which improves the effect of control while reducing environmental impact. BASF's insecticidal Efficon® (Dimpropyridaz) aims to control sucking pests in India, being effective against aphids, leafhoppers, and whitefly in different growth stages, with a fast-acting, systemic and long-lasting residual effect, which can quickly control the growth of pest populations to reduce pest damages.

New-generation fungicides: Multi-ingredient mixtures, precision targeting, long-lasting and broad-spectrum

The new-generation fungicides fulfilled the needs of diverse and complex disease control of global agricultural production via targeted solutions, a mixture of multiple active ingredients, versatility, excellent durability, and applicability.

1. Multi-ingredient mixture to increase broad-spectrum

The mixed application of multiple active ingredients has become the mainstream of fungicide development. By mixing a variety of highly effective active ingredients, the spectrum and effect of control of fungicides are greatly improved. BASF launched a variety of fungicide mixtures, such as Aramax™ Intrinsic® (Pyraclostrobin + Triticonazole), Melyra ® (Mefentrifluconazole + Pyraclostrobin), Keyra® (Fenpropimorph + Mefentrifluconazole) and Belyan® (Mefentrifluconazole + Pyraclostrobin + Fluxapyroxad). These products can significantly increase the spectrum and effect of control through reasonable mixing.

Syngenta's Miravis® Duo in India (Pydiflumetofen + Difenoconazole) and Reflect® Top (Difenoconazole + Isopyrazam) not only expand the control spectrum but also improve the durability through a reasonable design of the mixture.

Corteva's launch of the ternary soybean seed treating agent lumitreo™ (Oxythiapiprolin + Picoxystrobin + Ipconazole) in India not only enhances the product's control effect but also provides a powerful tool for resistance management.

In addition, Sumitomo Chemical's novel fungicide Pladius® in Brazil consists of three active ingredients: Inpyrfluxam, Difenoconazole, and Picoxystrobin. This combination provides a high-effect solution for controlling cotton leaf spot.

2. Precision targeting, with provision of specific solutions

Targeted solutions are highly appreciated among developed fungicides, as targeted solutions provide precise application to specific crops against specific diseases.

For example, BASF's Melyra® (Mefentrifluconazole + Pyraclostrobin) targets at citrus disease control in Brazil, which is an advanced crop protection solution for this world's largest citrus-producing country; BASF's fungicide Keyra® (Fenpropimorph + Mefentrifluconazole) provides a high effect of control of soybean leaf spot and rust; for soybean solutions, BASF also launched two fungicides, Belyan® (Mefentrifluconazole + Pyraclostrobin + Fluxapyroxad) and Blavity® (Fluxapyroxad + Prothioconazole), which further enriched BASF's soybean crop solution portfolio.

In the Chinese market, BASF launched its novel rice fungicide, Cevya® (Mefentrifluconazole). This is the latest isopropanol triazole fungicide registered for rice in China in the past 20 years, and it is capable of effectively controlling rice false smut.

Green, Precise Mixture, Intelligent, Biological, and Regulation-guided Development will Continue to be the Future of Pesticide Development

The future pesticide industry is envisaged to show a trend toward green, precise, mixture, intelligent, biological, and regulation-guided development. Concerning green development, with the worldwide growing emphasis on food safety and environmental protection, low-toxic, low-residue, and environment-friendly pesticides are expected to become mainstream, whilst the development of novel active ingredients and formulation technology will focus on precision spraying, with the help of digital technologies such as big data and artificial intelligence, the application of pesticides will become more precise, including the development of specialized products against specific pests, diseases or weeds, as well as the application of precision pesticide application and intelligent control system. Regarding the mixture, multi-functional, multi-target mixtures may dominate the market, whilst comprehensive control strategies will become popular with closer integration of biological control and chemical control; in terms of intelligent development, it is worth noting that intelligent and digital technology will be deeply integrated with the industry development, covering intelligent formula design and intelligent pesticide application, IoT-based early warning of pests and diseases as well as technological innovation, which will run through the whole process of pesticide application. With respect to biochemistry, biopesticides and emerging biological control technologies (such as RNAi technology and pheromone technology) are expected to be developed in parallel with chemical pesticides to provide new solutions in support of the sustainable development of agriculture; speaking of regulatory guidance, the concept of sustainable development will prevail through the whole life cycle of pesticide products, from raw material selection to production process, from application technology to packaging design, the regulatory policies will guide and promote research and development of safer and more environment-friendly substitutes to accelerate knock-out of high-toxic and high-risk pesticides. AP

INDUSTRY INSIGHT

New Biologicals in 2024: A Year of Breakthroughs

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The biological agri-inputs sector witnessed significant innovations throughout 2024. New biologicals have reinvigorated sustainable agriculture through novel active ingredients, formulations, and production processes.

Based on AgroPages' 2024 reports, this article will show unique technologies and high-demand products that were registered or launched in 2024.

Some newly registered or launched products are unique locally or even globally:

UPL's seed treatment based on three strains, providing both nematicide and biostimulant efficacy

UPL's NIMAXXA has been registered and launched in Brazil and is the country's first biostimulant bionematicide. The product, as a result of a partnership between UPL and Novonesis, contains *Bacillus paralicheniformis*, isolate CH2970, *Bacillus paralicheniformis*, isolate CH0273, and *Bacillus subtilis*, isolate CH4000. According to UPL, these strains work in a complementary manner; once applied, they quickly colonize the roots, effectively controlling nematode eggs and juveniles; the product also provides biostimulant activity that promotes root growth and helps plants maintain resilience throughout the growing season. Nimaxxa offers practical advantages, including a two-year shelf life without refrigeration and six-month viability on treated seeds. Its compatibility with chemical inputs makes it versatile for various seed treatment combinations.

UPL has also launched Nimaxxa in the United States, the country's only nematicide seed treatment with three strains for season-long nematode control for soybean and corn. The product effectively controls major destructive nematodes, including soybean cyst nematode, root-knot nematode, and reniform nematode.

EU's first pollen polysaccharide provided by BASF

BASF has introduced the EU's first pollen polysaccharide product, which Newsun Crop Science developed. This biostimulant, derived from rapeseed pollen through green extraction technology, contains water-soluble sugars, such as polysaccharides, oligosaccharides, and monosaccharides, enriched with amino acids, minerals, and other ingredients. It promotes root development, enhances nutrient uptake and growth, and improves crop stress resistance and quality. This natural solution demonstrates high biological activity and is both cost-effective and environmentally friendly.

Pollen polysaccharide is protected by 13 invention patents, with applications filed and granted across major markets, including China, Brazil, the United States, and the EU. The patent protection encompasses novel molecular structures, functional applications, and formulation development. BASF and Newsun Crop Science will strengthen their strategic partnership and expand their joint presence in the European market.

China's unique Kasugamycin-*Paenibacillus polymyxa* co-formulant, launched by Kernel

Wuhan Kernel Bio-tech has launched Qiji in East China, introducing the country's only pesticide co-formulated with kasugamycin and *Paenibacillus polymyxa*. Kernel uses a selected *Streptomyces kasugaensis* strain that will undergo an advanced process to produce fermentation broth with fewer impurities, followed by multi-stage ion exchange for further purification. The fermentation broth results in kasugamycin of exceptional purity. The company's patented *Paenibacillus polymyxa* KN-03 strain features a robust spore coat, demonstrating high tolerance to antibiotics and other compounds while enhancing crop resilience.

This dual-action formulation combines kasugamycin's systemic properties with KN-03's diverse modes of action and persistent protection. Together, they deliver consistent pathogen control. According to Kernel, the product application demonstrates rapid colonization and targeted efficacy, with the product protecting foliage and fruit while treating infection sites and promoting wound healing. The formulation has proven particularly effective in the sustainable control of various bacterial diseases, such as canker, soft rot, and angular leaf spot.

World's first *Trichoderma harzianum* OD developed by MoonBiotech

MoonBiotech's Weiquanjin has been registered

in China. The product is the world's first *Trichoderma harzianum* dispersible oil suspension (OD) pesticide. The product's active ingredient is the company's patented strain, *Trichoderma harzianum* TH7. In developing this formulation, MoonBiotech has overcome significant technical challenges, including oil medium selection, grinding process optimization, oil-water compatibility, and maintaining fungal dispersibility despite emulsifier presence.

According to the company, the product demonstrates excellent efficacy in controlling foliar pathogens while offering numerous advantages: a good safety profile, long-lasting protection, and strong compatibility with chemical pesticides. Its use can effectively reduce both pesticide resistance development and residue concerns. It shows promising potential for application on vegetables, flowers, and many other high-value crops.

Brazil's first approval of fully inactivated *Burkholderia*

Bioceres Crop Solutions has secured Brazilian registration for three new biological insecticides/nematicides derived from inactivated cells of their proprietary *Burkholderia*. The company highlights that their advanced biopesticides, which use metabolites of inactivated microbes, offer advantages over live microbial preparations, including enhanced efficacy, precision, shelf-life, and greater consistency. Furthermore, these non-living bacterial formulations deliver higher potency at costs

comparable to conventional chemical products.

Brazil, pioneering the use of biocontrol products in row crops, is projected to become the world's largest biocontrol market by 2030. Currently, bioinsecticides and bionematicides represent about 11% of Brazil's total insecticide and nematicide market, valued at US$5.5 billion, with an impressive average annual growth rate of 44% over the past five years. This regulatory approval enables Bioceres to commercialize their *Burkholderia*-derived products in Brazil and establishes a foundation for future related product launches in the market.

Microbes take center stage: Novel technologies elevate product efficacy

In the AgroPages 2024 reports on newly registered and launched biologicals, microbial solutions continue to dominate, with cutting-edge technologies to increase product efficacy emerging as a key innovation driver.

Bioiberica's biostimulant Terra-Sorb SymBiotic, containing *Bacillus velezensis* PH023, features their proprietary Priming Tech. This patented fermentation technology allows for the selection and conditioning of beneficial microbes, ensuring their great adaptability to field conditions. Terra-Sorb SymBiotic, as the first probiotic biostimulant utilizing this technology, strengthens the symbiosis between biostimulant and biofertilizer.

Similarly, Rovensa Next's Brazilian launch of three *Bacillus subtilis*-based fungicides, Row-Vispo, Ospo Vi55, and Mirarum, is combined with Bioevology technology. This technology leverages Rovensa Next's unique co-formulants to optimize the fermentation process and secondary metabolite production, enabling these biopesticides to achieve faster efficacy.

Regional market watch: Nitrogen fixation takes center stage in Brazil

Brazil is the country with the most newly registered and launched bio-products reported in 2024. The country's dynamic market has shown particular strength in solutions for biological nitrogen fixation.

These include many products based on nitrogen-fixing bacteria. For example, Corteva's Utrisha N stands out with its innovative *Methylobacterium symbioticum* SB23. It enters plants through leaf stomata, achieving complete colonization within seven days of application and active throughout the crop's cycle. Syngenta's Rizoliq UHC Innovation, an advanced liquid *Bradyrhizobium* formulation, is designed for soybeans, allowing a 90-day pre-inoculation treatment period. Novonesis' LeguMax Plus features a high-concentration inoculant of 5 billion CFU/mL *Bradyrhizobium japonicum*, allowing for reduced dosage and improved logistics of applying the biological inputs. ICL's contributions are ActiBioX Brady (*Bradyrhizobium japonicum* SEMIA 5079 and SEMIA 5080), and ActiBioX Azos (*Azospirillum brasilense* AbV5 and AbV6).

As the world's largest soybean producer, Brazil offers significant market potential for above *Bradyrhizobium*-based soybean inoculants. Meanwhile, Corteva's Utrisha N (for corn) and ICL's ActiBioX Azos (for corn, wheat, and rice) serve distinct crop segments, providing differentiated solutions in the biologicals market.

Beyond nitrogen-fixing bacteria, Revella, a Brazilian company, has introduced Sylos W-Se, a nanoselenium-based product that enhances nitrogen fixation. This product stimulates flavonoid and sugar synthesis, promoting nodule formation and providing essential substrates for nitrogen-fixing bacteria. It also enhances ureide production and transport, ultimately improving nitrogen fixation efficiency for crops.

The biologicals sector demonstrated remarkable innovation in 2024, with companies leveraging unique technologies and products to expand their global presence. These advances in formulation development, process technologies, and market expansion position the industry for continued growth. As technologies advance and market demands increase, biologicals are expected to play an increasingly crucial role in global food security and environmental protection. AP

Gene Editing Technology:

A New Catalyst for Agricultural Innovation and Global Growth

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Genome editing technology, particularly CRISPR, has emerged as a groundbreaking innovation in life sciences in recent years. Unlike traditional transgenic methods,gene editing enables precise modifications at specific locations within the genome, allowing for the insertion, deletion, or replacement of gene fragments or even individual bases. This technology offers the advantage of efficiently editing multiple genes at a low cost, without introducing foreign genes. Notably, CRISPR can accurately modify endogenous genes, altering their molecular functions and enabling the expression of specific traits in organisms.

The development of gene editing technology has progressed through stages, beginning with tools like zinc finger nucleases (ZFN) and transcription activator-like effector nucleases (TALEN). However, CRISPR technology has become the most widely used and studied method since its introduction in 2012. It has rapidly advanced and is considered one of the most significant breakthroughs in life sciences in the 21st century. In recognition of its transformative potential, CRISPR was awarded the Nobel Prize in Chemistry in 2020, further solidifying its importance within the scientific community. Additionally, Nature magazine named CRISPR one of the most influential scientific events of the past decade, with a wealth of research papers continuing to emerge annually, maintaining its status at the forefront of global scientific attention.

Research Progress in Gene Editing Technology

CRISPR, the genome editing tool, has made significant strides in plant and animal agriculture just 12 years after its introduction. Its applications span multiple areas, including reducing food waste, enhancing climate resilience in crops and livestock, developing weed-resistant plants, improving crop harvest efficiency, and advancing sectors like food production, biofuels, and papermaking. At the same time, researchers are continuously improving CRISPR tools, expanding their use across a wider range of species and applications.

Ongoing Development and Innovation in Gene Editing

Gene editing technology continues to evolve, with new breakthroughs and optimizations emerging in key areas:

1. Next-Generation Gene Editing Tools

Traditional CRISPR technology works by inducing double-strand breaks in DNA. Recently, researchers have developed new tools like base editing (BE) and prime editing (PE), which do not rely on double-strand breaks and offer significant improvements in accuracy. However, challenges such as limited editing scope, low efficiency, and usability remain. To address these, Harvard University has developed Click Editing (CE), a new technology designed to make gene editing even more precise and adaptable.

2. Expansion of the CRISPR Nuclease Family

To improve the efficiency and specificity of gene editing, researchers are optimizing Cas nucleases. New systems, including CRISPR-Cas12b, Cas12n, Cas12f1, Cas14a, CasF, and CasΦ, have increased the flexibility of gene editing. Among these, the CRISPR-CasΦ system, which is only half the size of CRISPR-Cas9, can target a broader range of DNA sequences. Additionally, the discovery of RNA-guided DNA nuclease Fanzor in eukaryotes, with its compact structure, has made it easier to deliver into cells and tissues, offering greater application potential than traditional CRISPR-Cas systems.

