

۳۱ آذر = روز جهانی بدون سم

۳۱ آذر ۱۳۹۳
۴ دسامبر ۱۹۸۴



The Bhopal Syndrome

Pesticides, Environment and Health

David Weir



The Bhopal disaster or Bhopal gas tragedy was a chemical accident on the night of 2–3 December 1984 at the Union Carbide India Limited (UCIL) pesticide plant in Bhopal, Madhya Pradesh, India.

In what is considered the world's worst industrial disaster, over 500,000 people in the small towns around the plant were exposed to the highly toxic gas methyl isocyanate (MIC). Estimates vary on the death toll, with the official number of immediate deaths being 2,259. In 2008, the Government of Madhya Pradesh paid compensation to the family members of 3,787 victims killed in the gas release, and to 574,366 injured victims. A government affidavit in 2006 stated that the leak caused 558,125 injuries, including 38,478 temporary partial injuries and approximately 3,900 severely and permanently disabling injuries. Others estimate that 8,000 died within two weeks, and another 8,000 or more have since died from gas-related diseases.

The owner of the factory, UCIL, was majority-owned by the Union Carbide Corporation (UCC) of the United States, with Indian government-controlled banks and the Indian public holding a 49.1 percent stake. In 1989, UCC paid \$470 million (equivalent to \$1.01 billion in 2023) to settle litigation stemming from the disaster. In 1994, UCC sold its stake in UCIL to Eveready Industries India Limited (EIL), which subsequently merged with McLeod Russel (India) Ltd. Eveready ended clean-up on the site in 1998, when it terminated its 99-year lease and turned over control of the site to the state government of Madhya Pradesh. Dow Chemical Company purchased UCC in 2001, seventeen years after the disaster. Civil and criminal cases filed in the United States against UCC and Warren Anderson, chief executive officer of the UCC at the time of the disaster, were dismissed and redirected to Indian courts on multiple occasions between 1986 and 2012, as the US courts focused on UCIL being a standalone entity of India. Civil and criminal cases were also filed in the District Court of Bhopal, India, involving UCC, UCIL, and Anderson. In June 2010, seven Indian nationals who were UCIL employees in 1984, including the former UCIL chairman Keshub Mahindra, were convicted in Bhopal of causing death by negligence and sentenced to two years' imprisonment and a fine of about \$2,000 each, the maximum punishment allowed by Indian law. All were released on bail shortly after the verdict. An eighth former employee was also convicted, but died before the judgement was passed.







کیمیا گهر فارما



صنایع شیمیایی زاغنه



شرکت کیمیا پوشی رستاک



فردش شیمیایی



شرکت کیمیا خاک لان

BIOPESTICIDES

محصولات بیولوژیک در کنترل آفات

تهیه شده در : گروه فنی (مهر ۱۴۰۳)

ارائه توسط : بابک سلیم زاده

WHY

BIOPESTICIDES?

R&D in Crop Protection and Production

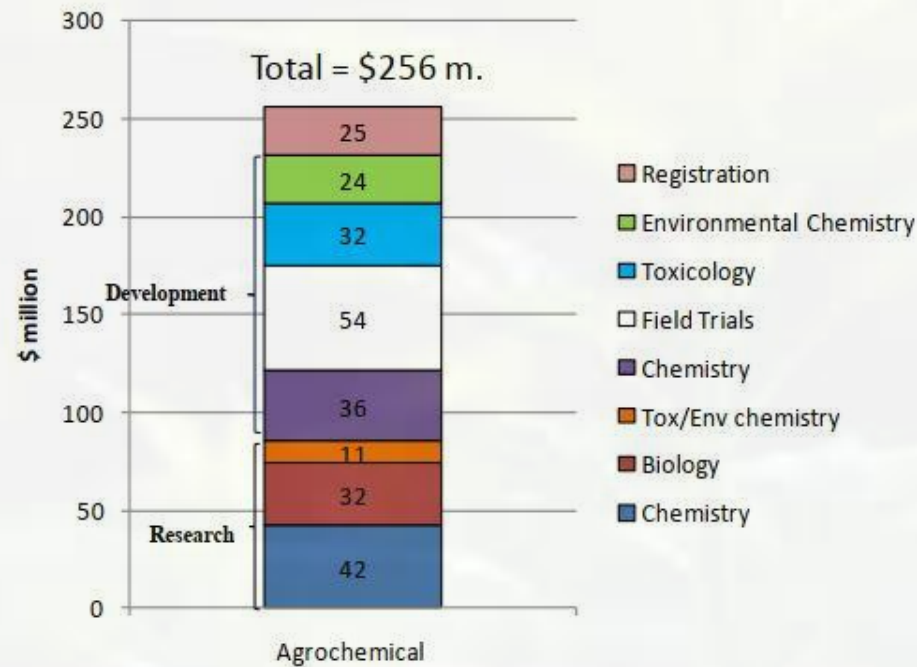
Cost of Bringing a New Product to Market



Results of Study undertaken for ECPA and CropLife America

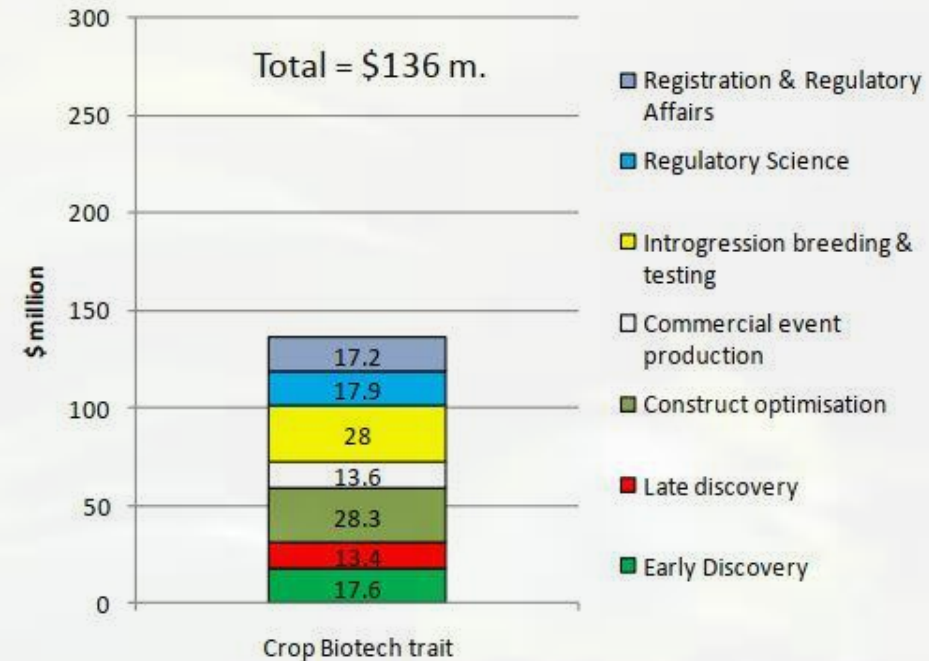
Cost of Bringing a New Product to Market

