Agrochemicals - Where are we heading?

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Global Mega Trends

Adapting to Climate Change

- Increasingly unstable climate
- Expect to live in more volatile climate – characterised by unprecedented weather events
- **Opportunities in wind and solar energy**

Leaner, cleaner and greener

- Resource scarcity and constraints
- **Synthetic biology, alternative proteins, advanced recycling**

The escalating health imperative

- Global pandemics
- Aging population and growing burden of chronic disease
- Drug resistant super bugs
- **Burning platform to respond to health risks and improve outcomes**

Geopolitical shifts

- Disrupted patterns of global trade
- Geopolitical tensions and growing investment defense

Diving into digital

- Increase in cybercrime
- **Digital innovation**
- **Leverage AI to solve challenges**

Increasingly autonomous

- Explosion in artificial intelligence

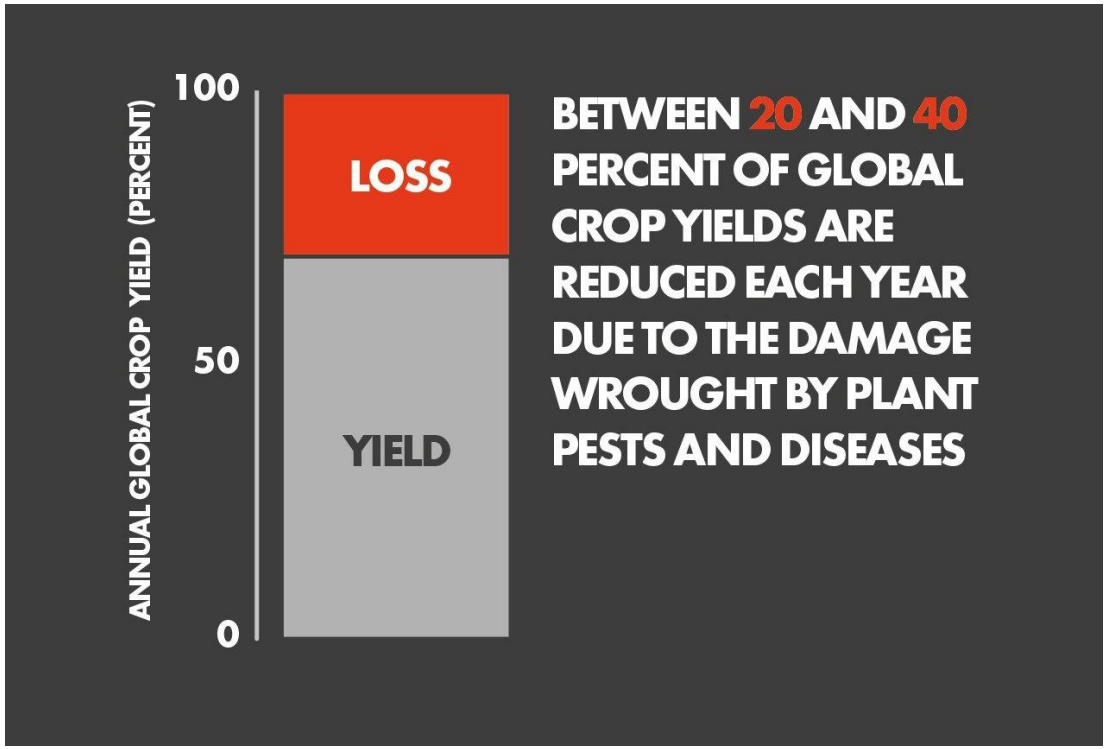
Unlocking the human dimension

- Strong consumer and citizen push for decision makers to consider trust, transparency, fairness and ESG