3. Design and Optimization of Gene Editing Delivery Vectors

Effective and safe delivery of CRISPR components is crucial for precise gene editing. Current delivery methods include Agrobacterium-mediated delivery, protoplast delivery, and gene gun delivery, each with its pros and cons:

- Agrobacterium-mediated delivery works well for various plants but may randomly insert DNA into the plant genome, leading to long-term retention of CRISPR tools and potential off-target effects. Additionally, plants modified this way are classified as genetically modified organisms (GMOs).
- Protoplast delivery is useful for genomic studies in the lab but has limited applications in breeding due to difficulties in regenerating complete plants.
- Gene gun delivery is versatile but may result in multiple random insertions of CRISPR tool DNA, which can reduce editing efficiency and complicate the removal of excess DNA.

4. The Role of Artificial Intelligence in Advancing Gene Editing

Artificial intelligence (AI) is increasingly driving advancements in gene editing tools. While AI's application in plant research is still developing, it has already led to breakthroughs in animal cell research. For instance, the Broad Institute used the fast locality-sensitive hashing clustering algorithm (FLSHclust) to identify 188 new CRISPR systems, some of which showed lower off-target effects compared to traditional CRISPR-Cas9 systems. Additionally, Profluent launched the OpenCRISPR™ program, the world's first AI-generated open-source gene editing tool, OpenCRISPR-1, which successfully enabled precise editing of the human genome.

Gene editing technology is rapidly advancing, driven by innovations in tool optimization, delivery methods, and AI integration. These developments are pushing the field toward higher precision, stronger safety, and broader applicability. As research progresses, gene editing is poised to unlock tremendous potential in agriculture, medicine, bioengineering, and beyond, with profound impacts on society.

Business Progress in Gene Editing Technology

Gene editing technology encompasses a range of techniques, each with distinct applications depending on the specific approach. Internationally, these technologies are commonly classified into three categories: SDN-1, SDN-2, and SDN-3. This classification is based on technical characteristics and the extent of gene modification.

SDN-1 gene editing involves no repair templates and does not introduce exogenous genes. It primarily achieves gene modification through point mutations or the insertion/deletion of a small number of bases.

SDN-2 employs homologous recombination to repair the gene, resulting in mutations involving one to several bases.

SDN-3 introduces longer exogenous gene fragments, resulting in more substantial changes to the organism compared to SDN-1 and SDN-2.

Among these, SDN-1 technology is the most widely applied, especially in the early stages of gene editing. It typically involves the insertion or deletion of a small number of bases at the target site, often using double-strand breaks (DSBs) and homologous end-joining repair mechanisms. This approach can lead to the loss of gene function. While the specific editing effects and outcomes are still being refined, SDN-1 technology has already been used in the study of functional genes such as the fragrance-related gene BADH2 (Betaine Aldehyde Dehydrogenase), the herbicide resistance gene ALS (Acetolactate Synthase), and the flowering time gene FAF (FANTASTIC FOUR).

Compared to traditional transgenic methods, gene editing technology offers a more precise way to enhance the traits of plants and animals without introducing foreign genes, resulting in fewer ethical concerns. This makes it highly promising for agricultural applications. As gene editing continues to evolve, many traditional agricultural biotechnology companies have begun to explore gene editing for breeding, and specialized companies focused on gene editing-based breeding are emerging as well.

Overview of Global Agricultural Gene Editing Breeding Companies

Currently, the majority of agricultural gene editing breeding companies focus on improving crop production and stress resistance through gene editing. Below, we highlight 10 representative commercial companies in the global gene editing space.(p40) Among these, Bayer has quickly consolidated its dominant position in the gene editing breeding market after acquiring Monsanto, while Corteva has emerged as its primary competitor, strengthening its position through the integration of DuPont and Dow's relevant businesses.

In 2024, Bayer announced two major vegetable genome editing projects as part of its open innovation strategy. First, Bayer partnered with Korean biotech company G+FLAS to develop gene-edited tomatoes rich in vitamin D3, addressing global vitamin D deficiency, especially in regions with limited sunlight or during winter months. Additionally, Bayer is collaborating with Pairwise to develop a gene-edited version of the Preceon vegetable variety, with an eye on the global market. These partnerships not only accelerate

innovation but also shorten the product development cycle. Bayer's exclusive licensing agreement with Pairwise strengthens this initiative. Pairwise, known for its genetic innovation in food and agriculture, also made headlines in North America with its CRISPR-edited leafy green vegetable, improving flavor. The two companies are now working together to promote the large-scale commercialization of these products.

Pairwise differentiates itself by focusing on high-value crops such as mustard, blackberries, raspberries, and cherries, in contrast to other companies which mainly target staple crops. In addition to its collaboration with Bayer, Pairwise has formed strong ties with Corteva.

In 2024, Corteva, a global leader in agricultural technology, announced a partnership with Pairwise to enhance gene editing solutions for farmers, addressing challenges like climate change. This partnership includes Corteva's $25 million equity investment in Pairwise, part of Corteva's Catalyst platform dedicated to advancing agricultural innovation. The investment aims to broaden the application of gene editing, particularly in staple foods and specialty crops. Additionally, the two companies have established a joint venture to further accelerate gene editing technologies, focusing on climate resilience and higher crop yields. This joint effort leverages Corteva's expertise in plant breeding and genetics, positioning their products to better withstand extreme weather events.

Corteva's relationships extend beyond Pairwise. The company has also collaborated with Bejo, Sustainable Oils, and Vilmorin & Cie. However, Corteva's partnership with Inari has been controversial. In August 2024, Corteva accused Inari of violating its plant variety rights and related patents by genetically editing corn seeds obtained from a seed depository and attempting to patent the improved traits, leading to a legal dispute.

Inari, a leading seed technology company, focuses on advancing seed innovation using artificial intelligence and gene editing tools. Recently, Inari secured $144 million in funding to support its long-term growth. The company's first products—soybeans, corn, and wheat—have generated significant industry attention as it aims to design more sustainable seeds for global food security and agricultural innovation.

Syngenta, another major player in agricultural technology, has adopted an open-source collaboration model. Through its innovative cooperation platform, Shoots by Syngenta, the company has partnered with global academic institutions, research entities, and companies to promote sustainable agricultural development. Syngenta has also licensed CRISPR technology to academic and breeding organizations to accelerate crop innovation. The platform has already made significant strides in tackling global challenges such as food security, climate change, and biodiversity.

BASF has also made strategic moves in the gene editing field. In addition to acquiring a CRISPR-Cas9 gene editing license in 2017, BASF signed a partnership with UK biotech company Tropic Biosciences in 2020 to utilize Tropic's GEiGS technology in developing strategic crop varieties. However, BASF's gene editing initiatives remain relatively low-profile, with limited public developments.

Cibus, a leader in plant gene editing, focuses on creating sustainable, high-yield crops to address global food security and environmental concerns. Through its proprietary Cibus Precision Gene Editing Technology Platform (CPGET), the company is developing gene-edited crops like high-erucic acid rapeseed, polyunsaturated fatty acid-rich soybeans, herbicide-resistant corn, and drought-resistant wheat, all aimed at increasing crop efficiency while reducing environmental impact.

Benson Hill, founded in 2012 and headquartered in St. Louis, USA, integrates advanced technologies such as data science, genomics, AI, and machine learning into its biotechnology platform, CropOS. This platform accelerates crop breeding by using gene sequences, AI-driven predictions, and CRISPR 3.0 gene editing to shorten breeding cycles and enhance crop growth, significantly improving breeding efficiency.

Yield10 Bioscience is focused on advancing sustainable seed products based on the oilseed Camelina sativa. These products include renewable diesel, aviation biofuel, omega-3 oils for pharmaceuticals and nutrition, and PHA biomaterials for biodegradable plastics. Yield10's business model involves partnering with the biofuel industry and licensing its Camelina genetic technology to meet the growing demand for low-carbon feedstocks and omega-3 oils.

The global agricultural gene editing field is rapidly evolving, with leading companies such as Bayer, Corteva, Pairwise, and Syngenta driving widespread adoption through strategic partnerships and technological advancements. These companies are not only improving crop yields and stress resistance but are also addressing the challenges of global food security and environmental change. While legal and ethical issues persist, the potential for gene editing technology in agriculture remains vast, offering strong support for sustainable agricultural development, food security, and innovation. As technology continues to advance and multi-party collaborations deepen, gene editing is poised to become a crucial driver of global agricultural innovation.

Company	Nation	Main Technologies	Main Projects
Bayer	Germany	CRISPR	Corn, soybeans, cotton, etc.
Corteva	USA	ZFN , CRISPR	Drought-resistant corn, wheat and EXZACT™ , a precision genome modification technology platform
Syngenta	China	CRISPR	Corn, soybeans, wheat, tomatoes, rice, sunflowers and innovation platform Shoots by Syngenta
Cibus	USA	TALEN, CRISPR	Flax, herbicide-tolerant rapeseed
Yield10 Bioscience	USA	CRISPR	Camelina
Benson Hill	USA	CRISPR	Corn, soybeans, wheat, barley, etc.
Inari Agriculture	USA	CRISPR	Corn, soybeans, canola and cotton
Pairwise	USA	CRISPR	Mustard greens, blackberries, raspberries, cherries, etc.
Tropic Biosciences	U.K.	CRISPR	Bananas, coffee and rice
Sanatech Seed	Japan	CRISPR	Tomato

Figure 1. 10 representative commercial companies

The Promise of Gene Editing in Chinese Agriculture

Biological breeding has become a key national strategy for China. The country has explicitly outlined in the "14th Five-Year Plan" and the Long-Term Goals for 2035 that the industrialization and application of biological breeding should be promoted in a systematic manner, with a focus on nurturing leading seed companies that can compete internationally. Currently, domestic companies are quite active in the field of agricultural gene editing, particularly in crop gene editing. However, there are still relatively few companies involved in animal gene editing and breeding.

The following overview of China's agricultural gene editing sector highlights the dominance of crop-focused gene editing companies, while animal gene editing remains a relatively underdeveloped area.

BellaGen is a leading plant gene editing company in China that has successfully broken the foreign monopoly on core gene editing technologies. The company has independently developed the CRISPR-Cas SF01 and CRISPR-Cas SF02 gene editing tools, which have driven the industrialization of plant gene editing. In April 2023, BellaGen Bio became the first company in China to receive a plant gene editing safety certificate. It followed up with two additional safety certificates in 2024, including the groundbreaking approval in May 2024 for its gene-edited dwarf corn, China's first staple food crop to receive this certification.

Qi-Biodesign, founded in 2021, is a global leader in gene editing biotechnology. With independent core intellectual property rights and a competitive technology platform, Qihe has developed the full-chain SEEDIT R&D platform. Its PrimeROOT and other gene editing tools have bypassed existing patent restrictions, providing crucial technical support

Company	Main Technologies	Main Projects
BellaGen	CRISPR	Industrial operation of gene editing in plants such as rice, wheat, soybeans, and corn
Misheng Biological	CRISPR	peanut
Biogle GeneTech	CRISPR	Arabidopsis to rice, soybean, corn, tomato, tobacco to mice
Edgene	CRISPR	Rice, soybeans, corn, tomatoes
Qi-Biodesign	CRISPR	Rice, wheat, soybeans, corn, potatoes and more than 30 kinds of economic and special plants

Figure 2. China's gene editing companies

for developing a new generation of transgenic and gene-edited products. The company's achievements have garnered international recognition, including Cell's 2023 Best Paper and Nature's 2024 Most Noteworthy Seven Technologies.

Edgene has developed a self-owned precision breeding platform, HiGeMP™, and worked extensively with research teams, breeders, and seed companies to promote the industrial application of gene editing technology. To date, Edgene has supported over 1,000 research teams and companies, successfully transforming more than 20 crop varieties, including major crops such as corn, soybeans, and rice, overcoming the limitations of traditional breeding methods.

Misheng Biological has developed a world-leading peanut gene transformation platform, utilizing gene editing technology to create "super peanuts." These new varieties are expected to significantly increase yield and oil quality, contributing to the diversification of the peanut industry.

Biogle GeneTech has built extensive experience in both animal and plant gene editing using CRISPR/Cas9 technology. The company has provided genome editing services to over 200 research institutes worldwide. Its efficient gene editing capabilities and collaborations with leading domestic laboratories have advanced the adoption of gene editing technology.

The continuous innovation and breakthroughs from these companies showcase China's strong technical capabilities and the immense potential in the gene editing field. As the technologies mature, biological breeding will play an increasingly important role in enhancing crop yields, improving quality, and driving agricultural modernization.

Genome editing technology, particularly the breakthrough CRISPR system, is redefining the boundaries of life sciences, offering unprecedented opportunities in agriculture, medicine, and bioengineering. From the precise modification of endogenous genes to the development of stress-resistant, high-yield crops, and from optimizing delivery systems to the innovation of AI-powered tools, the evolution of this technology demonstrates its vast efficiency and versatility.

Globally, companies like Bayer, Corteva, and Syngenta are accelerating gene editing commercialization through strategic partnerships and technological innovation, while the rise of Chinese companies such as BellaGen and Qi-Biodesign underscores China's strength in breaking technological monopolies and advancing industrial applications.

As gene editing technology matures and its applications expand, it will undoubtedly become a core solution for addressing critical challenges like food security, climate change, and sustainable development. This innovation is poised to make a lasting impact on global prosperity and the balance of the earth's ecosystem. AP

The Digital Agricultural Revolution: Shaping a New Era of Global Farming Innovation

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In the Netherlands, greenhouses use IoT systems to precisely control light exposure for each tomato plant; in Northeast China, satellite remote sensing monitors the fertility of thousands of acres of black soil; and in Brazil, coffee farms employ blockchain to trace the growth journey of every coffee bean. These scenes collectively illustrate the unfolding digital transformation of global agriculture. Driven by rapid advancements in information technology, digital agriculture has transcended traditional production limitations, reshaping millennia-old agricultural practices through the integration of data and traditional methods.

Currently, global agriculture faces unprecedented challenges. The UN Food and Agriculture Organization forecasts a 60% increase in global food demand by 2050, yet arable land is degrading at a rate of 10 million hectares per year. Climate change exacerbates the crisis, with global drought-related agricultural losses in 2022 reaching $29 billion. More concerning is the "triple paradox" of traditional farming: mechanized methods increase carbon emissions, chemical farming disrupts soil ecosystems, and inefficient water management wastes 14% of the world's freshwater annually. These pressing contradictions underscore the urgent need for digital agriculture, where technological innovation is building a new paradigm for sustainable growth.

Digital agriculture's transformative power is evident in the systematic evolution of its technological architecture, which can be broken down into three interconnected layers: The top layer, the "digital agricultural platform," facilitates resource allocation and strategic coordination through systems like cloud platforms and industrial Internet hubs. The middle layer, the "intelligent application matrix," includes vertical solutions such as precision farming, smart machinery, and supply chain finance. The bottom layer, "digital infrastructure," encompasses key elements like IoT networks, 5G private networks, and Beidou positioning systems. This layered structure ensures both the openness and coherence of the technical ecosystem, creating a sustainable "agricultural technology pyramid" where each layer adds distinct value to the whole.

When we examine the digital agricultural technology architecture from a vertical perspective, we see three distinct strategic levels, each with its unique functional characteristics and development logic. At the top, the "digital agricultural platform" is emerging as the central hub of industrial innovation. In the application layer, the "intelligent application matrix" is driving paradigm shifts in agricultural production methods. Meanwhile, at the foundational level, the evolution of "digital infrastructure" determines the overall pace of technological advancement across the system. This layered interaction resembles a "trio sonata" within the digital agricultural ecosystem—each part performs independently yet harmonizes to create a dynamic symphony of agricultural transformation.