Agrochemical



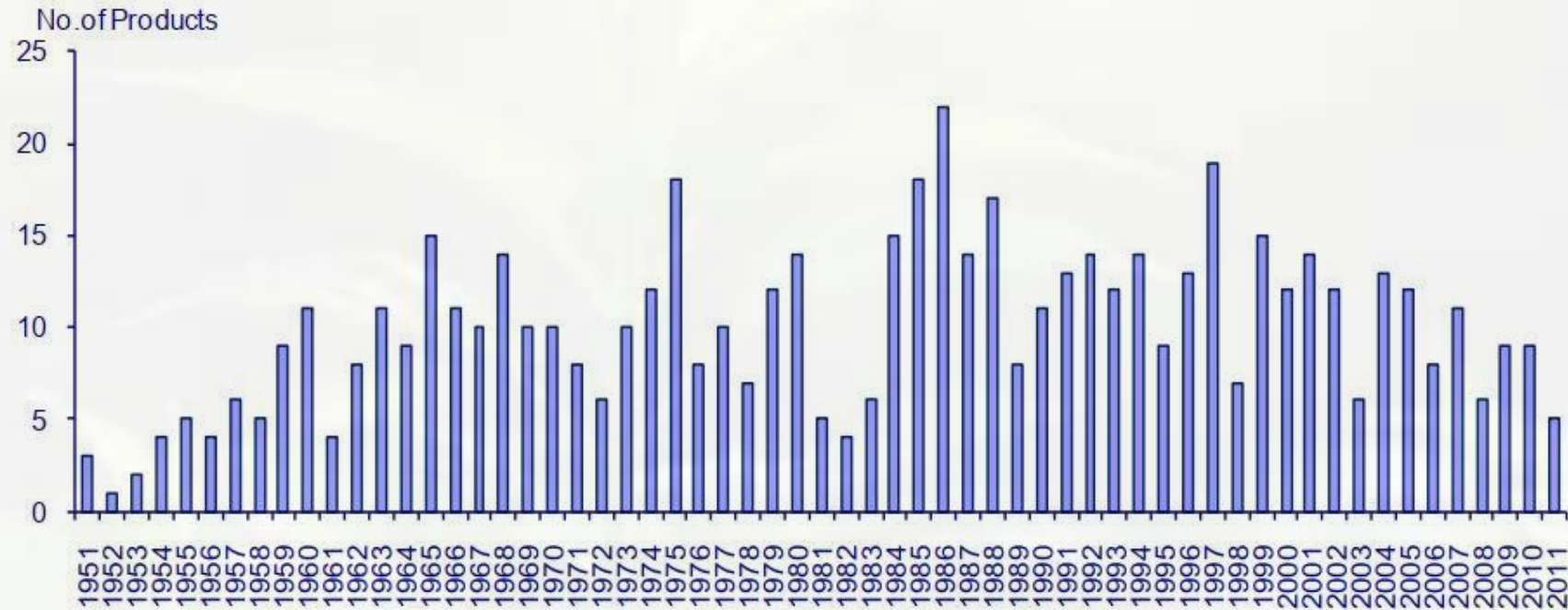
Agrochemical costs based on 2009 Crop Life America/ECPA study