Source: CSIRO

Setting the Stage – Why Crop Protection Matters

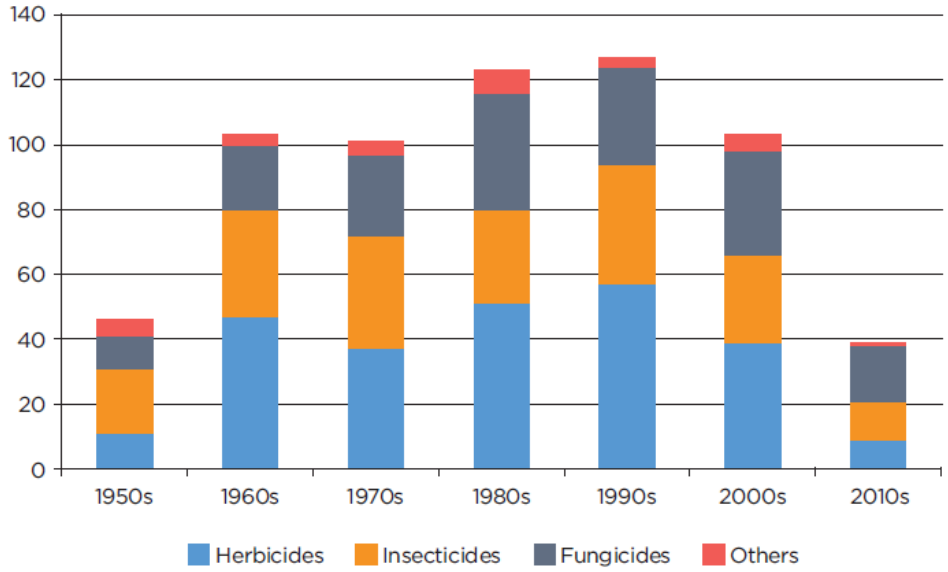
- By 2050, the global population is projected to exceed 9.7 billion.
- Today over 295 million people across 53 countries experienced acute hunger,
- Agricultural production must increase by approximately 60% to meet future food demand.
- The crop protection industry stands at a crossroads: balancing sustainability, technology, and consumer trust.
- Approximately 1.05 billion tonnes of food waste globally in 2022 at the retail, food service, and household levels. This is in addition to the 13% of food lost earlier in the supply chain between harvest and retail.



The State of Crop Protection Today

- Chemical pesticides still dominate, representing 80% of market value.
- 1960's – 15 groups, today over 40 groups (MoA's)
- The biological segment—biopesticides, microbial and natural extracts—is growing rapidly. (10-15% CAGR)
- Increasing regulation on chemical residues, such as the EU Farm-to-Fork strategy, is reshaping the market.
- Rising R&D costs and shrinking portfolios of new active ingredients challenge innovation.

Figure 2: Number of new active ingredients introduced per decade: 1950s to present day



Source: Phillips McDougall Database

Most significant new introductions to come

Active compound (discovered by)	New Insecticide Active (Mode of action)
Indazapyroxamet (FMC)	Chordotonal organ Transient Receptor Potential Vanilloid channel modulator
Alkylsulfones (Syngenta)	Vesicular acetylcholine transporter
Pyrazoline insecticides (BASF)	Voltage-gated sodium channel blocker
1,3,4-Trisubstituted pyrazoles (FMC)	Unclassified
Dimpropyridaz (BASF)	Chortodonal organ modulator
Fenmezoditiaz (BASF)	Nicotinic acetylcholine receptor competitive modulator

Active compound (discovered by)	New Fungicide Actives (Mode of action)
Mefentrifluconazole (BASF)	P450 cytochrome lanosterol 14-a demethylase inhibitor
Pyridachlomethyl (Sumitomo)	Tubulin dynamics modulator
Picolinamides (Globachem)	Complex III inhibitor

Active compound (discovered by)	New Nematicide Actives (Mode of action)
Cyclobutrifluram (Syngenta)	Mitochondrial complex II electron transport inhibitor (SDHI)
Triazolones (FMC)	Mitochondrial complex II electron transport inhibitor (SDHI)

Active compound (discovered by)	New Herbicide Actives (Mode of action)
Rimisoxafen (FMC)	SPS and PDS inhibitors/dual mode of action
Ketoenols (Bayer)	Acetyl CoA carboxylase inhibitor
Dimesulfazet (Nissan)	Lipid biosynthesis inhibitor (very long chain fatty acid synthesis)
Epyrifenacil (Sumitomo)	PPO inhibitor
Trifluoromethyl pyrazoles (Bayer)	PPO inhibitor