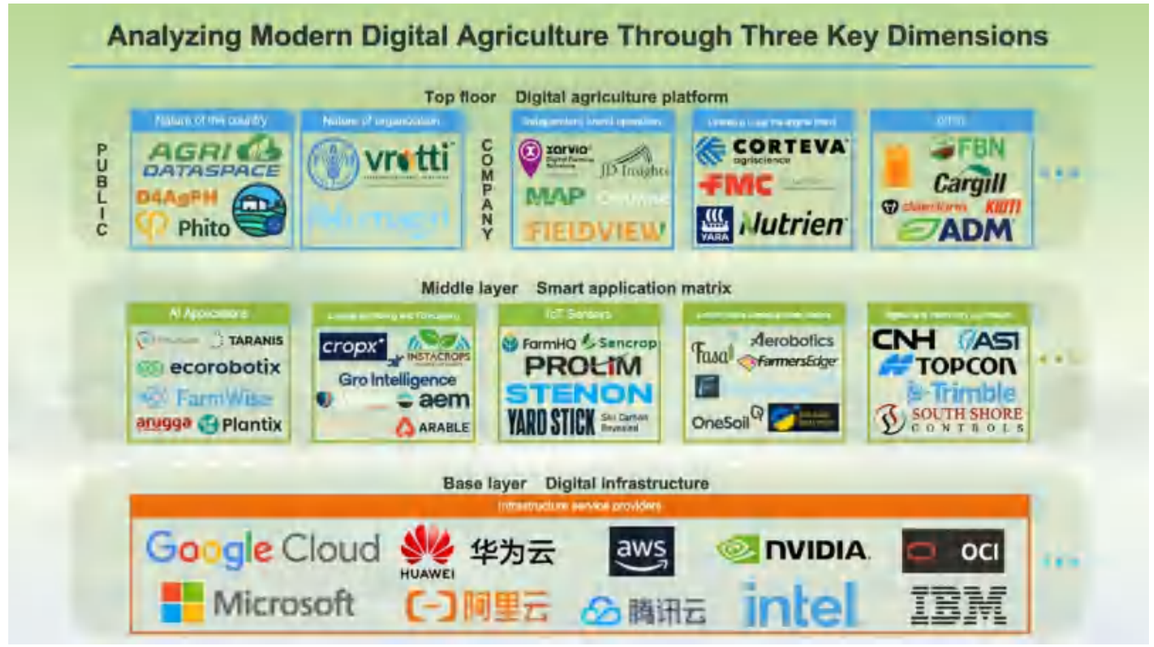

Figure 1. Analzing Modern Digital Agriculture Through Three Key Dimensions

Digital Agricultural Platforms

When discussing digital agricultural platforms, leading examples like BASF's Xarvio, Bayer's FieldView, and Syngenta's CropWise are well-known industry benchmarks. However, beyond these prominent enterprise-led platforms, numerous government and research institution-driven platforms are also playing a crucial role in advancing agricultural digitalization. These platforms contribute significantly to the development and widespread adoption of agricultural technologies.

Currently, global agriculture is undergoing a profound platform transformation, and digital agricultural platforms are evolving into a dual-track system: on one side, there are public-oriented platforms, and on the other, commercial platforms led by enterprises. Both types of platforms are creating distinct value networks, working together to drive the digital transformation and sustainable development of agriculture.

Digital Platforms with Public Attributes

In the realm of public platforms, the EU's FaST platform stands out as a leading initiative. Leveraging space data from systems like Copernicus and Galileo, along with a wide range of public and private data sources, FaST aims to become the world's premier agricultural solution-generation and reuse platform. By integrating agricultural data hubs across multiple European nations, the platform adopts a modular design that supports the implementation of EU agricultural policies. Additionally, it fosters sustainable development and enhances sector competitiveness through machine learning-driven image recognition and the integration of IoT, public sector data, and user-generated content.

Similarly, Uganda's YoPay Agric system brings agricultural services directly to rural farmers, improving access to agricultural information and services. This platform focuses on enhancing information flow and service delivery in rural areas, helping farmers make informed decisions. The International Semi-Arid Crops Research Institute's ICT platform also offers timely, targeted information, such as weather forecasts, market prices, crop management tips, and pest and disease diagnostics. Delivered via mobile apps, these services allow farmers to access decision-support tools, improve productivity, and better manage their farms.

Although these platforms are non-profit, they play a crucial role in bridging the digital divide, supporting agricultural development, and ensuring food security. They equip farmers with reliable tools to navigate challenges like climate change, market volatility, and technological gaps.

In contrast, corporate-driven digital platforms, created by agricultural giants, tech companies, and cross-border investors, are rapidly transforming agricultural production practices at a much faster pace.

Enterprise-Led Digital Agriculture Platforms

In contrast to public platforms, enterprise-led digital platforms are more commercially focused and play a central role in the agricultural value chain. These platforms are not just innovative products developed by ag-tech companies; they are becoming a key driver of agricultural technology advancements. The core value of enterprise-led platforms lies in offering a range of precision services to agricultural practitioners, including crop management, pesticide application, weather forecasting, and soil monitoring.

Enterprise-led platforms can be grouped into several categories. The first includes platforms developed by agricultural input companies, such as BASF's Xarvio, Bayer's FieldView, and Syngenta's CropWise. Another category features platforms created by agricultural machinery manufacturers, like John Deere's JDInsight™, which provides intelligent connectivity and data analysis for farm equipment. Additionally, the Farmers Business Network (FBN), backed by American grain giant ADM, has emerged as a significant player in the digital agriculture sector, becoming an essential tool for agricultural producers engaged in digital farming.

BASF's Xarvio Digital Platform

BASF's Xarvio platform is one of the most influential digital agriculture tools globally, focused on enhancing crop growth and yield. By providing farmers with precise data and decision-making support, Xarvio helps optimize production management. Its core functions include precision planting, intelligent pesticide application, and crop protection. The platform integrates satellite imagery, weather data, soil information, and more to offer farmers a comprehensive farm management tool that enables them to monitor and manage various activities on their land.

Xarvio's main modules include Crop Protection, Seeding, Nutrition, Data Management and Analytics, and Connectivity. Together, these modules allow farmers to make more accurate planting decisions, reduce resource waste, and boost the sustainability of agricultural production. Additionally, Xarvio leverages advanced artificial intelligence (AI) and machine learning (ML) to analyze field data in real-time, predict pest and disease outbreaks, and offer precise pesticide application recommendations.

Bayer's FieldView Platform

Bayer's FieldView platform is another major innovation in digital agriculture. It provides farmers with smarter decision-making tools to optimize production. FieldView's modules include Gather Information, Build Prescriptions, Scout Fields, and Analyze Data, which help farmers refine planting strategies and enhance crop health and yield through data collection and analysis.

FieldView excels in data integration, combining weather data, soil quality, crop health, and pesticide use into a unified platform. This offers farmers comprehensive decision support. Bayer has also introduced precision fertilization and pesticide management tools within FieldView, enabling farmers to minimize waste and reduce production costs through targeted applications.

Syngenta's CropWise Platform

Syngenta's CropWise platform is highly adaptable to regional agricultural needs. Its seven core modules—Commodity Pro, Planting, Protector, Spray Assist, Imagery, Operations, Seed Selector, and Sustainability—form a comprehensive agricultural management system that supports precision and scientific management from planting through to harvest.

What sets CropWise apart is its regional customization. The platform is available across six continents, in 48 countries, including 26 in Europe, 8 in South America, 7 in Africa, 4 in North America, 2 in Asia, and 1 in Australia. This global reach allows Syngenta to tailor the platform's features to the specific needs of each region, driving the digital transformation of agriculture worldwide.

Key modules such as Operations optimize field management, crop monitoring, and real-time data analysis,

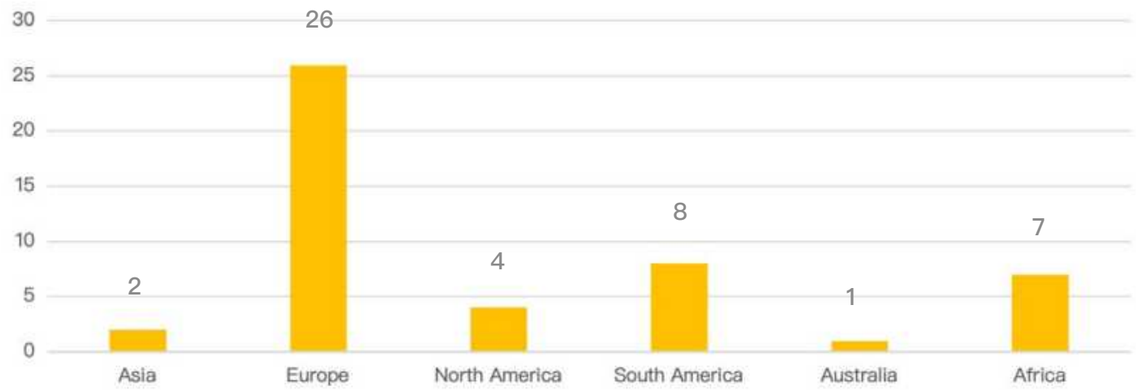

Figure 2. Syngenta's CropWise application areas

Intercontinental	country	Specific services							
		Commodity Pro	Planting	Protector	Spray Assist	Imagery	Operations	Seed Selector	Sustainability
North America	Canada						★		★
	United States	★		★		★	★		★
	Mexico			★			★		
	Guatemala			★					
South America	Argentina		★	★		★	★		★
	Panama						★		
	Colombia			★			★		
	Peru			★			★		
	Bolivia						★		
	Paraguay			★			★		
	Uruguay		★				★		
	Brazil		★	★		★	★		
Africa	Egypt						★		
	Namibia						★		
	Mozambique			★					
	South Africa				★		★		
	Rwanda						★		
	Zambia						★		
	Congo						★		
Australia	Australia	★					★		
Asia	Kazakhstan						★		
	Uzbekistan						★		
Europe	Russia	★						★	
	Turkey						★	★	
	Georgia						★		
	Spain			★			★	★	
	France			★					
	United Kingdom				★		★	★	
	Ireland				★				
	Greece				★				
	Italy		★			★		★	
	Switzerland								★
	Belgium				★				
	Ukraine		★				★	★	
	Moldova						★		
	Romania	★	★		★		★	★	
	Bulgaria	★			★		★	★	
	Serbia							★	
	Hungary	★	★	★	★	★	★	★	
	Austria				★				
	Estonia						★		
	Lithuania						★		
	Poland				★		★	★	
	Slovakia						★	★	
	Czech Republic						★	★	
	Germany		★	★	★	★	★	★	
	Netherlands				★		★		
	Denmark				★				

★ CropWise delivers this service locally on Syngenta's behalf.

Figure 3. Syngenta's CropWise application countries and services

while the Sustainability module focuses on promoting green agriculture in select countries. CropWise not only improves productivity but also helps farmers tackle challenges like climate change, market fluctuations, and resource management through intelligent data support.

In addition to BASF, Bayer, and Syngenta, several other companies are making significant strides in the digital agriculture space. For instance, Yara, Corteva, and FMC have launched impactful digital platforms that assist farmers in improving productivity and achieving sustainable agricultural management.

Corteva's Digital Agriculture Platform

Corteva's digital agricultural products, such as Granular Insights, Carbon Solutions, and LandVisor, are designed to help farmers make informed decisions and optimize production through intelligent data analysis and tailored recommendations.

Granular Insights integrates farm data to provide dynamic agronomic layers and financial charts, offering farmers a clear view of their financial management and crop production. This enables better planting plans and resource allocation. The platform's operational data analysis helps farmers adjust strategies in real-time, boosting production efficiency.

Carbon Solutions is an innovative service aimed at promoting sustainability. It helps farmers improve soil health by adopting climate-friendly regenerative practices, while enabling them to sell carbon credits to Corteva, thus creating additional value. This program supports sustainable agriculture and contributes to the growth of the carbon credit market.

LandVisor is another advanced tool that combines image analysis and data technology to give farmers deeper insights into soil conditions, crop growth, and the broader agricultural environment. This helps inform farmland management decisions for better outcomes.

FMC's Digital Agriculture Products

FMC has introduced several cutting-edge solutions in digital agriculture, including the Arc™ Farm Intelligence Platform, which focuses on precision agriculture. By monitoring real-time farm data, it helps farmers predict pest pressure, make informed pest control decisions, reduce pesticide use, and improve crop yield and quality. The platform provides targeted pesticide recommendations based on data analysis, optimizing resource use.

FMC's 3RIVE 3D® application technology is another breakthrough, offering more efficient crop protection. It enables faster land coverage with fewer pesticide applications, saving water, fuel, and labor, ultimately reducing costs and improving resource efficiency. Additionally, PrecisionPac® offers tailored herbicide combinations for specific crops and fields, enhancing the accuracy and effectiveness of crop protection.

Yara's Diversified Digital Solutions

Yara has built a comprehensive digital agriculture portfolio with region-specific solutions. In Europe, platforms like YaraPlus, Atfarm, and TankMix support precise fertilization, crop management, and pesticide application. These tools help farmers optimize agricultural practices by providing guidance based on climate and farm data, driving efficient and sustainable production.

In Africa, Yara has developed FarmCare, AllFarm, and YaraConnect platforms to boost productivity, improve farmer education, and promote smart farming practices. The Yara Crop Nutrition Recommendation System helps farmers apply fertilizers precisely at different growth stages, minimizing waste and maximizing yield. Atfarm enhances nitrogen use efficiency, and TankMix offers advice on safe mixing for crop protection.

As digital agricultural technology continues to evolve, platforms like BASF's Xarvio, Bayer's FieldView, and others are not only enhancing production efficiency but also reducing resource waste and improving crop health and yields. However, challenges remain, including data privacy concerns, the adoption of new technologies, and farmers' willingness to embrace digital tools.

Smart Application Matrix

Having discussed digital agriculture platforms, let's now focus on the Smart Application Matrix that operates within these platforms. This matrix can be divided into two parts:

- Smart Application Suppliers Integrated into Platforms: These are the companies that either provide services to the platforms or have their solutions embedded within them.
- Innovative Companies Providing Specific Digital Agriculture Services: These companies offer specialized services that support digital agriculture applications.

Strategic Partnerships and Platform Integration

One of the most notable developments in the first category is the strategic collaboration between Orbia Netafim and Bayer. This partnership aims to deliver advanced digital solutions for fruit and vegetable growers, simplifying data collection and offering customized recommendations to optimize crop yields, resource use, and environmental impact. Despite increased digital tool usage, current solutions in horticulture still fall short, with growers often juggling multiple software applications that complicate rather than simplify operations. To address this, Bayer introduced HortiView, a platform that streamlines the collection and sharing of essential data in fruit and vegetable cultivation. This integrated system enables growers to benefit from an interconnected ecosystem that supports data-driven decision-making and market access.

Netafim, a leader in precision irrigation, has also contributed to this partnership with irrigation insights available through HortiView. These tailored irrigation recommendations are based on specific grower data, rather than a one-size-fits-all approach. The partnership further integrates with GrowSphere™, Netafim's irrigation operating system, to optimize irrigation, crop protection, and water-fertilizer application.

This partnership, which builds on years of successful cooperation, including joint efforts in programs like Better Life Agriculture and Farm2Fork, is currently in a pilot phase with a few planting consultants, with plans to expand further.

In addition, Bayer's collaboration with AgVend has accelerated digital agriculture's growth. AgVend, a retail management platform, connects agricultural retailers and growers, enabling customized product recommendations, precise pesticide application plans, and real-time data support. This collaboration enhances Bayer's ability to deliver more precise customer service and facilitates data-driven decision-making for growers.