Plant biotechnology trait

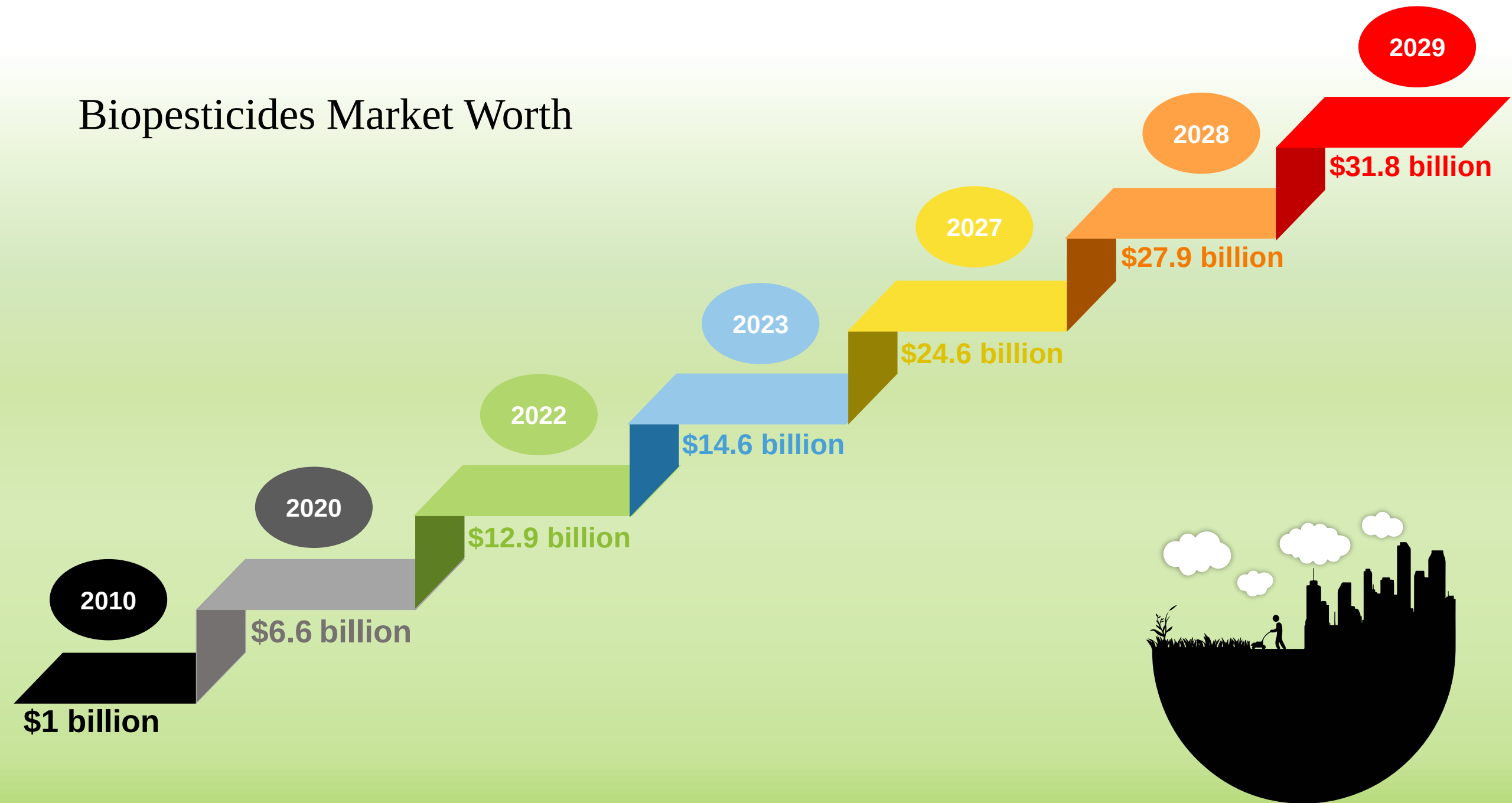


Plant biotechnology trait costs based on 2011 Crop Life International study

New Active Ingredient Introductions

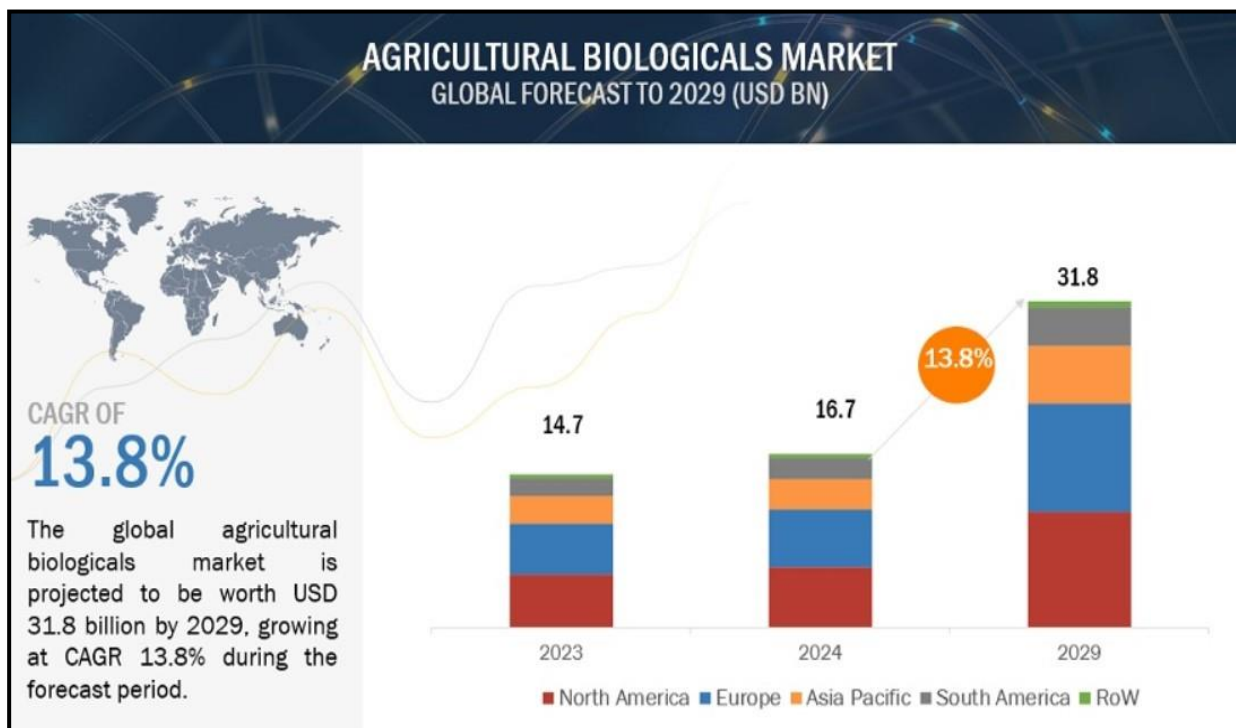


Biopesticides Market Worth

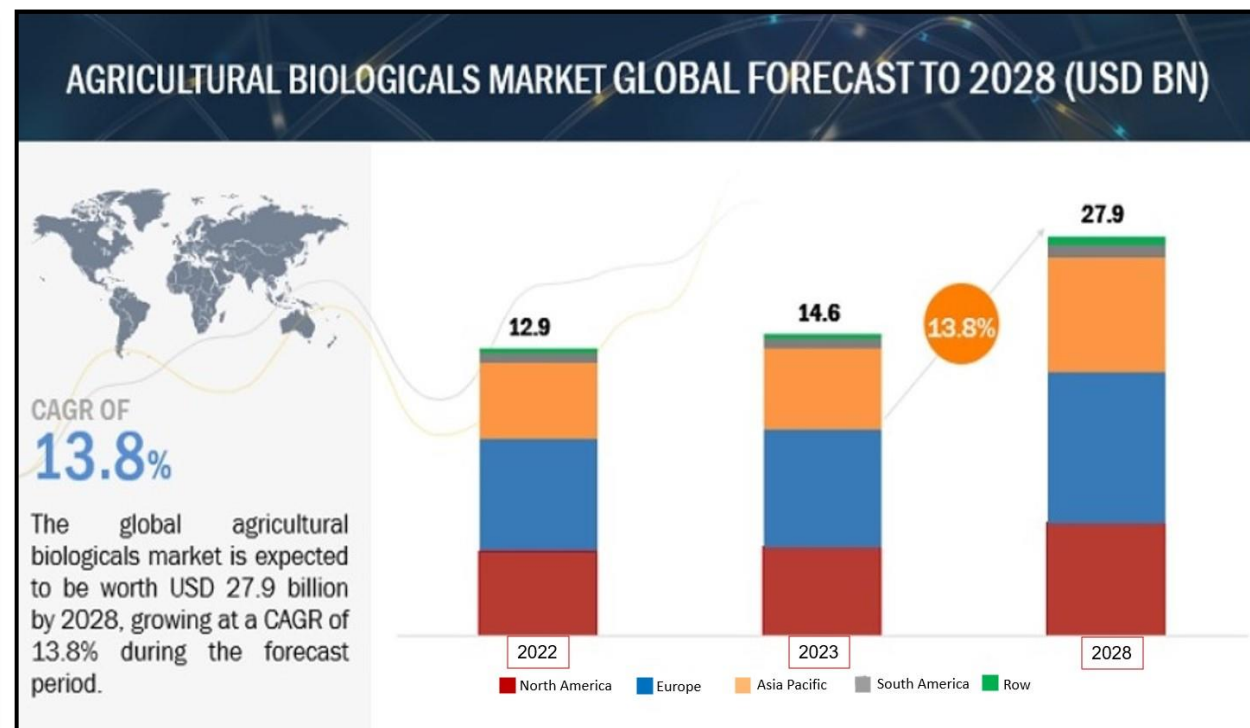


AGRICULTURAL BIOLOGICALS MARKET

GLOBAL FORECAST TO 2029



GLOBAL FORECAST TO 2028



Fungal and Bacterial Pesticides Registered or Launched by Syngenta, FMC, ADAMA, Mitsui and others in 2020-2023



Joyce Wang
Editor of AgroPages
joyce@agropages.com

Fungal and bacterial pesticides are used to combat a variety of pests that cause the destruction of the agricultural economy. Such microbial pesticides have helped reduce the use of chemical pesticides and residues, and assisted in resistance management.