Crop Protection Actives off patent and due off patent till 2028

2023	Category
Bixafen (Bayer Crop Science)	Fungicide
Isopyrazam (Syngenta AG)	Fungicide
Mandipropamid (Syngenta AG)	Fungicide
2024	
Chlorantraniliprole (Corteva/FMC)	Insecticide
Flubendiamide (Bayer Crop Science)	Insecticide
Fluopicolide (Bayer Crop Science)	Fungicide
Fluopyram (Bayer Crop Science)	Fungicide / Nematicide
Penflufen (Bayer Crop Science)	Fungicide
Penthiopyrad (Corteva Agriscience)	Fungicide
Pyriofenone (Ishihara)	Fungicide
Pyroxsulam (Corteva Agriscience)	Herbicide
Saflufenacil (BASF)	Herbicide
Sedaxane (Syngenta AG)	Fungicide
Thiencarbazone-methyl (Bayer Crop Science)	Herbicide
Valifenalate (Ishihara)	Fungicide
2026	
Cyantraniliprole (Corteva/FMC/Syngenta)	Insecticide
Pinoxaden (Syngenta AG)	Herbicide
2027	
Sulfoxaflor (Corteva Agriscience)	Insecticide
2028	
Benzovindiflupyr (Syngenta AG)	Fungicide

Growth opportunities persist:

- Continuous expansion of off-patent crop protection market share as blockbuster compounds lose exclusivity;
- Rapid growth of excellent multinational generic crop protection companies
- Interplay among different product categories driven by transgenic seed and biologicals
- Government prohibition or restriction policies

Forces Shaping the Industry's Future

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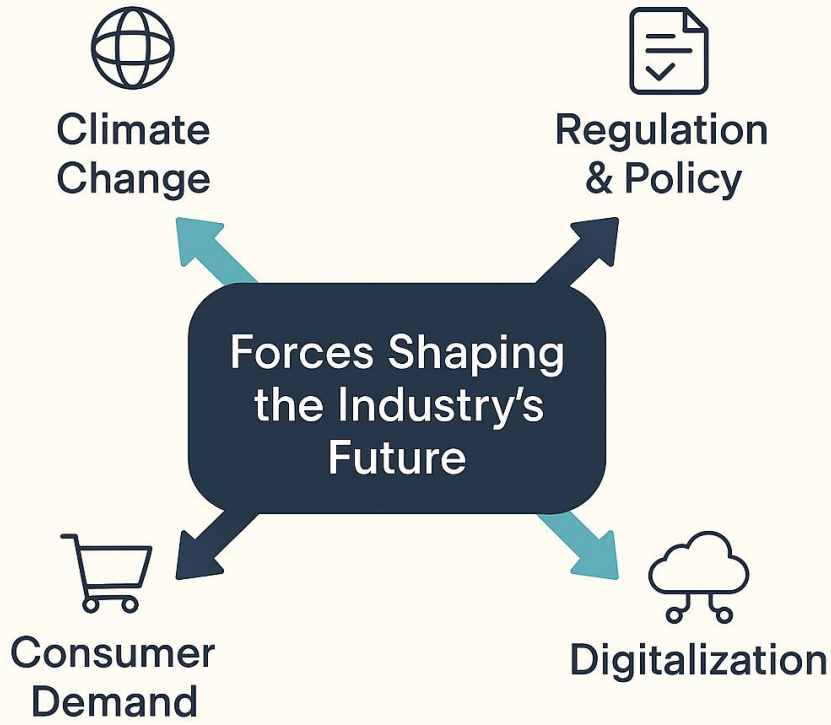
Forces Shaping the Industry's Future

Climate Change: Alters pest pressure, disease distribution, and requires new strategies and crop choices.

Regulation & Policy: Push for reduced pesticide use, eco-labeling, and integrated pest management (IPM).

Consumer Demand: Growing preference for sustainable, residue-free products.

Digitalization: Precision agriculture, AI, and sensor-driven decision support are transforming farming.

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Climate Variability, Climate Change, Climate Smart Agriculture

South Africa is expected to experience:

- Increase in mean, maximum and minimum **temperatures**.
- Increase in **very hot days – above 35 °C** and the frequency of heat wave events.
- **Drier conditions** in the future, with regional variation.
- Slight **increases in rainfall** towards the north-eastern region.
- A strong **drying signal** over the **southwestern region**, which could result in reductions in rainfall of more than 40 mm per year.
- Increase in the **frequency of extreme rainfall** events (20 mm of rain falling within 24 hours) over eastern parts during the summer months.
- **Sea level rise** and an increase in the frequency and intensity of **sea storms**, accompanied by increases in wave heights
- Increase in the **number of high fire danger** days over north-eastern region and along the Cape south coast and the south-western Cape.

www.metos.co.za
www.terraclim.co.za
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Consumer demand