Meanwhile, BASF has expanded its digital agriculture capabilities through a partnership with Planet Labs to leverage satellite data for precision agriculture. This collaboration helps growers improve farmland management, crop monitoring, and sustainable farming practices. Additionally, BASF is working with Arable Labs to integrate field measurement data into its Xarvio® Digital Farming Solutions, optimizing field decisions for better crop production and protection.

Syngenta is also advancing digital agriculture, particularly in AI and precision agriculture. It has partnered with Taranis, an AI-driven crop intelligence platform, to help agricultural retailers provide precise agronomic advice, optimize farm decisions, and increase yields. Syngenta has also teamed up with CNH Industrial to combine Cropwise with CNH's agricultural machinery, enhancing decision-making and creating a more connected data source. This integration extends to John Deere and AG Leader, with plans for future collaboration with Farmobile.

Innovative Companies Providing Specific Digital Agriculture Services

Several innovative companies are leading the way in providing specialized services that contribute to digital agriculture.

AI and Computer Vision Applications

Intello Labs (India) offers AI-based quality inspection systems, including FruitSort (fruit sorting), ShelfEye (food monitoring), and FlowStar (high-speed packaging), to automate quality control across the entire supply chain.

Plantix (Germany) is a mobile app that diagnoses pests and diseases in seconds by analyzing photos. The app covers major crop systems in 127 countries and provides edge computing capabilities with a 15MB micro-installation package.

Sensors and IoT Innovations

Stenon (Germany) has developed a real-time sensor for soil health optimization, replacing traditional lab tests and providing actionable insights within 15 minutes.

Instacrops (Chile) combines IoT, satellite, and drone technologies to create an integrated platform, offering accurate frost warnings (92% accuracy) and smart irrigation control to save 23% of water.

Satellite Remote Sensing and Data Analysis

OneSoil (Switzerland) uses machine learning to process satellite data across 5% of the world's arable land, providing farmers with free monitoring tools and achieving an 18% paid conversion rate.

Arable (USA) has established a sensor network that combines meteorological, soil, and crop data to provide actionable agronomic insights via an API interface.

Intelligent Agricultural Machinery and Automation

Augmenta (Greece) has developed the LiveVRA module, which dynamically adjusts fertilizer application based on canopy health monitoring. Its Mantis adapter kit is compatible with leading agricultural machinery brands like John Deere, significantly reducing investment payback periods.

Arugga (Israel) focuses on facility agriculture with its Polly pollination robot, which uses AI and air pressure pulse technology to achieve 300% greater efficiency than manual pollination.

Agricultural Finance and Integrated Management

AGRIVI (Croatia) offers a SaaS platform with a multi-dimensional management system that includes farm insights, IoT data centers, and supply chain modules, impacting food production for over 1 billion people.

A de Agro (Brazil) innovates agricultural credit by using big data to assess risk across the entire planting cycle, providing fair credit services to Latin American farmers.

Digital Infrastructure

In the realm of digital agricultural infrastructure, global cloud service providers such as Microsoft Azure, AWS, and Google Cloud, alongside China's tech giants like Alibaba Cloud and Tencent Cloud, are collaborating to build a global digital agricultural ecosystem. By leveraging Infrastructure as a Service (IaaS) and Platform as a Service (PaaS) models, these platforms not only provide computational support for multinational agrochemical companies like Bayer and Syngenta, but also play a role in developing digital agriculture platforms. Although these cloud providers extend their reach into various fields like the Internet of Things (IoT), blockchain, and AI modeling, their core mission is to advance digital infrastructure in agriculture.

The growing trend of market consolidation has led cloud platforms to reshape the technical foundation of the

agricultural value chain. International examples include John Deere, whose precision agricultural machinery system runs on AWS, and Bayer's Climate FieldView, which is hosted on Microsoft Azure. In China, Alibaba Cloud's ET Agricultural Brain supports over 200 digital agricultural bases, and Tencent AI Lab's AI planting solution spans multiple provinces via Tencent Cloud Services. This technology convergence has prompted traditional agricultural enterprises to move away from self-built data centers and adopt scalable cloud architectures. For example, during peak sowing seasons, cloud platforms can reduce computational costs by up to 40% while maintaining real-time data analysis.

The smart application ecosystem in digital agriculture has formed a clear collaborative structure: platform integrators and vertical innovators work together in a two-pronged approach to technology implementation. Industry leaders such as Bayer, BASF, and Syngenta have integrated cross-sector capabilities through strategic partnerships (e.g., Bayer × Netafim's HortiView platform, BASF × Planet Labs' satellite data integration, and Syngenta × Taranis' AI agronomy platform). These collaborations aim to address data silos and provide growers with integrated solutions—from irrigation optimization (e.g., GrowSphere™ system) to sustainable farming (e.g., Xarvio® precision analysis).

At the same time, long-tail innovators continue to make breakthroughs in specialized agricultural scenarios. Examples include:

Intello Labs' 360° AI sorting machine that grades fruits and vegetables at three times per second.Arugga's pollination robot that boosts greenhouse efficiency by 300%.Stenon's sensor that reduces soil testing from 5 days in the lab to just 15 minutes in the field.

These technologies, driven by precision and response speed, are being integrated into mainstream platforms via API interfaces (e.g., Arable's cross-platform data flow) or hardware compatibility solutions (e.g., Augmenta's integration with John Deere machinery). This has created an "aircraft carrier fleet + special operations unit" model, where large platforms collaborate with specialized innovators for maximum efficiency.

This hierarchical collaboration model not only drives the adoption of digital agriculture (e.g., OneSoil has covered 5% of the world's arable land), but also reshapes industry value distribution. By aggregating data, platform companies help reduce farmers' decision-making costs (e.g., Instacrops' frost warning system with a 92% accuracy rate). Meanwhile, vertical innovators generate added value through technological advances (e.g., Plantix's 15MB lightweight diagnostic network across 127 countries).

The digital transformation of agriculture is no longer just about technological innovation—it has evolved into the fundamental operating system of the global food system. For instance, Agrosmart's climate intelligence platform and AGRIVI's management system, which serves over a billion people, are sharing irrigation data across Latin America. A de Agro's dynamic risk assessment model, powered by real-time field data, is revolutionizing agricultural credit models. As these technologies spread, digital agriculture is increasingly becoming the backbone of the global food ecosystem. AP

2023-2024 Global Agricultural Policy Comprehensive Review and Trend Analysis

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Policies play a crucial role in global agricultural development, running through several key areas and triggering trend change. Recently, AgroPages conducted a systematic review of significant new agricultural policies launched worldwide in 2023-2024, covering chemical pesticides,biopesticides,biostimulants, genetic technologies, fertilizers, seeds, agricultural products, and the transformative and sustainable development of agriculture.

- Intensified integration of digitalization and precision management. The management of agricultural inputs is experiencing an accelerated digital transformation; industry sectors such as pesticides, fertilizers, and seeds are introducing advanced digital tools to carry out delicacy management covering whole-course traceability, from production to marketing.
- Accelerated transformation towards environment-friendly development and sustainability: Environmental impact regulation becomes stricter; the use of chemical substances is more strictly restricted; promotion of eco-friendly products and digital labels becomes a growing trend.
- Biopesticide and biostimulant regulatory frameworks are constantly improving. As their market acceptance increases, more countries are beginning to establish specialized registration and administration systems.
- A major change in biotechnology regulation: The developed economies represented by the European Union are beginning to relax control of new biotechnologies such as gene editing. At the same time, some emerging countries are open to applications of gene-editing technology.
- Global trade protectionism tends to increase: The trade pattern of agricultural products is being reshaped as some countries adjust tariffs on farm products, try to protect the agricultural industry, or stimulate exports to increase international competitiveness.

Pesticide Regulation Policies

Since 2023, the global pesticide regulation system has been noticeably moving towards scientific, efficient, environment-friendly, and sustainable development. All countries/regions have shown the common trend of enhancement of registration management, optimization of the approval process, strengthening of environmental impact assessment, and the whole process control of pesticide registration and application to be placed under delicacy management.

China: In November 2024, the Chinese Ministry of Agriculture and Rural Affairs updated and revised five regulations, which were made public for comment, including the Measures for Administration of Pesticide Registration, which was issued in June 2023, aiming to improve the pesticide management system further. The pesticide registration management measures clearly stipulate that the same pesticide label of the same registrant should be only marked with the same trademark. In addition, since 2023, the Ministry of Agriculture and Rural Affairs has taken measures to improve the efficiency of management, such as the imposition of responsibility on pesticide registration applicants and the implementation of the electronic licensing system; the measures have defined clearly the process of "re-application" of pesticide registrations which are not approved, and the adoption of classified management and clean-up of pesticide granule products within the specific time limit.

United States: In 2023, the US EPA issued guidelines to improve the efficiency of ESA analysis of applications for novel conventional pesticidal active ingredients, having established the Vector Expedited Review Voucher Program to incentivize the development of novel pesticides. At the same time, the ESA guidelines for the review of novel outdoor use of registered pesticides were issued to streamline the process of PRIA pesticide application review. In November 2023, the US EPA started to enhance certification of the Restricted Use Pesticide (RUPs) applicators, having raised the capacity requirement and recertification standard. In addition, in 2024, the US EPA finalized its first plan of protection of endangered species, the Herbicide Program, and also promulgated the Vulnerable Species Action Plan to protect species that are "vulnerable" to pesticides. In January 2025, the US EPA launched the MyPest tracking system to provide pesticide registrants with a real-time tracking tool to check on the progress of applications, which is a promotion of intelligent and transparent pesticide management.

Brazil: In November 2023, the Brazilian Senate passed Bill 1459/2022, which authorizes the centralized processing of pesticide product registration within the Ministry of Agriculture (Mapa), setting a new and shorter registration deadline, also addressing the issue of issuance of temporary licenses for product registrations that are not completed on time. Meanwhile, Brazil issued two new pesticide registration regulations – Ordinance No. 02/2023 and No. 03/2023, countersigned by Mapa, Anvisa, and Ibama, aiming to simplify the process of approval of low-risk products, with a 4-year term of approval to optimize the efficiency of the assessment. Moreover, in May 2024, the Brazilian Congress exclusively delegated the responsibility of registration for pesticides, environmental control products, and associated products to Mapa, which is a further optimization of the pesticide registration process.

European Union: Measures taken in crop protection management since 2023 include the European Commission's new regulation passed in May 2024 setting a data requirement for the approval of safeners and synergists used in crop protection products, while a comprehensive plan of review of these substances was formulated to ensure their safety and efficacy. In September 2024, the European Commission published a list of safeners and synergists contained in crop protection products that are already registered in member states. It is worth noting that the European Union finally issued a notification in November 2023 announcing the

extension of the valid period of the approved herbicide glyphosate for 10 years.

Argentina: In November 2024, Argentina announced that the registration process for all crop protection products and biological inputs be undertaken in unison on the SIGTrámites platform to streamline the process of registration, which enables self-managed process, online payment, process traceability and shortened time of processing.

Ukraine: In December 2023, Ukraine issued a notification amending the Regulations on Pesticides and Agrochemicals. The amendment introduces a new requirement for the provision of information that should be indicated on the label of pesticides and agrochemicals.

In addition to the changing pesticide management regulations, since 2023, some countries and regions have banned a variety of pesticidal active ingredients, as shown in the following table:

In addition to dozens of pesticidal active ingredients banned by various countries or regions, the global regulatory restriction on chlorpyrifos has occurred frequently in the past two years. In June 2023, Colombia revoked registration of chlorpyrifos while rejecting new applications. In the meantime, Nigeria announced a ban on chlorpyrifos. In 2024, the US EPA updated the final status of the cancellation order and the requirement of handling the existing stock of chlorpyrifos of ADAMA, Corteva, Drexel, Loveland, Kaizen, and Gharda, and added other restrictions, which prohibit the sale and distribution of the existing stock of chlorpyrifos products after the specified deadline. In October 2024, Australia also announced the termination of most of the applications of chlorpyrifos for agricultural production and urban pest control.

In the past two years, the ban and restriction of neonicotinoid pesticides in major agricultural markets around the world have been growing drastically. In April 2023, the European Court of Justice prohibited member states from the temporary use of such kind of banned substances in the treatment of seeds, having terminated emergency authorizations of 3 banned substances: Imidacloprid, clothianidin, and thiamethoxam. In June 2023, the New York State Assembly passed the Birds and Bees Protection Act, prohibiting the sale of neonicotinoid pesticides. Prior to this, the US states of New Jersey and Maine had already banned neonicotinoid pesticides. In March 2024, Ibama of Brazil announced a stop to spraying of thiamethoxam by machinery such as tractors or agricultural aircraft.

In addition, a number of pesticides are put under control in different manners in different countries, such as the Industrial Restructuring Guidance (2024 Edition) implemented by China in February 2024, which restricts the use of 28 pesticides, including glyphosate, diquat and glufosinate; the registration and production license of high-toxic aluminum phosphide formulations will be revoked in March 2025, and the use of chloropicrin formulations will be restricted. In the United States, new restrictions are added to the applications of dicamba, glufosinate-P, atrazine, and methomyl, requesting the implementation of a lower concentration standard or protection of endangered species. Canada has called off the use of tebuconazole in lawns, while Australia has banned malathion for use in water bodies and larval mosquito control.

Country/ region	Pesticidal Active Ingredients	
	Banned	Not to be renewed
European Union	Dacthal, methoxychlor, ipconazole, activated Ester, fenpyrazamine.	Dimethomorph, metolachlor, metiram, clofentezine, dimoxystrobin, tritosulfuron, metribuzin.
China	Phorate, isofenphos-methyl, isocarbophos, ethoprophos, omethoate, carbofuran, methomyl, and aldicarb.	
United States	Dacthal	
Australia	Dacthal	
United Kingdom		Silver thiosulfate
Punjab, India	Acephate, buprofezin, chlorpyrifos, hexaconazole, propiconazole, thiamethoxam, profenofos, imidacloprid, carbendazim, tricyclazole.	
India	Monocrotophos, dicofol, dinocap, methomyl.	
Myanmar	Atrazine, mesotrione, terbuthylazine, metolachlor, fomesafen.	
Colombia	Chlorpyrifos, fipronil.	
Costa Rica	Chlorothalonil	
Nigeria	Paraquat, chlorpyrifos, atrazine.	

Biopesticide and Biostimulant Management Policies

Although global biopesticide and biostimulant management policies have focused differently since 2023, they generally demonstrate a combination of scientific, systematic, and efficient characteristics. Overall, regulatory measures in countries such as Brazil, the United States, and Argentina are primarily focused on whole-course supervision, process simplification, risk-classified management, and digital management.

Brazil: In June 2024, the Brazilian ANVISA issued RDC 876/2024 to simplify the process of post-registration amendment and cancellation of biologics. In December 2024, Brazil's Chamber of Deputies approved PL658/2021, which allows farm production of biological inputs under appropriate supervision but prohibits the reproduction of commercial products and commercial sale of products for personal use. In the same month, the President of Brazil signed Law No. 15070, which is a comprehensive stipulation of production, commercialization, and regulation of biological inputs, covering production, import and export, the definition of concepts, and the setup of Trepda to ensure a smooth going of the process.

United States: In December 2024, the US EPA announced a simplified registration review process for several low-risk biopesticides, including methyl mannoside, for which no further review is required, as proposed by the EPA.

Argentina: In October 2023, SENASA of Argentina updated the registration requirement for biologics through Resolution 1004/2023. In November 2024, Argentina announced that the registration process for all crop protection products and biological inputs, including biological inputs, fertilizers, and pesticide products, would be processed on the SIGTrámites platform.