Below is an overview of fungal and bacterial pesticides registered or launched by multinationals and other companies in 2020-2023.

Bacillus velezensis functions as both fungicide and nematicide

Bacillus, containing a large number of species, are important plant growth-promoting rhizobacteria that are widely used in crop production around the world. These bacteria produce various biologically active secondary metabolites that inhibit the growth of plant pathogens and harmful rhizospheric microorganisms. *Bacillus* also release substances that act on crops to facilitate growth and development. Benefitting from the ability of endospore formation, *Bacillus* can survive in hot and dry conditions, and be formulated into stable dry powders with long shelf lives.

Bacillus velezensis is one of the most widely used *Bacillus* species, due to its ability to protect crops from pests. For example, *B. velezensis* FZB42 (formerly *B. amyloliquefaciens* FZB42), produces bioactive metabolites, including amylocyclidin, bacilysin, bacillomycin-D, bacillaene, difficidin, fengycin, macrolactin, plantazolin, surfactin and others, which suppress pathogens [1]. In addition, the metabolite bacillibactin plays a key role in promoting the acquisition of Fe³⁺

from minerals and organic compounds in the soil, which inhibits pathogens from absorbing these essential substances [2]. *B. velezensis* combats not only bacterial and fungal phytopathogens, but also inhibits nematode reproduction, egg hatching and juvenile survival [3]. There is also an interaction between the beneficial bacteria and plants that involves protection. Surfactin secreted by *B. velezensis* FZB42 can enhance the defense responses of plant roots [4]. Plant roots can release some molecules that attract *B. velezensis* that move towards the root surface to form biofilms, which promote plant growth and protect plants from infectious microbes by releasing antimicrobial compounds.

B. velezensis secretes metabolites that promote plant growth. One of these metabolites is cytokinin [5]. Some *B. velezensis* releases volatile organic compounds that boost crop growth by regulating auxin homeostasis [6].

B. velezensis can be found in several multinationals' new product launches. For example, Syngenta launched ARVATICO and CERTANO, which both contain *B. velezensis* isolate CNPSo 3602, to control nematodes and pathogens for the Brazilian market. ARVATICO, in Syngenta's Seedcare portfolio, was registered to combat nematodes, such as *Heterodera glycines*, *Pratylenchus brachyurus* and *Meloidogyne incognita*, as well as diseases, such as *Fusarium solani*, *Macrophomina phaseolina* and *Rhizoctonia solani*. CERTANO is Syngenta's first BioSolution with bionematicide, biofungicide and growth-promoting action in one formulation for sugarcane, providing immediate and prolonged effects compatible with other products.

Table 1. Part of companies registered/launched fungal and bacterial pesticides in 2020-2023

Provider	Product	Active ingredient	Benefit	Region
Syngenta	CERTANO	<i>Bacillus velezensis</i> isolate CNPSo 3602	Providing bionematicide, biofungicide and growth-promoting action	Brazil
Syngenta	Arvatico	<i>Bacillus velezensis</i> isolate CNPSo 3602	Control of nematodes and diseases in all crops	Brazil
ADAMA	Protege	<i>Bacillus thuringiensis</i> , <i>Bacillus velezensis</i> , <i>Bacillus amyloliquefaciens</i>	Control of nematodes and pathogens	Brazil
FMC	Provilar	<i>Bacillus velezensis</i> strain RT1301, <i>Bacillus subtilis</i> strain RT1477	Promoting leaf spot and white mold protection	Brazil
Syngenta	ARBIOGY	<i>Beauveria bassiana</i> ATCC 74040	Control of thrips, mites, leafhoppers, whiteflies, fruit and cherry flies	Italy
Symborg		<i>Beauveria bassiana</i> 203	Control of insect pests	Europe
Andermatt Madumbi	Eco-Bb	<i>Beauveria bassiana</i> strain R44	suppressing Mealybug and Red spider mite	South Africa
Andermatt Biocontrol	Bb-Protec	<i>Beauveria bassiana</i>	Control of sucking pests in vegetables and fruit crops	Tunisia
Koppert	Boveril EVO	<i>Beauveria bassiana</i>	Control of insect pests	Brazil
Anatis Bioprotection	BioCeres EC	<i>Beauveria bassiana</i> strain ANT-03	Control of whiteflies, aphids and thrips	USA, Canada
Mitsui & Co. (Brasil) S.A.	BIOSTAT WP	<i>Purpureocillium lilacinum</i>	Control of <i>Meloidogyne incognita</i> and <i>Meloidogyne javanica</i>	Brazil
Certis Biologicals	MeloCon LC	<i>Purpureocillium lilacinum</i> strain 251	Control of nematodes	California
Agrivalle	Profix	<i>Purpureocillium lilacinum</i> , <i>Bacillus subtilis</i> , <i>Bacillus licheniformis</i>	Control of <i>Meloidogyne incognita</i> and <i>Pratylenchus brachyurus</i>	Brazil
NOVAGRO-AG SAC	AWESOMEAG	<i>Trichoderma harzianum</i>	Control of powdery mildew, blackworm, gray mold, downy mildew, rust, black sigatoka on banana, grapes, coffee, cocoa, strawberry, various fruit trees, vegetables	Peru, Colombia
De Sangosse	Restrict	<i>Bacillus amyloliquefaciens</i> strain CPOBA 040-11DRM 01, <i>Bacillus amyloliquefaciens</i> strain CPOBA 040-11DRM 04	Control of foliar diseases: <i>Colletotrichum lindemuthianum</i> , <i>Colletotrichum truncatum</i> , <i>Corynespora cassicola</i> , <i>Phaeosphaeria maydis</i> and <i>Ramularia areola</i>	Brazil
Syngenta	Taegro	<i>Bacillus amyloliquefaciens</i> strain FZB24	Control of diseases	Portugal, Spain, Italy etc.
Bayer	Minuet	<i>Bacillus subtilis</i> strain QST 713	Control of soil-borne diseases such as rhizoctonia root rot, black scurf and stem canker, and pink rot and root rot caused by <i>fusarium</i> , <i>phytophthora</i> and <i>pythium</i>	Canada
Bayer	Sonata	<i>Bacillus pumilis</i>	Control of pathogens on wine and table grapes	Italy
BASF	Votivo Prime	<i>Bacillus firmus</i>	Seed treatment to control nematodes	Brazil
UPL	Nimaxxa	<i>Bacillus subtilis</i> strain CH4000 and <i>Bacillus paralicheniformis</i> strains CH0273 and CH2970	Control of nematodes	Brazil

Fungal and Bacterial Pesticides

Registered or Launched by:
Syngenta, FMC, ADAMA, Mitsui and others
in 2020-2023

An overview of fungal and bacterial pesticides registered or launched by multinationals and other companies in 2020-2023

Bacillus velezensis functions as both fungicide and nematicide

- Containing a large number of species
- Important plant growth promoting rhizobacteria that are widely used in crop production

Advantages

- Produce various biologically active secondary metabolites that inhibit the growth of plant pathogens and harmful rhizospheric microorganisms.
- Release substances that act on crops to facilitate growth and development.
- Can be formulated into stable dry powders with long shelf lives due to its surviving ability in hot and dry conditions.