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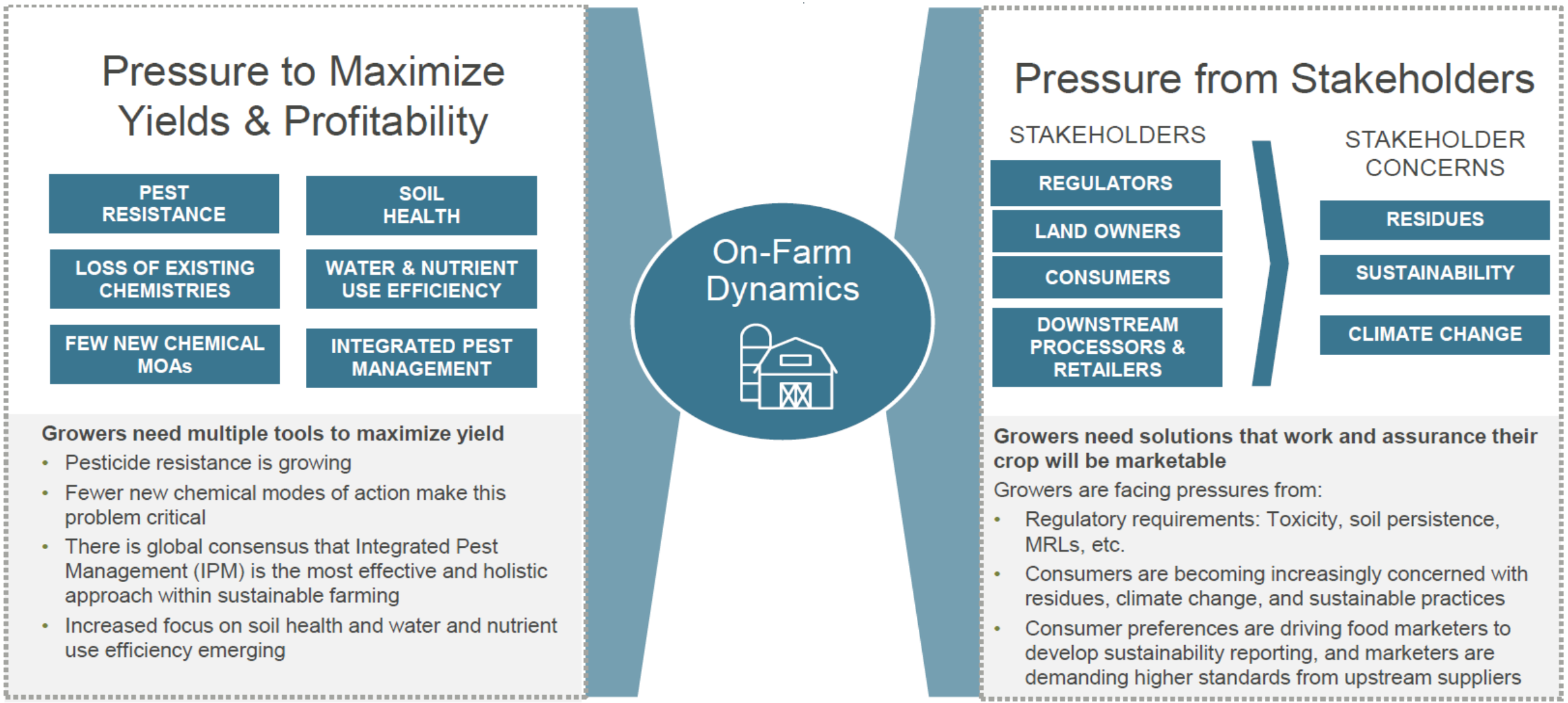
As growers face increased pressure to maximize yields and profitability, they also face increasing pressure from a variety of stakeholders



Innovation and technological advances that will change the ag-industry. (some examples)

RNA Interference (RNAi): Enables targeted pest control at the genetic level.

Biologicals: Microbial solutions, pheromones, and plant extracts offer new modes of action.

CRISPR & Gene Editing: Developing pest-resistant crop varieties for future resilience.

Digital Platforms: AI-driven pest prediction, autonomous spraying, and drone monitoring are becoming mainstream.