India: In December 2024, India amended the Fertilizer (Inorganic, Organic, or Mixed) Control Order 1985 to amend the addition of biostimulants. The amendment also adds "live microorganisms" as a category of biostimulants and has exempted some of the low-risk biostimulants from toxicity testing.

Pakistan: In January 2024, Pakistan approved its biopesticide registration guideline, which includes a new application form and related information requirements for the registration of biopesticides, in particular regarding the minimum data requirement, registration exemptions, and stipulations on the cases of exemption of active ingredients and formulation products.

GMO/Gene Editing Technology Regulatory Evolution

At present, global GMO/Gene-editing technology has moved into a new stage, and regulatory policies in various countries have shown diversified development trends.

Some countries or regions, such as the European Union and the United States, have made adjustments to the GMO/gene-editing regulatory framework to adapt to the needs of technological innovation and industrial development. For example, in July 2023, the European Commission put on a proposal on NGTs and PRMs, which was initially raised by the Council of the European Union in 2019. The proposal prohibits the authorization of patents for NGTs-modified plants and related materials, genetic information, and processes.

In January 2024, the European Parliament's Environment Committee voted through the amendment to the proposal concerning NGTs. In February 2024, the European Parliament formally approved the proposal on NGTs. The Council requires mandatory labeling of NGT plant products and a blanket ban on patenting NGT plants and related technologies. Regulation-oriented negotiations on NGTs have been at a standstill since December 2023 due to concerns about the traceability, labeling, and patenting of gene-edited foods.

In the United States, in May 2024, the US EPA, FDA, and USDA released a joint biotechnology regulation plan that clarifies the responsibilities of each department for regulation. This aims to reduce repeated supervisory work and improve the transparency and efficiency of regulation. In addition, the EPA clearly announced exemptions for two types of gene-edited crops using novel biotechnology, requiring applicants to demonstrate that PIPs are not substantially different in safety from conventionally bred crops. In July 2024, USDA-APHIS circulated a Request for Information (RFI) to invite public comment on options for reducing regulations for modified microbes so as to explore risk-based, non-regulatory standards and mechanisms to provide a framework for future formulation of rules.

China has been progressing steadily with prudential supervision in the development of agricultural GMOs, and it has constantly improved policies and the regulatory system. First of all, the No. 1 Central Government Documents in 2023 and 2024 both proposed acceleration of industrialization of biological breeding as well as a further promotion of expansion of the scope of industrialization, which is a strong policy support to the industrial application of GM crops. Since 2023, the Ministry of Agriculture and Rural Affairs has successively put out specific programs of supervision,

review, and labeling, such as the 2023 Work Plan for Supervision of Agricultural GMOs, the Detailed Rules for Evaluation of Gene-Edited Agricultural Plants (Trial), and the Decision on Revision of Measures of Management of GMO Labeling (Draft for Comments). These measures provide strong policy support and a standardized mechanism of management in favor of the GMO industry development. In February 2025, the relevant policies on agricultural GMO experimentation and pilot testing were released.

Countries like Thailand, Singapore, New Zealand, Costa Rica, and Ghana have shown a positive attitude towards GMO/gene-editing technology. They have gradually relaxed regulations and begun developing or adjusting the relevant regulatory framework to promote the commercial application of GMOs.

In July 2024, the Ministry of Agriculture of Thailand announced legislation for applications for genome-edited organisms. In August, the new regulation Principle, Method, and Condition for the Certification of Organisms Developed from Genome Editing Technology was released, which is a follow-up and detailed implementation of relevant policies. Singapore has published the Regulatory Framework for the Use of Genome Edited Crops for Food and Animal Feed, which aims at premarket safety assessment of all genome-edited crops and approval of GM food. In December 2024, New Zealand's Gene Technology Regulation passed the review of parliament, followed by the next step of legislation proceeding. This Regulation proposes classified management of gene-edited products according to level of risk, with exemptions available to low-risk gene-edited products.

Earlier, in 2023, Ghana's National Biosafety Authority (NBA) published its guidelines on Genome Editing, which guides potential applicants with respect to the application of genome-edited organisms or products. In November 2023, the Costa Rican government amended its agricultural biotechnology regulation through

an administrative order to allow the marketing of crops developed using novel genetically modified technologies like gene editing, as genome-edited products are deemed equivalent to conventional crops. Accordingly, the process of application for the use of GM food is simplified.

On the other side, some countries appear cautious or restrictive of GMO/gene editing technology. For example, in August 2023, the Ukrainian Congress passed the law on regulation of national genetic engineering, genetically modified organisms, and circulation of genetically modified products to ensure food safety, which permanently banned cultivation and distribution of genetically modified corn in Ukraine, while prohibiting cultivation and distribution of genetically modified sugar beet and oil rape for 5 years. In October 2023, Switzerland decided to extend the ban on GMOs for another 2 years. Mexico has extended the ban on the import of genetically modified corn from the United States to 2025, which was initially scheduled to resume in March 2024.

Fertilizer Management Policies

The fertilizer management policies of major countries and regions are as follows:

China: In May 2024, the State Council issued the Decision on Adjusting and Improving Administration of Industrial Product Catalogue Subject to Licensing, which proposes changing the process of approving fertilizer production permits from "provision of commitment" to "grant of license after examination." The examination and approval of production permits are undertaken by the competent department in charge of industrial production licensing at the provincial level, which shall not be delegated to lower-level authorities.

United States: In March 2024, the United States added potash fertilizer and phosphate fertilizer to its Final List of Critical Minerals.

European Union: In 2024, the European Commission released two new regulations amending the Fertilizing Products Regulation (Regulation-EU 2019/1009), strictly restricting the use of synthetic polymers in fertilizer products. In addition, the European Commission has passed a resolution on digital labeling of fertilizer products, which promotes the use of digital labeling on fertilizer products in the EU, simplifying the supplier labeling requirement while reducing costs to the benefit of manufacturers.

Brazil: In March 2023, Brazil executed Decree No. 10991 covering the National Fertilizer Program, aiming to increase domestic production, especially nitrogen fertilizer and phosphate fertilizer, as well as promotion of the use of alternative fertilizer technologies to improve sustainability. At the same time, Brazil has increased import tariffs on certain fertilizer products, whilst increased support is provided to domestic fertilizer production to encourage enterprises to carry out technological innovation.

India: In December 2024, India amended the Fertilizer (Inorganic, Organic, or Compound Fertilizer) Control Order 1985 to enhance the control of fertilizer quality. The revision included optimizing the sampling, analysis, and dispute resolution processes.

Russia: Russia implemented a non-tariff export quota system for nitrogen fertilizer and compound fertilizer in December 2021 to control rising domestic food prices. Since 2023, Russia has twice prolonged the implementation of the fertilizer export quota system.

Thailand: In 2023, Thailand strengthened its supervision of the import, production, and sales of fertilizers, requiring all imported fertilizers to satisfy Thailand's quality standards and labeling requirements. Meanwhile, regular inspections are made on domestic fertilizer manufacturers, who are encouraged to develop and produce new fertilizers.

Vietnam: In March 2024, Vietnam established a new national technical and quality standard for fertilizers, which clearly regulates the quality of fertilizers, testing methods, management measures, and the responsibilities of relevant corporations and individuals. In June of the same year, the Vietnamese Ministry of Finance planned to impose a 5% value-added tax on fertilizers.

Seed Management Policies

As regards the seed management policies, in the past two years, almost all countries have strengthened seed quality supervision to ensure seed safety and reliability. On the other side, policy focuses have somewhat shifted to innovation in the seed industry, which includes facilitation of the establishment of seed industry bases, provision of support to the application of new technologies (such as gene editing), and promotion of international cooperation in the seed industry. At the same time, a lot of countries have implemented differentiated policies on seed market access and seed variety management, which have simplified the approval process to stimulate the market while imposing strict restrictions on imported seeds.

China: In August 2023, China issued a regulatory document on crop seed certification, which clearly says that seed certification should follow the principles of "unified management, common criteria, government guidance, and market operation," demonstrating the formal establishment of China's unified crop seed certification system. In addition, in January 2024, the National Plan for Development of Nanfan Silicon Valley (2023-2030) was proposed, which aims to build Nanfan Silicon Valley into a national seed industry innovation base, a new drive engine to high-quality development of the seed industry, a significant platform for international cooperation in seed science and technology and a pilot area for deepened reformative development and opening up of the seed industry.

Brazil: In March 2023, a new seed management regulation was implemented, which simplified the approval process for seed production and established specific standards for seed production, packaging and storage, analysis and certification, sales, and applications.

Bangladesh: In August 2023, the Ministry of Agriculture of Bangladesh issued a special regulatory order on the amendment to the Bangladesh Seed Rules 2020, permitting private seed dealers to publish and register their proprietary crop varieties in 1 year after being incorporated as a seed dealer, which used to be required to be 5 years.

Canada: In May 2023, Agriculture and Agri-Food Canada (AAFC) published new guidance on regulating the seed industry, stating that gene-edited seeds and plant materials are no longer classified as GMOs and are deemed conventional crops.

Ethiopia: In May 2023, the Ethiopian Parliament enacted a new seed law, the third revision in the country's seed regulatory system's history.

Russia: Russia's 2024 seed import quota restricts the import of seeds of various crops, such as potatoes and wheat. Foreign companies engaged in the seed business in Russia are required to invest in the construction of complete breeding and localized production facilities, and seed companies are required to provide seed production plans to the Russian Ministry of Agriculture on a yearly basis.

South Korea: The Ministry of Agriculture, Food and Rural Affairs (MAFRA) has developed and released the Third Five-Year Plan for Seed Industry Development (2023-2027), proposing major strategies, such as expanding the seed industry's scale, increasing seed exportation, commercializing new breeding technologies, including digital breeding, and concentrated development of competitive key seeds.

Kenya: In 2023, Kenya issued the Seeds and Plant Varieties (Vegetatively Propagated Seeds) Regulation, which aims to improve the quality and diversity of vegetatively propagated seeds. The regulation states that product registration is required for the sale of vegetatively propagated seeds.

Trade Policies of Agricultural Products and Agricultural Inputs

It is a common practice for all countries in a certain period to regulate and control the primary domestic agricultural market through trade policies so as to ensure the stability and security of domestic supply, which also includes tariff adjustment in some countries on necessary agrarian inputs such as fertilizers and pesticides. For instance, in September 2023, the Russian government decided to implement the flexible export tariff system (rates at 4% to 7%) on a wide range of goods in effect from October 1, 2023, till the end of 2024. In April 2024, Argentina announced a significant reduction of import duties on the herbicidal atrazine, glyphosate, and 2,4-D. In November 2024, the Brazilian GECEX issued a vital resolution to implement the preferential tariff of 3.8% on glyphosate as imported from markets outside Mercosur countries.

Since 2023, anti-dumping investigations and measures taken on pesticides of international trading have taken place a lot. For example, the United States and India have successively initiated anti-dumping investigations or taken anti-dumping measures against pesticides from China, such as glufosinate, 2,4-D,

atrazine, and chemicals like resorcinol and MIPA. In the meantime, China is trying to safeguard its industry interest and has launched anti-dumping investigations on pesticide products or intermediates, such as cypermethrin, from India, the United States, and Japan, having continuously imposed anti-dumping duties on the imports of involved products.

To ensure domestic food security, many countries have opted for tariff cuts to increase agricultural imports or to suspend import duties on specific agricultural products. For instance, in June 2023, for the first time in 15 years, India imposed restrictions on trader's stock of wheat. Meanwhile, India planned to cut down or cancel the 40% tariff on imported wheat. In May 2024, Brazil implemented a zero-import-tax policy on two types of non-parboiled rice and 1 type of polished rice. Also, Bangladesh lifted import duties on rice in October 2024. On the other hand, some countries have increased import tariffs to protect the domestic agricultural industry. For example, at the beginning of 2024, 5 Eastern European countries demanded that the EU impose import duties on Ukrainian agricultural products on the grounds that the import is an unfair competition. In June 2024, the European Union imposed high import duties on grains, oilseeds, and processed products from Russia and Belarus.

At the same time, some countries reduced or suspended export tariffs to promote the export of agricultural products. For example, in August 2024, Russia reduced its wheat export tariffs for consecutive weeks.

Moreover, some countries have raised export tariffs or imposed export bans on key agricultural products to restrict the export of farm products. For example, India restricted the export of basmati rice and broken rice while imposing a 20% export duty on parboiled rice. In January 2024, the Russian Ministry of Agriculture proposed raising the soybean export duty from 20% to 50%; in September of the same year, Russia increased its corn export tariff tenfold due to a poor harvest.

Policies Related to Transition Towards Sustainable Agriculture

Since 2023, many countries and regions around the world have been active in promoting the sustainable and transformative development of agriculture by formulating and revising policies and regulations that cover various aspects of agricultural production, including environmental protection, resource utilization, technological innovation, ecological restoration, and adaptation to climate change.

European Union: In 2023, the European Union began to implement new standard agricultural policies, which aim to promote the development of sustainable agriculture, laying more emphasis on environmental protection and adaptation to climate change. In April 2024, the European Parliament initiated a draft EU soil protection law. In November 2024, the Council of the European Union approved the establishment of the first EU-level framework for certification of permanent carbon dioxide removal, low-carbon agriculture, and product carbon storage to promote high-quality carbon dioxide removal and reduce soil emissions, with the purpose of boosting the EU's achievement of the objective of carbon neutrality by 2025.

China: In January 2024, China's first regenerative farming management group standard, the Regenerative Farming Practices—Crop Planting, was released. This standard sets specific specifications for improving soil health, restoring biodiversity, efficiently using water resources, reducing greenhouse gas emissions, upgrading the value chain, and improving the management system.

United Kingdom: In March 2024, the United Kingdom released the Agricultural Transition Plan (2024 Revision), specifying the future development goals of British agriculture.

Besides, international organizations have contributed to the transition towards sustainable agriculture, such as the Food and Agriculture for Sustainable Transformation Initiative FAST), as launched by the United Nations in 2023. In addition, the OECD's report of Agricultural Outlook 2023-2032, released after monitoring and evaluating agricultural policies in 54 countries, documented nearly 600 measures taken by the countries to adapt to climate change in agriculture. AP

Back to Basics:

Lessons from Brazil's Agri-input Market Transformation in 2024 and Road Ahead

By Christina Xie
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In a year marked by turbulence and transformation, Brazil's agricultural input market has emerged as a case study in resilience and reinvention. As the sector grapples with climatic challenges, shifting distribution dynamics, and the rise of innovative models, understanding these changes is critical for stakeholders navigating this complex landscape. In this exclusive AgroPages interview, we sit down with Renato Seraphim - a seasoned industry leader, former CEO, and board member renowned for his expertise in agri-tech and innovation - to dissect the pivotal shifts of 2024 and their implications for the future.

Seraphim's insights reveal a market in flux. From the unraveling of overambitious consolidation strategies to the resurgence of farmer-centric, localized models, his analysis underscores a return to fundamentals: expertise, relationships, and adaptability. He highlights the pitfalls of prioritizing corporate agendas over cash flow and farmer needs, while celebrating nimble players like Paulo Assunção's agronomy-driven service and Ouro Safra's export-savvy approach. The discussion also delves into the burgeoning biologicals sector, where differentiation and quality are emerging as non-negotiables, and the challenges facing international entrants in Brazil's high-cost, high-reward market.

Looking ahead, Seraphim envisions a hybrid future - where cooperatives thrive, digital adoption accelerates, and agronomists reclaim their role as trusted advisors. For companies eyeing growth, his advice is unequivocal: innovate, streamline, and invest in talent.