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An overview of fungal and bacterial pesticides registered or launched by multinationals and other companies in 2020-2023

- Protect crops from pests (One of the most widely used *Bacillus* species)
- The *Bacillus velezensis* FZB42 (formerly *B. amyloliquefaciens* FZB42), produces bioactive metabolites to suppress pathogens.

Bioactive metabolites including;

1. Amylocyclicin
2. Bacilysin
3. Bacillomycin-D
4. Bacillaene
5. Difficidin
6. Fengycin
7. Macrolactin
8. Plantazolicin
9. Surfactin and others

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- The metabolite bacillibactin plays a key role in promoting the acquisition of Fe^{3+} from minerals and organic compounds in the soil, which inhibits pathogens from absorbing these essential substances.
- inhibits nematode reproduction, egg hatching and juvenile survival.
- Interaction between the beneficial bacteria and plants that involves protection:
Surfactin secreted by *B. velezensis* FZB42 can enhance the defense responses of plant roots (Plant roots can release some molecules that attract *B. velezensis* that move towards the root surface to form biofilms, which promote plant growth and protect plants from infectious microbes by releasing antimicrobial compounds).
- Promoting plant growth:
B. velezensis secretes metabolites that promote plant growth. One of these metabolites is cytokinin. Some *B. velezensis* releases volatile organic compounds that boost crop growth by regulating auxin homeostasis.

Fungal and Bacterial Pesticides

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Examples of *B. velezensis* in several multinationals' new product:

- ❖ Syngenta launched ARVATICO and CERTANO, which both contain *B. velezensis* isolate CNPSO 3602, to control nematodes and pathogens for the Brazilian market.
- ❖ ARVATICO, is registered to combat nematodes, such as *Heterodera glycines*, *Pratylenchus brachyurus* and *Meloidogyne incognita*, as well as diseases, such as *Fusarium solani*, *Macrophomina phaseolina* and *Rhizoctonia solani*.
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FMC	Provilar	Bacillus velezensis strain RTI301, Bacillus subtilis strain RTI477	Promoting leaf spot and white mold protection	Brazil
Syngenta	ARBIOGY	Beauveria bassiana ATCC 74040	Control of thrips, mites, leafhoppers, whiteflies, fruit and cherry flies	Italy
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REQUIEM[®]

EC

INSECTICIDE AND ACARICIDE FOR CONTROL OR SUPPRESSION OF THRIPS, WHITEFLIES, PLANT-FEEDING MITES, LEAFMINERS, AND LEAF HOPPERS IN AGRICULTURAL CROPS.

NOT FOR RESIDENTIAL USE

ACTIVE INGREDIENT:

Terpene Constituents of the Extract of
Chenopodium ambrosioides near *ambrosioides*
as Synthetically Manufactured

16.75%
83.25%
Total: 100.00%

EPA Reg. No. 264-1159

EPA Est. No. 264-MEX-001

USE OF PRODUCT INDICATES ACCEPTANCE OF
"CONDITIONS FOR SALE AND WARRANTY"

KEEP OUT OF REACH OF CHILDREN CAUTION

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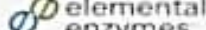
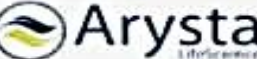
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2024 AGRIBUSINESS BIO-BASED REVENUE COMPARISON

COMPANY	CURRENT BIO-BASED REVENUE	FORECASTED REVENUE	FORECASTED CAGR THROUGH PERIOD	2023 R&D EXPENDITURE*	PARTNERSHIPS, INVESTMENTS & ACQUISITIONS****
	\$215 million (2022)	\$1.61 billion by 2035	17%	\$2.5 billion***	Sound  JOYN  ACRAQUEST  kimatec  MustGrow 
	\$400 million (2023)	NA	NA	\$1.4 billion	Valagro  VESTARON  biotalys  azotic  Bioceres  lavie bio  Sound 
	\$420 million (2023)	\$2 billion by 2035	17%	\$1.34 billion	Symborg  Stoller  elemental enzymes  lavie bio 
	\$180 million (2023)	\$2 billion by 2033	20%	\$329 million	AgroSpheres  BioPhero  micropep  novonesis 
	~\$400 million (2022/23)**	NA**	14% through 2027	\$195 million	SOLASTA Bio  IMPETUS &G  Arysta 

*2023 Numbers with USD conversion, except UPL 2022/23

**UPL has not release its 2023/24 results in detail as of June 27th 2024. UPL "NPP Business Unit not entirely made up of biologicals. Given destocking challenges, UPL numbers likely significantly down in 23/24 so refraining from calculating the CAGR from 22/23 numbers

*** Bayer Annual Report cite \$1.9 Billion USD, but have a "special Items" EBITDA adjustment

**** Not all encompassing

Note: BASF has not publicly shared any biological numbers so they have been excluded

Sources: Company Annual Reports



The Top 10 Biological Companies in 2025

The Rise of the Biological Market

The biologicals market is booming. Valued at over **\$10 billion in 2023**, it is expected to surpass **\$25 billion by 2030**. Biocontrol products dominate with a **\$7 billion** market, followed by biostimulants at **\$3 billion** and biofertilizers at **\$2 billion**. However, growth is not uniform across regions—Latin America, for example, is expanding at an impressive rate of 30% annually.

At **Doriane**, we specialize in data-driven agronomy solutions. Our latest software, Bloomeo biologicals software, simplifies data centralization and analysis, enabling biocontrol and bioproduct companies to better understand the conditions in which their products perform best.

As part of our research, we compiled a ranking of the top biological companies worldwide—and we decided to share it with the community!

Top Biological Companies by Revenue

COMPANY	REVENUE	% BIOLOGICALS
 Rovensa Next	N/A	100%
 BioFirst	Eur 500M	100%
 CORTEVA agriscience	USD 476M	6,5%
 DE SANGOSSE Leader Français des BioSolutions	Eur 450M	100%
Koppert	Eur 417M	100%
 syngenta Biologicals	USD 400M	2,5%
 UPL	USD 365M	10%
 FMC An Agricultural Sciences Company	USD 240M	4%
 BAYER	USD 200M (2022)	1,5%
 BASF The Chemical Company	N/A	N/A

1) RovensaNext

RovensaNext positions itself as the global leader in biosolutions, aiming to reach €1 billion in revenue by 2025. The company owns brands such as TradeCorp, Agro K, and Cosmocel and employs 2,000 people worldwide. While recent figures are not publicly available, RovensaNext consistently communicates its dominance in the sector.