What is RNAi Technology and why is this exciting?

clade	order	family	target organism	targets								
				cell cycle/cell integrity	development	energy metabolism	reproduction	immune system	neuronal system	pathogenesis	sporulation	total
insects	Lepidoptera	Noctuinae	*Helicoverpa armigera* (Cotton bollworm/Chickpea pod borer)		3				3			6
			Agrotis ipsilon (Ipsilon dart)		1							1
			Spodoptera frugiperda (Fall armyworm)	1	1							2
			Spodoptera littoralis (Egyptian cotton leaf worm)	1								1
			Spodoptera litura (Common cutworm)	1								1
		Crambidae	*Ostrinia furnacalis* (Asian corn borer)		1							1
			Chilo suppressalis (Rice stem borer)	1	1	1	1					4
		Bombycidae	*Bombyx mori* (Silkworm)			1		1				2
		Plutellidae	*Plutella xylostella* (Diamondback moth)	1	2	1	1					5
		Gelechioidea	*Tuta absoluta* (Tomato leafminer)	1		1						2
		Castnidae	*Telchin licus licus* (Sugarcane giant borer)			1						1
			total	6	9	5	2	1	3	0	0	26
	Hemiptera	Delphacidae	*Laodelphax striatellus* (Small brown planthopper)		1	1						2
			Nilaparvata lugens (Brown planthopper)	1	3				1			5
			Sogatella furcifera (White-backed planthopper)		1							1
		Aphididae	*Aphis gossypii* (Greenfly)						1			1
			Sitobion avenae (Wheat aphid)				1					1
		Pentatomidae	*Nezara viridula* (Southern green stink bug)					1				1
		Aleyrodidae	*Bemisia tabaci* (White fly)	1		1						2
		Cicadellidae	*Nephotettix cincticeps* (Rice green leafhopper)		1	1						2
		Liviidae	*Diaphorina citri* (Asian citrus psyllid)	1								1
		Miridae	*Adelphocoris suturalis* (Mirid bug)			1						1
			total	3	6	4	1	1	2	0	0	17
	Coleoptera	Chrysomelidae	*Diabrotica virgifera virgifera* (Western corn rootworm)	3		1						4
			Leptinotarsa decemlineata (Colorado potato beetle)	4								4
		Coccinellidae	*Harmonia axyridis* (Asian ladybug)		1							1
			Henosepilachna vigintioctopunctata (28-spotted ladybeetle)	3				1				4
		Tenebrionidae	*Tribolium castaneum* (Red flour beetle)	1	2		1	1				5
		Nitidulidae	*Brassicogethes aeneus* (Pollen beetle)	1								1
		Brentidae	*Cylas puncticollis* (Sweetpotato weevil)					1				1
			total	12	3	1	1	3	0	0	0	20
	Diptera	Tephritidae	*Bactrocera dorsalis* (Oriental fruit fly)				2					2
		Culicidae	*Aedes aegypti* (Yellow fever mosquito)	1								1
			total	1	0	0	2	0	0	0	0	3
	Orthoptera	Acrididae	*Locusta migratoria manilensis* (Oriental migratory locust)			1						1
arachnida	Trombidiformes	Tetranychidae	*Tetranychus urticae* (Red spider mite)	1		1						2
fungi	Hypocreales	Nectriaceae	*Fusarium graminearum*	2		1		1		1		5
			Fusarium culmorum	1		1				2		4
			Fusarium oxysporum	1						1		2
			Fusarium spp.	3								3
			total	7	0	2	0	1	0	4	0	14
	Helotiales	Sclerotiniaceae	*Botrytis cinerea*	2				1		4	1	8
			Bortryotinia fuckeliana			1						1
		Erysiphaceae	*Podosphaera xanthii*	1		1						2
			Blumeria graminis							1		1
			total	3	0	2	0	1	0	5	1	12
	Pucciniales	Phakopsoraceae	*Phakopsora pachyrhizi*							1	1	2
	Peronosporales	Peronosporaceae	*Phytophthora infestans*	1		1				1		3
	Magnaporthales	Magnaporthaceae	*Magnaporthe oryzae*	1						1		2
	Glomerellales	Glomerellaceae	*Colletotrichum truncatum*	1								1
	Eurotiales	Trichocomaceae	*Aspergillus flavus*							1		1
viruses			*Tobacco mosaic virus*							1		1
			Pepper golden mosaic virus							1		1
			Cucumber mosaic virus							1		1
			Papaya ringspot virus							1		1
			Potato virus Y							2		2
			Tobacco rattle virus							1		1
			total	0	0	0	0	0	0	7	0	7
angiospermae	Asterales	Asteraceae	*Mikania micrantha*			1						1
total				38	18	18	6	7	5	20	2	112

Mechanism: RNAi relies on double-stranded RNA (dsRNA) molecules that match a sequence in a target pest's or pathogen's gene. This dsRNA triggers the cell's machinery to degrade the corresponding messenger RNA (mRNA), preventing the production of essential proteins for survival, development, or function.