This interview is a must-read for anyone invested in Brazil's agricultural ecosystem. Seraphim's candid reflections offer not just a diagnosis of 2024's trials but a roadmap for sustainable success - one rooted in simplicity, farmer trust, and the timeless wisdom of "rice and beans" execution.

You've closely monitored Brazil's agricultural input market throughout 2024. What would you say were the most significant structural changes in the market this year?

In 2024, Brazil's agribusiness sector underwent significant transformations. Adverse weather conditions in some regions negatively impacted productivity, leading to reduced profitability for Brazilian farmers, particularly those growing grains. Additionally, there was a noticeable lack of strategic vision from the government, which seemed disconnected from the needs of agribusiness and unclear about its direction.

One of the most striking changes was the disruption in the distribution model. The consolidation trend took a step back, with judicial recoveries, store closures, and asset sales becoming more common. This shift brought the sector back to basics, emphasizing the importance of traditional practices and the role of founders and individuals who deeply understand the needs of farmers. Essentially, the market returned to a "back-to-basics" approach, where expertise and personal relationships with farmers regained prominence.

Renato Seraphim

Speaker, Board Member, Especialista em Tecnologia e Inovação no Agro (Former CEO Albaugh / Agro100 / Ciarama Maquinas)

The judicial recovery of AgroGalaxy marked a turning point for large distributors. In your analysis, what were the key factors that led to the failure of the consolidation model pursued by these large distribution groups?

The consolidation model failed because it did not account for the tight margins inherent to distributors, prioritizing EBITDA and multiple expansion over cash flow management, which is far more critical in this sector. Heavy and overly verticalized structures were created, where the farmer's needs became an afterthought. The corporate agenda was driven more by investor expectations than by a genuine focus on the business itself, ultimately leading to the system's collapse.

Additional factors included frequent leadership changes, with new executives lacking deep market knowledge, and high turnover rates within the commercial teams. Expansion was driven more by ego and less by actual market demand, further exacerbating the issues. These missteps highlight the importance of aligning business strategies with the realities of the agricultural sector and maintaining a farmer-centric approach.

I would like to emphasize that these mistakes have been made in the past by the same distributors that were acquired by these larger companies, and some of them are still struggling to recover. A case I often reference is Campofert, a distributor from São Paulo. They experienced rapid growth, excessive spending, and a significant increase in SG&A (Selling, General, and Administrative) costs - mistakes that ultimately cost them dearly. These are the same issues we are now seeing with some of the major distributors.

While we've seen some major distributors struggle, there seem to be success stories among smaller, more specialized players. Could you share an example of a company that has successfully adapted to the new market dynamics and explain what sets them apart?

I'm particularly impressed by two models that are thriving in Brazil, both of which are deeply focused on the farmer's needs. The first is a model created by Paulo Assunção, an agronomist in Mato Grosso. Paulo successfully identified the key needs of farmers: producing efficiently, achieving profitability, reducing risks, and ensuring effective commercialization. His approach is centered on understanding the entire agricultural cycle. He provides farmers with access to cutting-edge technologies, tailors input purchases to their specific needs while ensuring competitiveness, and delivers high-quality technical assistance. This holistic approach has made his model highly effective and farmer-centric.

The second model I admire is that of Ouro Safra, a distributor located in the interior of São Paulo. Their strength lies in their expertise in commercialization and export, combined with a team that truly understands the business. They've built a company that grows sustainably, expands cautiously, and maintains a strong focus on quality. Their success is rooted in their deep market knowledge and their ability to adapt to the evolving needs of farmers.

Both examples highlight how a farmer-first approach, combined with specialized expertise and strategic execution, can lead to sustainable growth in today's challenging market.

We're seeing increased interest from Indian companies entering the Brazilian market. Based on your observations, what are the critical success factors for these new entrants, and what common pitfalls should they avoid?

It's not just Indian companies; I've also noticed growing interest from Argentinian, Paraguayan, Russian firms looking to enter the Brazilian market. Our market is vast and will continue to grow, but my advice to these newcomers is to thoroughly understand the market and make strategic decisions about where and how to enter.

The biggest challenges they will face include the high operational costs in Brazil, a bureaucratic and expensive regulatory environment, and, most importantly, the cost of capital. Unlike in some other countries, the Brazilian government does not provide direct financing to farmers; instead, it supports by the industry. This means that companies entering the market must be prepared to front both products and capital, as well as be ready to manage the inherent risks of the business.

To succeed, new entrants should focus on building strong local partnerships, understanding the unique needs of Brazilian farmers, and developing a long-term strategy that accounts for the complexities of the market. Those who can navigate these challenges while maintaining flexibility and resilience will be better positioned to thrive.

The biologicals sector has shown remarkable growth in Brazil during 2024. What distinguishes the successful players in this segment from those who have struggled to gain traction?

The biologicals market in Brazil is growing rapidly and will continue to expand. However, one of the biggest challenges I see today is the low barrier to entry. With minimal capital, almost anyone can set up a factory and start selling products, which has led to a decline in market quality and reliability.

The key challenge for companies in this sector is to develop truly differentiated products that deliver consistent results for farmers. In my opinion, the only company currently achieving this is Chr. Hansen, which stands out for its innovative and high-quality products. Their ability to combine innovation with consistent performance sets them apart from others in the market.

Successful players in this segment will need to focus on research and development, build trust with farmers through reliable results, and maintain high standards of quality. Those who fail to differentiate themselves or prioritize short-term gains over long-term value will struggle to gain traction in this competitive and evolving market.

Given the market's transformation in 2024, what structural changes do you anticipate in Brazil's agricultural input distribution system over the next few years?

I foresee several key changes in Brazil's agricultural input distribution system. First, cooperatives will likely grow even stronger due to their vertical integration and the benefits they can directly pass on to farmers. Second, there will be a return to models where the role of agronomists and business owners becomes more prominent, emphasizing personalized service and expertise.

Additionally, I expect to see a significant rise in digital sales for more commoditized products. Technology is transforming agriculture, and farmers - increasingly younger and more innovative - are embracing these changes. Companies that can simplify technology and make it accessible to this new generation of farmers will come out ahead. I call this the "TikTok effect": delivering simple, fast, and clear messages that resonate with today's tech-savvy agricultural community.

In summary, the future will favor those who combine the strengths of traditional models - like cooperatives and expert-driven services - with the efficiency and accessibility of digital innovation.

For companies looking to enter or expand in the Brazilian market now, what would be your key piece of advice based on the lessons learned from 2024?

In my view, the foundation for any company aiming to enter or expand in this market successfully remains the same: differentiated and innovative products, efficient processes to deliver quality and speed to farmers, and, most importantly, skilled people.

Brazil is currently facing a significant labor shortage, particularly in specialized roles, so companies must continuously raise the bar for performance. Investing in talent development and retaining skilled professionals will be critical. Additionally, understanding the unique needs of Brazilian farmers and adapting to the local market dynamics - while maintaining a focus on innovation and operational excellence - will set successful companies apart.

In short, the key to thriving in Brazil's agricultural market lies in combining cutting-edge products, streamlined processes, and a highly capable team to meet the evolving demands of this competitive and dynamic sector.

As we look ahead to 2025, what indicators should industry watchers monitor to gauge the health and direction of Brazil's agricultural input market?

There are several key indicators that I consider essential for evaluating the health and direction of Brazil's agricultural input market, based on my experience leading businesses:

Traditional Financial Metrics: These provide insights into the quality of the business, such as margins, EBITDA, and, most importantly, cash flow. Cash flow is particularly critical in a market where liquidity and financial stability are paramount.

Commercial Performance Indicators: Metrics like market share and Net Promoter Score (NPS) are vital for understanding a company's competitive position and customer satisfaction levels. These reflect how well a business is meeting the needs of farmers.

Human Capital Indicators: Metrics such as Organizational Health Index (OHI) and employee turnover rates are crucial for assessing the strength and stability of a company's workforce. A skilled and motivated team is essential for long-term success.

At the end of the day, our customers - farmers - are straightforward and value simplicity. Companies that think and act in a clear, simple, and farmer-centric way will be the ones that thrive in this market.

Based on your observations of successful and failed cases in 2024, what do you believe will be the most sustainable business model for agricultural input distribution in Brazil going forward?

I believe the most sustainable and successful business model will be a return to the basics - what I call the "rice and beans" approach. This model relies on skilled professionals who deeply understand their customers and the local region, combined with effective risk management. Today, there are numerous tools and companies that can help distributors manage risks more efficiently.

The key is to stay close to the customer, maintain a consistent routine, and recognize that farmers follow a simple journey: investigation, planning, product use, and results. While outcomes won't always be positive, it's crucial to stand by the farmer, regardless of the results. Farmers are perennial - they are the backbone of the industry - and building long-term trust with them is essential.

In short, the most sustainable model will prioritize local expertise, customer proximity, risk management, and farmer support. Companies that embrace these principles will thrive in Brazil's agricultural input distribution market. AP

How Disruptive Technologies Are Reshaping the Biologicals Industry: Insights from Experts

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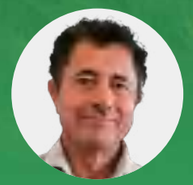

Rafael Juncosa
CEO and President of Futureco Bioscience

Claude Flueckiger
Founder of Flueckiger Consulting

Sarah Myers
VP Marketing at Agmatix

Ron Baruchi
President & CEO of Agmatix

In an era where sustainable agriculture has become a global imperative, biologicals —from biopesticides to biostimulants and soil health solutions— are emerging as critical tools for farmers worldwide. But what's driving the rapid advancement of these solutions? According to industry experts, disruptive technologies like artificial intelligence (AI) and machine learning (ML) are fundamentally transforming how biological products are discovered, developed, and deployed in the field.

The AI-Powered Transformation of Biologicals R&D

"Agriculture is on the brink of a revolution driven by disruptive technologies," notes Claude Flueckiger, Founder of Flueckiger Consulting. These innovations are driving tremendous progress across biologicals, crop protection, soil and plant health, seed technologies, biofertilizers, and water management.

At Futureco Bioscience, AI is already embedded in workflows, driving efficiency, precision, and scientific rigor. Rafael Juncosa, CEO and President, explains that "AI allows us to rapidly process, filter, and extract relevant insights" from overwhelming volumes of scientific literature. This technology is "particularly valuable in regulatory dossier preparation, where AI accelerates data compilation and analysis, ensuring compliance while significantly streamlining the approval process."

Beyond literature review, Juncosa highlights how "AI plays a crucial role in screening active ingredients, proteins, DNA, and RNA, allowing us to curate a more precise set of active ingredients candidates with the highest potential for efficacy and sustainability."

Dr. Pam Marrone, Co-founder & Executive Chair at Invasive Species Corporation, outlines several specific applications where AI and ML are driving innovation:

- More efficient analysis of field data to assess which biologicals work best and why
- Assessing phenotype and genotype changes when biologicals are applied
- Genome mining for microbial biopesticide and biostimulant discovery
- Discovering novel pesticidal proteins and peptides
- Optimizing fermentation processes
- Enhancing formulation development

Marrone notes that these approaches "allow practitioners to be more efficient at discovery and development of new biologicals or assessing current products, reducing resources and time." However, she cautions that quality datasets remain essential: "As one investor told me, 'Data eats algorithms for lunch.'"

Real-world application examples demonstrate this transformation in action. Sarah Myers, VP Marketing at Agmatix, shares how their company "has developed proprietary technology to harmonize and standardize agricultural data, addressing the industry's data inconsistency challenge." By utilizing Amazon Bedrock's generative AI capabilities, Agmatix enhances data-driven tools that enable researchers and marketing teams to analyze trial data more effectively.

Myers cites GG Biologicals as a case study, where adopting Agmatix's Trial Management and Insights platform transformed field trials through live data collection, centralized coordination, and real-time data visualization. This digital approach "reduced errors, improved efficiency, and enabled the creation of clear, visualized reports," allowing GG Biologicals to "confidently demonstrate product performance to customers and investors, accelerating product validation and strengthening market adoption."

Ron Baruchi, President & CEO of Agmatix, summarizes this impact: "AI and machine learning are transforming biologicals R&D by turning complex trial data into actionable insights in real-time. With tools like our GenAI analytics and integration with Amazon Bedrock, companies can streamline trials, ensure data accuracy, and quickly demonstrate product efficacy to drive market success."

Biologicals for Climate Resilience: The Most Promising Solutions

As climate change disrupts traditional growing conditions, biologicals are becoming increasingly critical for agricultural adaptation and resilience. Our experts highlighted several promising approaches.

"Microorganisms!" exclaims Dr. Marrone. "There are many companies and researchers that have shown quantitatively that certain microorganisms (alone or in mixtures) can sequester carbon or shift the soil microbiome to enhance C-sequestering microorganisms." She cites numerous examples, including Groundwork BioAg, Loam Bio, Andes, Pluton Biosciences, Indigo Ag, Locus Ag, and Biome Makers.

Additionally, Marrone points to companies like Pivot Bio, Azotic, Switch Bioworks, and Bioconsortia that are "using naturally occurring, gene edited, or engineered microorganisms to fix nitrogen and reduce chemical fertilizer usage." Plant and seaweed extracts can also "change the microbiome beneficially" or "signal plant beneficial microorganisms to colonize the roots."

At Futureco Bioscience, Juncosa identifies "biostimulants, microbial inoculants, soil regenerators, and advanced biocontrol solutions as some of the most promising tools for helping farmers adapt to shifting climate conditions while maintaining productivity and soil health." Their biostimulant products like Fitomaat and UltraV are "proving invaluable in enhancing crop resilience to drought, heat stress, and salinity."

Juncosa also highlights their Genomaat platform, which "integrates machine learning and soil metagenomic data for advanced agronomic analysis." This data-driven approach aligns with global initiatives like Climate-Smart Agriculture (CSA) promoted by the FAO and recommendations from the IPCC.

Flueckiger observes that disruptive technologies "enhance the development and field performance of biologicals" through precision application and by establishing resilience. He explains that integrating biologicals with new technologies presents "a breakthrough in strengthening self-regulating natural processes," enabling crops to recover from both biotic stresses (pests, diseases) and abiotic stresses (drought, salinity).

This combined approach, according to Flueckiger, "enhances

soil health, plant vitality, and overall farm resilience and productivity," making biologicals "an indispensable cornerstone of resilient, sustainable, and highly productive agricultural systems."

Regional Regulatory Impacts on Commercialization

While technological innovation drives possibilities, regulatory frameworks significantly influence which biological solutions reach farmers and how quickly. Our experts highlighted stark differences between key markets.

Brazil emerges as a bright spot. According to Dr. Marrone, the country maintains "a commitment to efficient regulatory review and adoption of biopesticides, eclipsing the US in new active ingredient approvals. This means Brazilian farmers benefit first, whereas the US had been the first place to go to get the fastest approvals."

Juncosa concurs, noting that Brazil "has recognized the strategic role of biologicals in reducing chemical dependence and has developed a streamlined regulatory framework that allows for faster approvals without compromising scientific rigor." This opportunity prompted Futureco Bioscience to recently open a Brazilian subsidiary, enabling them "to work more closely with regulatory bodies, farmers, and industry partners to accelerate product adoption."

By contrast, Dr. Marrone expresses concern about the US regulatory environment: "The current US administration and majority Congress are keen on reducing the spending for the EPA... without understanding how low the resources already are to review all the many biopesticide innovations submitted to the Agency." She warns that increased timelines will deprive "farmers of the new innovations that can help them increase yields and ROI."