RovensaNext is offering agricultural bionutrition, agricultural biocontrol and agricultural adjuvants and correctors.

2) BioFirst

A pure player in the biologicals industry, BioFirst is the parent company of BioBest, a pioneer in bumblebee pollination and biocontrol since 1987. BioFirst reports over €500 million in revenue across 32 subsidiaries and 2,800 employees. Its 2023 acquisition of Biotrop for \$532 million significantly boosted its market position.

BioFirst group is mostly focus on natural pollination, beneficial insects and mites and biopesticides, but also offers a range of biostimulants, biofertilizers and inoculants.

3) Corteva

Corteva has aggressively expanded into biologicals with the acquisitions of Symborg and Stoller (Stoller deal: \$1.2 billion in 2022). According to its 2024 financial report, biologicals generated \$476 million, representing 6.5% of its crop protection business. The company targets \$2 billion in biologicals revenue by 2035.

Corteva brings various solutions, especially microbiologicals (expertise of Symborg) and crop nutrition (via Stoller).

Biostimulant screening in RovensaNext research center

4) De Sangosse

Pure player of biologicals, De Sangosse is a strong contender with its 44 subsidiaries and 1,350 employees, thanks to its acquisitions of AgroNutrition and AlgaEnergy. With a turnover of Eur 450M, the independant group has developed a large range of biosolutions, biofertilizers, biostimulants, biocontrol and bioadjuvant products. They also propose services and crop management tools.

The French subsidiaries have achieved the highest level (3 stars) of the "Label Engagé RSE," recognizing their strong commitment to sustainability, governance, and social responsibility.

5) Koppert

A family-owned company from the Netherlands, Koppert has been a leader in biocontrol since 1967. HAL Investments, a private equity firm that invested in Koppert in 2024, reports a €417 million turnover. The company employs 2,635 people across 34 countries. Koppert is very strong in macro organisms.

6) Syngenta Biologicals

As of March 2024, Syngenta reports \$400 million in biologicals revenue, making up 2.5% of its crop protection business. Its acquisition of Valagro (€600 million in 2020) is a major growth driver, with an official target of \$1 billion by 2028. Syngenta is especially strong in biostimulants.

7) UPL (Natural Plant Protection - NPP)

UPL's NPP division generated \$365 million in revenue in 2024, representing 10% of UPL's crop protection business. Its portfolio includes acquisitions like Arysta and Goemar.

UPL is specially strong in biocontrol products, such as the Bordeaux mixture.

Biocontrol trial on field crop at one of Biofirst subsidiaries: Biotrop.

8) FMC

FMC's biologicals business grew 33% in 2024, reaching \$240 million in revenue—the highest growth rate in the market. The segment represents 4% of FMC's total revenue and was strengthened by the \$200 million acquisition of Biophero in 2022. FMC targets \$2 billion by 2033.

As a product, we can quote Fermate Rice biological pheromone

9) Bayer

The latest available data from 2022 reported \$215 million in biologicals revenue, about 1.5% of Bayer's crop protection business. Bayer aims to reach \$2.3 billion in biologicals sales by 203

Organic wheat treated with Corteva Biologicals biostimulant

Who Completes the Top 10 Biologicals?

Precise data is lacking, but we estimate that BASF should be included. While the company has not disclosed figures, its partnerships with Elicit Plant and Acadian Plant Health indicate strong engagement in the sector. Sumi Agro and Bioceres are also important organizations in the sector. Yara and Mosaic are also expanding their biological portfolios. The Danish Novonesis and Swiss Andermatt could also be among the top players.

Conclusion: Biological Market in Transformation

The biological market is undergoing rapid changes. While major agrochemical companies are increasing their presence, specialized pure players continue to grow and disrupt the industry. Who will dominate the market in 2030? Time will tell.

Another interesting aspect is the fragmented nature of the market of biologicals compared to the seed market. Remember our article on the top 10 breeding companies? The top three seed companies (Bayer, Corteva, and Syngenta) hold a 38% market share, whereas, in the biological market, the top eight companies collectively account for only 35%.

Are you conducting trials and want to optimize the conditions in which biologicals perform best?

 **Contact us to learn how Bloomeo can help!**

Sources:

All data is sourced from official company reports, websites, and industry publications. Market value and trends are based on Dunham Trimmer reports. Exchange rates as of February 28, 2025.

Biopesticide has the forefront of agrotechnology competition in China

- Data released by ICAMA reveal 53 novel pesticidal active ingredient registrations in China from 2019 to 2022, including 38 biopesticides (12 biochemical pesticides, 24 microbial pesticides and two botanical pesticides) accounting for 71.7% of the total number of novel pesticidal active ingredients.
- Speaking of products, the registrations cover 97 novel pesticide products, including 61 biopesticide products (14 biochemical pesticides, 43 microbial pesticides and 4 botanical pesticides), accounting for 62.9%.
- According to the National Bureau of Statistics, up to 2021, there were more than 260 biopesticide manufacturers in China, with an annual production output of about 140,000 tons and an annual output value of about RMB3 billion yuan.
- Regarding application, the annual use of biopesticides in China has arrived roughly at 80,000 tons, covering an application area of more than 400 million mu (1 mu=1/15 Ha), while considerable products are sold to the international market.

McKinsey & Company

20%+ of global farmers are adopting / willing to adopt biologicals; Brazil is leading the way, followed by European countries

■ Currently using
 ■ Planning to use
 ■ Not using/not planning to use
 ■ Never heard

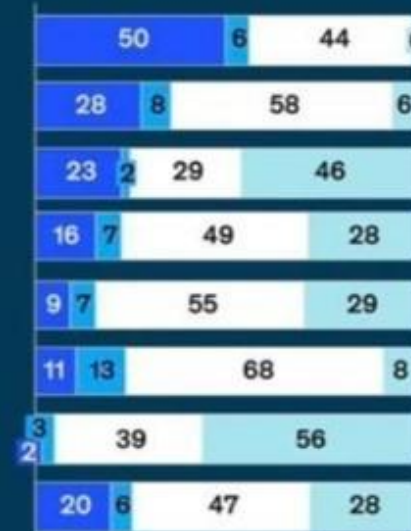
1. Biocontrols adoption

Q: Are you using alternative forms of crop protection into your pest management protocol? % of respondents (n=5,474)



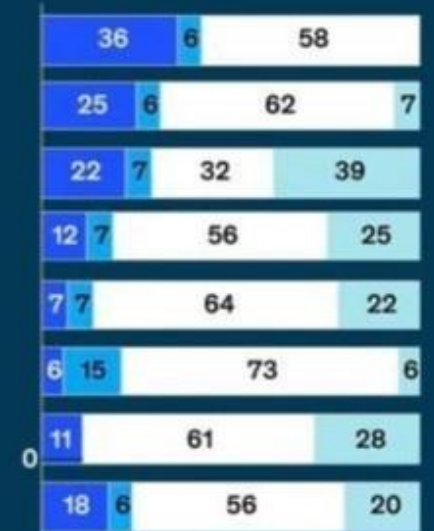
2. Biostimulants adoption

Q: Are you using biostimulants in your fertilizer and/or crop protection protocol? % of respondents (n=5,474)



3. Biofertilizers adoption

Q: Are you using biofertilizers in your fertilizer protocol? % of respondents (n=5,474)



A close-up photograph of green wheat stalks, showing the grain and the long awns. The image is slightly blurred, giving a sense of movement or a shallow depth of field.

Entering the Biologicals Market in India (Next Brazil)

Mark Trimmer believes the country could be the next Brazil if certain requirements were met.

Mark Trimmer:

“The one country we always focus on and point to is Brazil, because it is where all the growth is happening. I think India has the same potential opportunity if the government policy programs support the development of the market and help with the education of growers and users. I think there can be a huge market potential in the Indian subcontinent.”

Five challenges that could present an opening to a niche market for business in India

One of the biggest challenges for launching a product in India is that “80% of the country’s 93 million farm households consist of smallholders with less than two hectares of land,” says Lawrence Mittler, Senior Analyst for AgbioInvestor.

Opportunity:

Create products with extended shelf life.

1.

Fragmented Farming

As in many regions around the world, Indian growers are used to the quick acting synthetic crop protection products. There is work that needs to be done to convince growers of the efficacy, different preventative application process, and financial investment of biologicals.

Opportunity:

Enter the market as a trusted partner. Create or partner with educational programs for ag retailers and growers.

In a press release from the Pesticides Manufacturers & Formulators Association of India (PMFAI), it stated that India is one of the lowest pesticide consuming countries in the world with 0.65 gm/hectare against the global average of 3 kg/hectare.

Opportunity:

While there is a dependence on the products being used, there is a window for entry.

Indian farm incomes “typically fall below even that of the average per-capita income for the nation as a whole”.

2.

Lower Amount of Crop Inputs

4.

Lower Incomes

Opportunity:

Make your product price reflect the local economy. Find niche markets in fruits and vegetables.

5.

Climate Change

Opportunity:

Find niche F&V markets for pesticides. Biostimulants are a growing market and tool in a grower’s arsenal against climate change.

As climate change impacts growers with increased torrential rains, heat waves and droughts, India growers are turning to biostimulants to help plants weather abiotic stressors. As the government implemented stricter regulations for biostimulants, higher quality products have entered the market with greater efficacy and garnered trust from growers.

Advantages of Using Biopesticides

- Less toxic than conventional pesticides
- Affect only the target pest and closely-related organisms while conventional pesticides may affect different insects, birds and mammals
- As an integral part of Integrated Pest Management (IPM) programs, it significantly reduces the use of conventional pesticides, while crop yields remain high
- The risk of pests and disease developing resistance is often considered to be low
- Effective in very small quantities and often decompose quickly, resulting in lower exposures and environmental residues
- Zero or low re-entry and handling interval
- Some microbial biopesticides can reproduce on or near to the target pest or disease, giving some self-perpetuating control
- Useful as second line of defense or supplementary treatment

Disadvantages of Using Biopesticides

- Slow acting and not a “quick kill” when compared to conventional pesticides
- Lower efficacy and shorter persistence as compared to conventional pesticides
- Highly susceptible to adverse environmental conditions
- Grower or farmer requires greater level of knowledge to effectively use the biopesticides

Biopesticides are a diverse group of pest management tools derived from natural materials such as animals, plants, bacteria, and certain minerals. They offer environmentally friendly alternatives to conventional chemical pesticides, often with greater specificity and lower toxicity. While traditionally categorized into three main types—Microbial Pesticides, Plant-Incorporated Protectants (PIPs), and Biochemical Pesticides—biopesticides can also be further classified into additional categories based on their sources and modes of action. Here are five primary categories of biopesticides:

1. Microbial Pesticides

2. Plant-Incorporated Protectants (PIPs)

3. Biochemical Pesticides

4. Botanical Pesticides

5. Mineral-Based Pesticides

1. Microbial Pesticides

These biopesticides consist of living microorganisms like bacteria, fungi, viruses, or protozoa that target specific pests. They work by infecting, parasitizing, or producing toxins that kill or inhibit the growth of pests.

Examples:

- **Bacillus thuringiensis (Bt):** A bacterium that produces proteins toxic to certain insect larvae, such as caterpillars and mosquitoes.
- **Beauveria bassiana:** A fungus that infects and kills a wide range of insect pests, including aphids and whiteflies.
- **Nucleopolyhedrovirus (NPV):** Viruses that specifically target and kill caterpillar pests in agricultural settings.

2. Plant-Incorporated Protectants (PIPs)

PIPs are pesticidal substances that plants produce as a result of genetic modification. By integrating genes from pest-resistant organisms into the plant's genome, the plant itself can produce compounds that deter or kill pests.

Examples:

- **Bt Crops:** Genetically engineered crops like Bt corn and Bt cotton express Bt proteins, which are toxic to specific insect pests, reducing the need for external pesticide applications.
- **Virus-Resistant Papaya:** Papaya plants modified to express coat protein genes from the Papaya Ringspot Virus, providing resistance against the virus.

3. Biochemical Pesticides

These biopesticides are naturally occurring substances that manage pests through non-toxic mechanisms, often by disrupting their behavior, growth, or reproduction rather than killing them directly.

Examples:

- **Insect Pheromones:** Chemicals used to disrupt mating behaviors, such as pheromone traps for moths.
- **Plant Extracts:** Neem oil from the neem tree acts as an insect repellent and growth inhibitor.
- **Insect Growth Regulators (IGRs):** Compounds like methoprene mimic or block insect hormones, preventing pests from reaching maturity.

4. Botanical Pesticides

Botanical pesticides are derived directly from plants and are used to control a variety of pests. They can act as repellents, attractants, or toxins to pests.

Examples:

- **Pyrethrin:** Extracted from chrysanthemum flowers, pyrethrin is an effective insecticide against a wide range of insects.
- **Rotenone:** Derived from the roots of certain leguminous plants, rotenone is used to control insects and fish.
- **Essential Oils:** Oils like peppermint or citronella can repel insects such as mosquitoes and ants.