For biostimulants specifically, Marrone notes that "there is a national framework pending, which California approved. Now the other states all need to approve as well. This will bring predictability, quality and rigor to the US biostimulant market."

The European Union presents a mixed picture. Juncosa describes Europe as enforcing "some of the most stringent approval processes, often requiring extensive scientific validation and long timelines." However, he also notes that Europe is "leading the shift toward sustainable agriculture with policies like the Green Deal and the Farm to Fork Strategy."

Dr. Marrone sees "a little more hope in Europe for Biocontrol (Biopesticides), as the recognition of the need for alternatives to restricted or eliminated chemical pesticides has gained steam among regulators and politicians." She adds that "the EU already has a good framework for Biostimulants."

Juncosa summarizes the strategic implications of these regulatory differences: "While these regional differences present challenges, they also create opportunities. The shift toward sustainable agriculture is undeniable, and biologicals are at the center of this transformation." Success, he suggests, "will depend on scientific excellence, regulatory agility, and the ability to anticipate and respond to changing policy landscapes."

The Path Forward

As disruptive technologies continue to advance, biologicals are poised to play an increasingly central role in global agriculture. AI and machine learning are accelerating discovery, development, and field optimization, while regulatory frameworks continue to evolve—albeit at different paces in different regions.

Flueckiger notes that despite technical progress, adopting these technologies "remains challenging for resource-limited farmers due to relative high investment costs." The industry's future success will depend on "demonstrating profitability and creating new revenue opportunities—such as ecological services or premium market positioning."

Nevertheless, as Juncosa concludes, "The future of biologicals will be shaped by companies that can navigate this complexity, establish credibility, and drive adoption through effective positioning and proven field performance." With climate pressure mounting and technological capabilities expanding, biologicals enhanced by AI and other disruptive technologies appear set to transform agriculture in the coming decade. AP

ZDC:

Dedicated to Biotechnology Research to Power Up Development of Green Agriculture

Interviewee: ZDC Board Chairman Mr. Luan

Editor's Note:

In this interview conducted by AgroPages, we had the honor of having an in-depth exchange with Mr. Luan, Board Chairman of Qingdao Zhongda Agritech Co., Ltd.(ZDC). Through the interview, we are able to gain a more comprehensive understanding of ZDC's development history, core competency and future strategic planning.

First of all, we would like Mr. Luan to give us a briefing of the main business and development history of ZDC.

Mr. Luan: Okay. As founded in 2000, ZDC is a designated manufacturer of pesticide and fertilizer endorsed by the Ministry of Agriculture and Rural Affairs of the People's Republic of China. The main business covers research and development, production and marketing of pesticide and special fertilizer.

The company development has experienced three key stages:

The first, in 2002, we produced fungicides branded 'Yi sheng' and 'Guo ye an' in cooperation with Dow AgroSciences, which were sold well in the fruit tree regions in north China. This enabled establishment of the initial brand influence of the company.

The second, since 2009, our company has developed new-generation acaricides which were applied to citrus tree. After more than 10 years of market expansion, we have established our dominant position in the citrus tree market.

The third, after 2010, the marine-based biological product 'Oligosacharins'(Chitosan oligosaccharide) developed by ZDC was granted the first TC registration in China by the Ministry of Agriculture, followed by continuous development of 8 formulations; in 2015, the company made further biological-oriented research and carried out research on seaweed biostimulants, living microorganism and secondary metabolite, having developed differentiated and superior biological products and technologies with proprietary intellectual property rights. This is a substantive breakthrough for ZDC in the biological-oriented transformation and upgrading.

What is the business philosophy of ZDC?

Mr. Luan: Since its founding, ZDC has devoted itself to agriculture, with our special aspiration and passion. Guided by the green development concept and the actual needs of crop farming, the company has been constantly developing new technologies, new products and new solutions that are eco-friendly and uniquely valuable for agriculture, via scientific and technological innovation, such that we can better serve agriculture.

ZDC's strategic planning is concentrated on the following 5 aspects:

1.To consolidate ZDC's fruit tree market position; dig deep into the cash crop market; and explore the field crop market.

2.To promote the transformation of the company's product structure and service mode to better meet the needs of green ecological farming:

- To stress on development of new products or technologies such as granular, water-based, nanoscale and UAV spraying products;
- To constantly increase proportion of biological pesticide and fertilizer in the company's sales.
- To accelerate the innovative formulations layout to seize the first opportunity and grow market share to enable us to become a leading supplier of innovative formulations.
- To make use of ZDC's advantages of marine-based biological resources at home and abroad, endeavoring to become an influential brand in the specialty fertilizer industry.

3.To strengthen innovation capacity, enabling research and development to become an important driver to the company's strategic development.

4.To make continuous upgrade of the facilities of our plant located in Xinhe Eco-chemical Park to create a first-class production base via operating management systems such as HSEQ.

5.To accelerate the integration of high-quality international resources, and develop overseas market.

What are the reasons for ZDC to transform its business operation towards biological development?

Mr. Luan: There are 4 reasons:

The first, the challenges to modern agriculture. Due to the long-time use of chemical pesticide and fertilizer, the agroecological issue and soil degradation become a serious concern. It is urgent for the agrochemical industry to develop alternative environment-friendly products, which is a good opportunity of developing biological agricultural inputs.

The second, the study and judgment of the agrochemical development trend at home and abroad. In recent years, global agrochemical giants have continuously made deployment in the biological industry through strategic investment, mergers and acquisitions as well as multiple ways of cooperation. According to relevant data, biological ag products will grow at a compound annual growth rate of about 13.8% in the coming years. This shows that biological products have become an important pillar to the promotion of the sustainable development of agriculture. Therefore, it becomes a top priority to make deployment in the biological industry, develop biological pesticide and fertilizer, and enhance the core competency of enterprises.

The third, the rapid development of biotechnology. In particular, the application of gene editing technology and the natural product extraction technique in agricultural production has provided a technical safeguard to the research, development and industrialization of agricultural biological products.

The fourth, the company's long-year research and achievement in the marine biology. ZDC is located in the coastal city of Qingdao, where the marine research capacity takes up more than 50% of the country's marine research capacity. Since 2002, ZDC has cooperated with the Institute of Oceanology of the Chinese Academy of Sciences in development of Oligosaccharins series products, being one of China's earliest marine research enterprises with largest number of relative product registrations, having accumulated rich experience, resources and technology in research and development of marine biology. This has laid a solid foundation for the company's transformation towards biological development.

Can you tell us about ZDC's advantages built up in the course of transformation towards biological development?

Mr. Luan: In the process of transformation, we are faced with a lot of challenges, mainly due to the high spending in technology R&D, the long cycle of development and

the lack of awareness of biopesticides from the market.

Nevertheless, challenges and opportunities exist side by side. With the emerging conception of sustainable agriculture and the enhancement of environmental protection, biological products are more and more regarded and preferred by the market. Through technological innovation and product upgrading, we have successfully seized the market opportunity and built up our core competitive advantage, which is reflected in the following four aspects:

1. A talented work team: Through collaborative innovation, we have introduced industry expert team and cutting-edge technology which provide a technical safeguard to the development and industrialization of our biological products. In addition, we have set up our own biological R&D team, covering majors of molecular biological research, fermentation engineering, marine chemistry and detection technology. By undertaking government projects and cooperative research programs, our R&D team has been working dedicatedly on biological development. Hence, our biological research capacity is being improved constantly.

2. Resources: 1) Microbial strain resources. Through independent isolation and identification, we have established a library of strains which is biologically active on agricultural diseases, providing germplasm resources to the development of live microbial bacteria, secondary metabolite and enzyme preparations. In the next few years, after long-term painstaking research and accumulation, we are prepared to release in succession to market our live microbial bacteria and metabolite products. 2) Seaweed resources. Via screening of global seaweed species, we have consolidated high-quality seaweed resources – Durvillaea Potatorum from Australia and came into an exclusive strategic cooperation with the supplier. The development of seaweed-related products is also a key area for subsequent business expansion.

3. Technology: 1) A high-expression and high-activity alginate lyase engineering strain was configured, which enables stable and dependable production. 2) Development of the seaweed enzymolysis and extraction process to retain more active ingredients from seaweed, such as alginate oligosaccharides, auxin, cytokinin, phenolic substances, betaine and mannitol. 3) Development of 3 key technologies in the field of chitosan oligosaccharide enzymolysis, purification and formulation, which ensure the stable and reliable effect of products.

4. Products: 1) Have developed material grade products including seaweed enzymatic hydrolysate liquid and powder, alginate oligosaccharide using the high-quality seaweed raw material Durvillaea Potatorum from Australia, via patented enzymatic extraction process. 2) Have developed seaweed-based biostimulants and specialty fertilizers using our seaweed enzymatic hydrolysate products as material. 3) Formulating seaweed enzymatic hydrolysate material with pesticide, leading to development of biological innovative pesticide products in both solid and liquid form, of which the liquid product is a domestic initiation. 4) Have developed a series of products from marine biological plant defense elicitor - chitosan oligosaccharide, which can improve the crop's resistance to biotic and abiotic stress.

The industrialized production and application of the above 4 types of products are very much favored by the market and sales are greatly increased, thanks to the remarkable effects such as disease prevention and curation, growth promotion and stress resistance, wounds repair and soil amendment.

What is ZDC's product research development strategy? What are the innovations?

Mr. Luan: Our research and development strategy are to leverage modern biotechnology to build up the advantage of biological Technical/material while combining chemistry with biology, pesticide with nutrient. Hence, we aim at continuous development of differentiated and competitive agricultural products. This diversified R&D strategy enable us to better adapt to the market need and provide customers with more comprehensive and efficient solutions.

Marine source Technical and material is ZDC's distinctive R&D direction, where we utilize the rich marine biological resources to have developed the Chitosan oligosaccharide Technical(Oligosaccharins) and the seaweed enzymatic hydrolysate materials, through our unique enzymatic hydrolysis process, which are applied to agricultural production to promote crop growth and improve stress resistance while reducing the use of chemical pesticide and fertilizer.

The integration of nutrients with pesticide is another innovative business of ZDC. This type of product combines the functions of nutrients and pesticide, aiming to achieve a dual effect by one-time application, thus providing a synergistic effect of nutrients and pesticide, which increases agricultural production efficiency. By addressing technical issues such as compatibility between pesticides and nutrients, crop safety, stability of integrated formulations, balance between pesticide efficacy and nutrients effect as well as the environmental safety, we can ensure that pesticides and nutrient elements are released simultaneously in the course of application of pesticide-nutrients integrated products while the stability and interaction effect of the two are maintained.

How does ZDC ensure the product effectiveness and safety in the research and development process?

Mr. Luan: In the course of research and development, we take multiple measures to ensure the effectiveness and safety of our products. Firstly, in the product design stage, we give full consideration to the safety and environmental requirement of the product, such as selecting biodegradable raw materials, green and environment-friendly production processes. Secondly, we strictly evaluate product efficacy, residues and environmental impact during the R&D process, so as to ensure the effectiveness and safety of the products.

Moreover, we attach great importance to the product innovativeness and practicality. Via survey of the actual needs in agricultural production, we can ensure that the developed products can fix the difficulties and pain points of growers; our R&D team make constant exploration of new application technologies and application scenarios to constantly increase the market competitiveness of our products. These comprehensive measures are strong support to ZDC's continued technical development, as well as to the sustainable development of agriculture.

How does ZDC integrate agricultural service with product development and marketing? What is the role of agricultural service in ZDC's overall business strategy?

Mr. Luan: ZDC integrates agricultural service in all aspects of product development and marketing to ensure that our products can meet the actual needs of farmers, providing farmers with greatest value.

In the product development stage, we adhere to the customer demand-oriented product development concept, in combination with consideration of farmer's using habits

and real needs; we timely collect feedback from customers, listening to their practical suggestions, which is essential for the constant product development and optimization while enabling us to provide products of satisfactory effect and convenient use.

In terms of marketing, we provide professional agrotechnical service, including provision of pest control knowledge, pesticide application skill and technical lecture to help farmers better understand and use our products; we pay regular site visit and conduct field trials; we organize on-site observations and meet farmers regularly in field to increase the market recognition of our products.

Agricultural service plays an important role in ZDC's overall business strategy, it is also an important means for us to promote the sustainable development of agriculture. We advocate the concept of scientific pesticide application, promote application of bio-derived pesticide and fertilizer to reduce the dependence on chemical pesticide and fertilizer which improves the ecological benefit of agriculture. This is not only a contribution to the development trend of modern agriculture, but is also contributive to establishment of ZDC's reputation in social responsibility.

What is your view on the biopesticide market trend? What are your messages to the industry players and partners of cooperation?

Mr. Luan: We are optimistic about the biopesticide market development trend. With people's increasing concern on food security and environment, the market demand for biopesticide will continue to grow and the future prospect looks promising, attributable to biological properties of high efficiency, low toxicity, environment friendliness and low impact on human health.

In recent years, the biopesticide industry has progressed significantly. Looking into the future, there is still a long way to go, but we hope that bio-agricultural enterprises will work together to fix the pain points of crop protection and nutrition to promote the sustainable development of agriculture and contribute ourselves to agriculture; we also look forward to working with partners on a win-win basis via resource sharing, technical exchange, economic and trade cooperation to jointly make a blueprint for the development of green agriculture.

Conclusion:

Through this interview, we have gained a more comprehensive understanding of ZDC. Starting as an enterprise focusing on pesticide research and development, growing into an innovation leader in the fields of biopesticide, biofertilizer and agricultural service, ZDC's business development is full of wisdom and courage. Facing the future, ZDC is ready to go. There is a reason for us to believe that with ZDC's continuous dedication to the fields of biopesticide, biofertilizer and agricultural service, the company will continue to play its increasingly important role in the scientific and technological development of the global agriculture, which is a representation of China's contribution to promoting green agriculture. AP

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KingAgroot CropScience:

Transformation from Herbicide Specialist to Global Agricultural Technology Innovator

Kevin Cheng
General Manager, China/APAC

Jack Chen
Deputy General Manager and CMO, China/APAC

Hua Cheng
Marketing Director, China

Carrick Zhong
Customer Marketing Director, China

Editor's Note: Qingdao KingAgroot CropScience Co., Ltd. (hereinafter referred to as "KingAgroot") is an emerging multinational agricultural biotechnology company based in Qingdao. As a representative of the rapid advancements in China's agrochemical industry, KingAgroot is evolving into a globally influential agricultural technology innovator. The company's operations encompass pesticide research and development, manufacturing, sales, and biotechnology-based breeding, with a commitment to delivering innovative crop protection and enhancement solutions for agriculture worldwide. KingAgroot has escalated itself from a provider of solely herbicides to a comprehensive crop science company, expanding its portfolio to include insecticides, fungicides, plant growth regulators, and more.

Recently, AGROPAGES had the opportunity to conduct an exclusive interview with senior executives from KingAgroot. Let's explore the company's developmental journey, innovation strategies, and future aspirations.

The agrochemical industry is currently navigating a critical phase of development, with companies across different tiers of the global agrochemical value chain performing at varying levels. In this context, how do you perceive the present industry cycle?

Kevin Cheng: The industry is indeed experiencing a distinctive historical period due to factors such as supply-demand imbalances, geopolitical tensions, and a slowdown in innovation. Some industry peers refer to this as a downturn cycle. However, it is precisely in such challenging historical times that a company's innovation pipeline, talent pool, marketing system, sustained reserves for and construction of operational excellence, as well as its determination and execution in management optimization and transformation, are put to the test. Whether through adding or subtracting resources, restructuring, or pivoting, the capacity for continuous innovation and self-driven evolution is essential for most companies to navigate the challenges posed by industry cycles. Moreover, these cycles can act as both a crucible and an opportunity for a company's growth and success. In light of the current industry landscape, KingAgroot is also implementing more proactive adjustments.