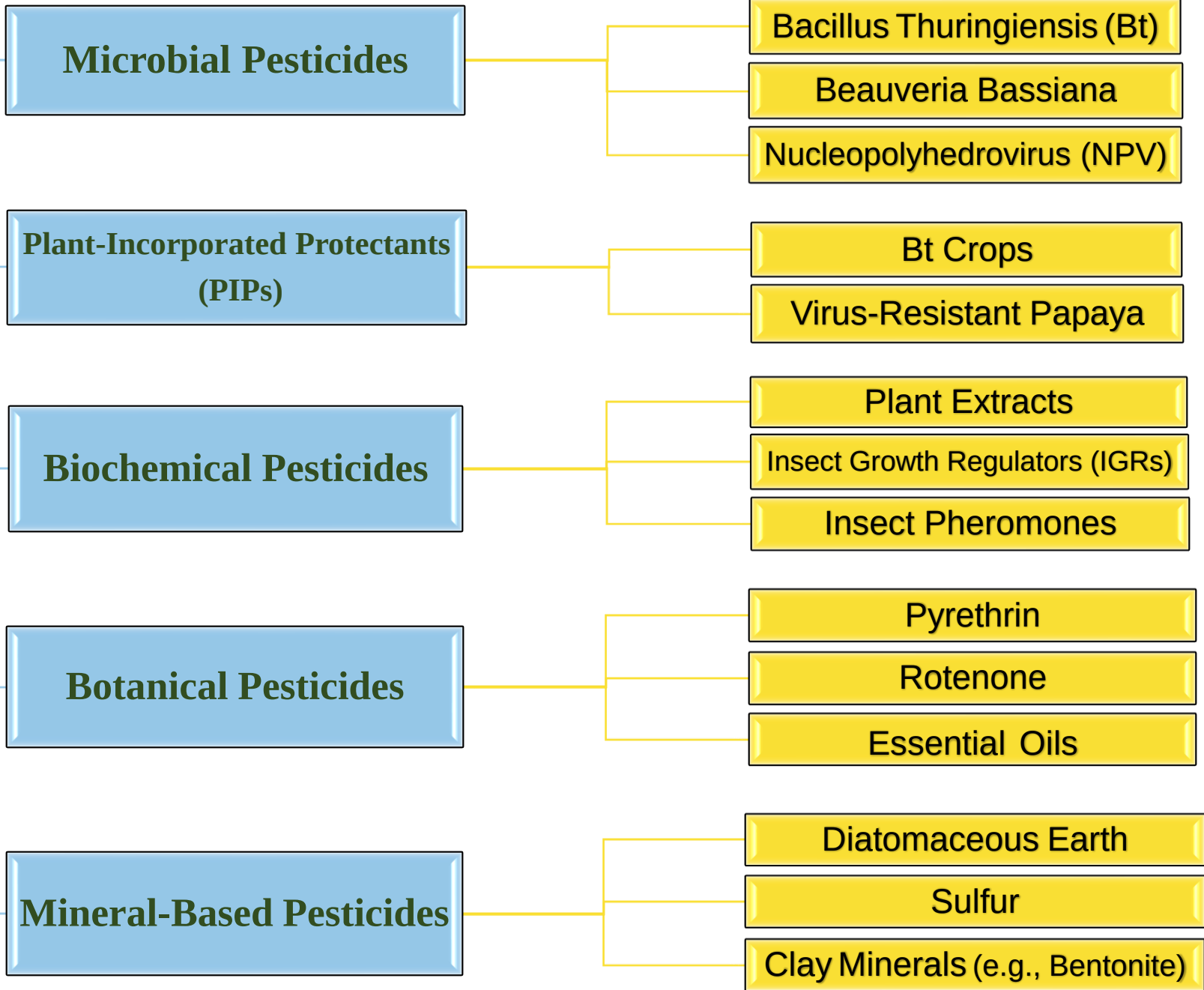
5. Mineral-Based Pesticides

These biopesticides utilize naturally occurring minerals to manage pests. They typically work by physically disrupting pests or by creating unfavorable conditions for their survival.

Examples:

- **Diatomaceous Earth:** Composed of fossilized remains of diatoms, it acts as a desiccant, causing insects to dehydrate.
- **Sulfur:** Used as a fungicide and insecticide, sulfur disrupts the metabolism of pests and inhibits fungal growth.
- **Clay Minerals (e.g., Bentonite):** These can be used to coat seeds or plants, creating a barrier that deters pests.

BIOPESTICIDES



حشره کش های تصویب شده از سال 1386 تا اردیبهشت 1403

نام عمومی	نام تجاری	درصد	فرمولاسیون	شرکت	آفت هدف	محصول	تاریخ تصویب
باسیلوس تورنجینسیس	بایولپ	10^8	SC	فناوری زیستی طبیعت گرا	خوشه خوار	انگور	97/7/29
باسیلوس تورنجینسیس	بایولپ	10^8	SC	فناوری زیستی طبیعت گرا	بید	کلم	98/8/27
باسیلوس تورنجینسیس	بایولپ پی	10^9	WP	فناوری زیستی طبیعت گرا	بید	کلم	97/5/1
باسیلوس تورنجینسیس	بایولپ پی	10^9	WP	فناوری زیستی طبیعت گرا	کرم غوزه پنبه	پنبه	98/4/10
باسیلوس تورنجینسیس	باسیلوس تورنجینسیس		WP	گیاه پر نیان اطلس	پيله خوار (لارو سن 1 و 2)	نخود	1401/4/6

قارچ کش های تصویب شده از سال 1386 تا اردیبهشت 1403

نام عمومی	نام تجاری	درصد	فرمولاسیون	شرکت	آفت هدف	محصول	تاریخ تصویب
باسیلوس سوبتیلیس	کانگ می	5%	WP	Deqiang Biology	بالست	برنج	97/2/24
باسیلوس سوبتیلیس	کانگ می	5%	WP	گیاه پر نیان اطلس Deqiang Biology	لکه موجی آلترناریایی	گوچه فرنگی	1401/4/20
باسیلوس ولزنسیس	پارس باسیل	10^8	SC	رویان تيسان	پژمردگی فوزاریوم	گوچه فرنگی گلخانه	98/8/27
باسیلوس سوبتیلیس	سرناد	10^{12}	SC	بایر آلمان	کپک خاکستری	توت فرنگی گلخانه	98/10/9
باسیلوس سوبتیلیس	سرناد	10^{12}	SC	بایر آلمان	پژمردگی فوزاریومی	گوچه فرنگی گلخانه	1400/9/22
باسیلوس سوبتیلیس	روبین 1	10^7	پودر مرطوب	زیست فناور سبز	پوسیدگی ریزوکتونیایی ریشه	چغندر قند	99/4/30



کیمیا گوهر فاک



زراورده های طلای سبز



شوکوه اشترافش و سناک



کرامت های طلای سبز



کرامت های طلای سبز

THANK YOU