In the current industry landscape, how does KingAgroot define its development strategy as an innovative company? What has been KingAgroot's development journey, and how will it evolve in the future?

Jack Chen: KingAgroot positions itself as an innovator in new pesticides and seeds from China, focusing on two key areas to drive agricultural advancement: first, plant protection, which involves the research and innovation of patented insecticides, fungicides, herbicides, and biostimulants; second, biotechnology-based breeding, which includes hybrid breeding, genetically modified organisms, and gene editing. KingAgroot's development can be divided into three stages:

- **First Stage (Before 2018):** KingAgroot primarily focused on in-depth research and innovation of post-patent compounds, such as cyhalofop-butyl, promoting it a more widely used herbicide to control barnyard grass following the introduction of penoxsulam.
- **Second Stage (2018 to 2023):** KingAgroot successfully launched its first batch of self-developed patented products. This included four patented herbicides—Cypyrafluone (CPF), Bipyrazone (BPZ), Fenpyrazone (FPZ), and Tripyrasulfone (TPS)—which effectively tackle significant resistant weed issues in wheat, corn, and rice. The success of these products established KingAgroot as one of the agrochemical companies capable of consistently developing new compounds.
- **Third Stage (Since 2024):** KingAgroot is set to launch its second batch of patented compounds, including Flusulfinam (FSM), Flufenoximacil (FFO), and Fluchloraminopyr-tefuryl (FCA). These compounds mark a new pinnacle in KingAgroot's R&D capabilities. From the perspective of the R&D pipeline, aligning with its repositioning as a leader in "Crop Science" after changing the company name, KingAgroot has expanded into the areas of insecticides, fungicides, plant growth regulators, and biotechnology-based breeding.

I would like to invite Hua Cheng, the Market Director for the China region, to give us a more in-depth introduction to KingAgroot's product pipeline.

Hua Cheng: Looking ahead to 2030, KingAgroot plans to introduce 16 innovative compounds into its pipeline, each with an average of 3-4 formulations, aiming to launch approximately 60 patented formulations in the Chinese market. From an R&D perspective, starting in 2024, we also intend to begin the registration process for 3-4 new patented compounds each year, covering categories such as herbicides, fungicides, insecticides, and more.

Here are some characteristics of several newly ISO-named compounds:

- **Flusulfinam:** This is a new generation of HPPD-inhibiting herbicides with an amide structure. It is safe for use on both indica and japonica rice varieties and effectively controls annual resistant grasses, some broadleaf weeds, and annual sedges, demonstrating excellent herbicidal efficacy even under low-temperature and low-light conditions.
- **Flufenoximacil:** This is a new generation of PPO herbicides that significantly enhances efficacy against grass weeds, exhibiting high activity even at gram-per-mu usage levels. It acts quickly, demonstrating exceptional effectiveness against resistant Eleusine indica and offers a broad spectrum of activity, effectively managing over 170 weed species. It also boasts stable performance in low temperatures, is environmentally friendly, and provides high flexibility for subsequent crops.
- **Fluchloraminopyr-tefuryl:** This synthetic hormone, non-selective herbicide has a broad spectrum of activity, effectively managing resistant Eleusine indica, Conyza canadensis, Commelina communis, Cirsium segetum, Sonchus arvnensis, Alternanthera philoxeroides, vines, small shrubs, and couch grass. It offers good stability in low temperatures and possesses strong systemic activity, making it an excellent tool for resistance management. Its extended control period provides 1 to 2 times longer weed suppression compared to conventional solutions, effectively reducing the frequency of application needed while saving labor.
- **Cinflubrolin:** This is a new type of FAT (fatty acid thiolase) inhibitor that can be safely applied in transplanted, dry direct-seeded, and wet direct-seeded rice fields. It effectively suppresses major grass weeds like Echinochloa, E. oryzicola, Leptochloa chinensis and Digitaria sanguinalis, as well as certain annual sedges, while also providing some efficacy against early-stage small weeds post emergence. With a long-lasting effect and no cross-resistance with current mainstream herbicides, it serves as an essential tool for managing weed resistance in rice cultivation.
- **Isoflualanam:** This is a γ-aminobutyric acid (GABA)-gated chloride channel allosteric modulator, featuring a unique mechanism of action that does not exhibit cross-resistance with other insecticides. Isoflualanam offers systemic and translaminar activity, acting rapidly against a broad spectrum of pests, including lepidopterans, coleopterans, acarina, hemipterans (such as aphids), and thysanoptera (thrips).
- **Broclozone:** This is a patented DOXP inhibitor, featuring both soil and foliar activity, making it suitable for a wide range of crops including wheat, soybeans, cotton, garlic, peanuts, watermelon, and rapeseed. It offers flexible post-crop application options and effectively controls key weeds like Italian ryegrass, cleaver, speedwell, malachium, wild oats, Echinochloa, Solanum nigrum, Amaranthus

retroflexus, and Portulaca oleracea. With no cross-resistance with existing mainstream herbicides, it represents a powerful solution for managing resistant weeds.

In addition to the above-mentioned compounds, KingAgroot's pipeline also includes FX-577, an excellent innovative fungicide/nematicide. This product helps growers effectively address challenges posed by Fusarium-induced diseases such as fusarium head blight, sclerotinia, stem base rot, bakanae disease, and root-knot nematodes. Another noteworthy addition is FL-131, a fungicide with a novel mechanism of action that delivers high efficacy against a range of higher fungi and oomycetes, including downy mildew, gray mold, powdery mildew, anthracnose, and sclerotinia.

It is predicted that, just for herbicides, the new products will serve over 300 million mu in the next five years, offering growers a more streamlined farming experience, effectively managing resistance development, and providing robust support for increased crop yields.

In 2022, your company transitioned from focusing solely on herbicides to becoming a comprehensive crop science company, rebranding itself as "Qingdao KingAgroot CropScience." What are the strategic motivations behind this shift? Could you elaborate on the brand structure and the origin of the name KingAgroot?

Jack Chen: As a biotechnology company, KingAgroot aspires to be an innovator and leader in the fields of new pesticides and seeds. We understand that future agricultural solutions will not depend solely on individual pesticides or seeds; instead, they will require integrated crop protection and biotechnological advancements in variety improvement. The rebranding to "Qingdao KingAgroot CropScience" marks our strategic transition from a firm dedicated to the herbicide sector to a comprehensive crop science company.

The 清原 brand draws its inspiration from the phrase " 思与天下式明王度，正本清源 " from the "Book of Jin: Annals of Emperor Wu," which implies solving problems from the root. The "root" in our English name "KingAgroot" also reflects this philosophy. In terms of the brand structure, the "KingAgroot" brand originated from the agrochemical sector and represents the main brand of the crop science company. Under the "KingAgroot" umbrella, we have established the sub-brand "KingField" specifically for the seed science sector.

We've observed that KingAgroot has recruited numerous talents from multinationals, many of whom have prior experience at leading firms like Syngenta, Bayer, and ADAMA. How do you perceive the shifts in KingAgroot's talent strategy, and how have these talents integrated into the company?

Kevin Cheng: Attracting talents from multinationals is a key aspect of KingAgroot's growth strategy. The inclusion of colleagues with international backgrounds brings international management experience and perspectives, showcasing our commitment to learning from global firms. Not only in the Chinese market, but as KingAgroot expands its teams overseas, we are adopting best practices from multinationals in talent attraction and development. I'd like to highlight a few reasons why these professionals chose to join KingAgroot and how they have integrated into our organization:

First, it's the environment. Recently, during a discussion with the founder about KingAgroot's inclusive corporate culture, we discovered that over 60% of our management team, including director-level scientists, have backgrounds in multinationals. Additionally, more than 20% of our R&D team, which consists of nearly 100 PhDs, has studied abroad. Embracing diversity and international perspectives has become a defining feature of KingAgroot's talent structure. While respect and empowerment are often touted as culture of knowing and practicing in many organizations, our founders, Lian Lei and Zhuang Runqing, take a more pragmatic approach. To build an extraordinary KingAgroot, we not only need to attract top talents but also inspire the dreams of every individual.

Second, it's innovation. Throughout the development and refinement of numerous compounds, multinationals have been the primary drivers of innovative research and development. KingAgroot's unique approach to innovation is focused on learning from and honoring all pioneering R&D multinationals. What sets us apart, I think, is that our innovation outcomes integrate traditional chemical pesticides with modern biotechnology, prioritizing practical resource allocation, swift market responsiveness, and targeted agility for specific crops and regions.

Third, we embrace the concept "You succeed, China succeeds." Many individuals are drawn to multinationals for their patent advantages, strong brands, advanced operational efficiency and effective management models, as well as fair performance recognition and incentives. They aspire to become elite professional managers as their companies grow. "You succeed, China succeeds" is prominently displayed on a wall in KingAgroot's lobby, and seeing it for the first time made me reflect: Can KingAgroot emerge as a leading voice and force for innovation in China's agrochemical industry? Is there potential for the KingAgroot brand to stand alongside established multinationals? As KingAgroot continuously refines its development, engages in agile learning, and implements practical empowerment, how do these efforts measure up against the challenges faced by traditional multinationals? Does KingAgroot's focus on talent and incentive policies provide a competitive edge comparable to that of leading global firms? If we can align our understanding on these questions and have the opportunity to witness and support the advancement of Chinese innovative enterprises, what remains is the courage to step out from under the shadow of larger platforms and redefine ourselves.

KingAgroot is currently at a pivotal moment for significant business growth, and the demand for diverse talents is greater than ever. As the saying goes, "Heroes are not defined by their origins." In this spirit, KingAgroot is embracing self-reflection, encouraging open-mindedness, and actively seeking to attract the best talents from across the industry.

In China, some large companies have recruited senior talents from multinationals, but these individuals often struggle to adapt. Mr. Chen, as an executive with a multinational background who has spent many years in a private enterprise, what are your thoughts on this?

Jack Chen: It's hard to believe I've been at KingAgroot for nearly seven years now, which is roughly the same length of time I spent at Syngenta. I think the reasons I've been able to stay at KingAgroot for so long—and plan to continue doing so—are primarily the following:

First and foremost is innovation. KingAgroot offers a wealth of opportunities for innovation, making it highly attractive to ambitious professionals. At times, I feel like KingAgroot resembles a school; our office buildings are named "Science Building," "Pursuit of Truth Building," and "Exploration Building," which lends an academic atmosphere to the environment.

Second, there is a strong emphasis on respect and collaboration. The distinction between foreign and private enterprises often hinges on specific qualities, and I believe there are notable differences even among similar companies. The experience of joining at various stages of development can vary significantly. The founders of KingAgroot are dynamic individuals who have no desire to turn the company into a personal venture; instead, they aim to build a company for a community of dreamers. The overall culture at KingAgroot greatly values professional expertise and talent. It has implemented equity incentive programs for management, key positions, and exceptional contributors. The company empowers its management team, facilitating agile decision-making. Beyond the typical characteristics of a startup, I find many aspects reminiscent of outstanding foreign companies. Additionally, KingAgroot offers free meals and well-equipped fitness facilities, and I personally enjoy the pleasant coastal climate of Qingdao.

Third, it's all about dreams. China is now in an era ripe for the emergence of a new generation of multinationals. We have the opportunity to leverage innovation to showcase Chinese technology on the global stage and create enterprises akin to Huawei or BYD.

What expectations does KingAgroot have when looking for channel partners?

Carrick Zhong: KingAgroot currently boasts a distribution network of over 10,000 partners across platforms, wholesale, and retail. When evaluating potential

channel partners, we consider several key factors in addition to financial strength and strategic alignment:

Willingness to collaborate and value alignment: Shared values are essential for successful partnerships, as they ensure all parties are aligned and working toward the same objectives.

Market coverage capability: We seek partners with strong market coverage that is both broad and deep, allowing for prompt and efficient delivery of products and solutions to end-users.

New product promotion capability: Experience and innovation in marketing and promoting unique or patented products are essential.

Reputation: The degree of contract compliance across different channel levels is also significant.

Whether for existing clients or new ones, with the launch of our pipeline products, KingAgroot hopes to grow and create value together with our partners. We believe that collaboration built on shared values and mutual benefit is essential for lasting stability, allowing us to tackle market challenges and seize opportunities together.

? In terms of external collaboration, does the company plan to expand its partnerships in the future? What is KingAgroot's strategy for external cooperation? What is KingAgroot's perspective on collaborating with multinationals?

Kevin Cheng: I've only been with KingAgroot for a few months, but I have witnessed a high volume of strategic partnership visits from global and China headquarters executives of top R&D multinationals and leaders of major domestic enterprises. This highlights a strong recognition and acknowledgement of our innovative R&D pipeline and capabilities. KingAgroot maintains an open attitude towards collaboration with multinationals, guided by a win-win principle that emphasizes respect, professionalism, and pragmatism. If opportunities arise, such as in business collaborations, KingAgroot is eager to jointly launch patented compound formulations in the domestic market and share resources while expanding into overseas markets with multinationals.

? Thank you for the insightful sharing. Finally, could you summarize and give us an outlook on KingAgroot's future development?

KingAgroot: As a rapidly growing innovative agricultural technology company, we see a future full of both opportunities and challenges. Our development strategy is centered around several key areas:

Continuous innovation: We will continue to invest in research and development in the pesticide and seed sectors.

Comprehensive approach: Our aim is to become a comprehensive crop science company that offers integrated solutions for growers.

International expansion: We are actively expanding into overseas markets, aiming to establish KingAgroot as a globally influential Chinese brand.

Digital transformation: We are embracing digital technology to drive the digital transformation of agricultural production and management, providing farmers with more precise and efficient solutions.

Sustainable development: We are committed to sustainable development principles, creating more eco-friendly products to support global sustainable agriculture.

Talent cultivation: We will continue to attract and nurture international talents to foster a diverse workforce.

Industry chain integration: We will capitalize on our strengths in the pesticide and seed sectors to explore opportunities for integrating the industry chain, delivering more comprehensive solutions for our clients.

Looking ahead, we will embrace the philosophy of "solving problems from the root," using innovation as a catalyst for development to make a meaningful contribution to the sustainable growth of global agriculture. Through our unwavering efforts, we believe KingAgroot will emerge as a leading example of the Chinese agrochemical industry on the global stage.

Conclusion

Through this in-depth interview, we have observed KingAgroot's strategic alignment and evolution from a firm primarily focused on herbicides to a comprehensive crop science company. KingAgroot's success is evident not only in its innovative capabilities and expanded product offerings but also in its keen understanding of industry trends and proactive strategic planning.

KingAgroot's development strategy encompasses innovation, market expansion, talent cultivation, and sustainable development, reflecting the holistic approach of a growing enterprise. Notably, KingAgroot's efforts to attract international talents and establish a global brand provide a strong foundation for its international expansion and offer valuable insights for other Chinese agrochemical companies venturing into the global market.

In light of the current challenges facing the global agrochemical industry, KingAgroot's growth strategies and future plans undoubtedly bring fresh energy to the industry. We look forward to witnessing KingAgroot maintain its innovative momentum and make greater contributions to the sustainable development of global agriculture. At the same time, we hope to see more Chinese agrochemical companies emerge on the global stage, demonstrating the strength of Chinese innovation. AP

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