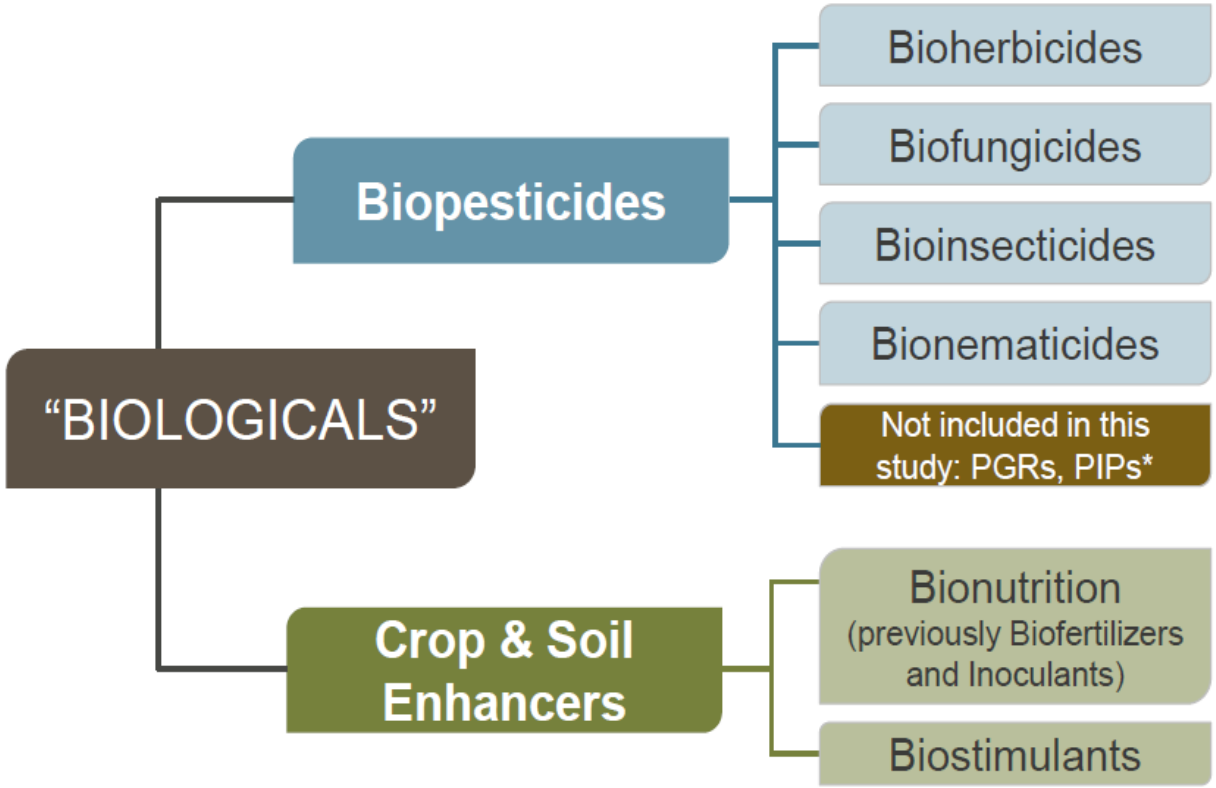
Specificity & Safety: It is highly sequence-specific, meaning it can be designed to target a gene unique to the pest, leading to minimal impact on beneficial insects, non-target organisms, and the environment compared to broad-spectrum chemical pesticides.

See Calantha: https://www.greenlightbiosciences.com/

The definition of Biological varies significantly across the market. A clear definition is critical for any discussion into the "Biologicals" market

FOR THIS STUDY, BIOLOGICALS ARE DEFINED AS:

An agricultural product where the active constituent consists of or is derived from a living organism *(plant, animal, microorganism, etc.),* with or without modification.



Represented by
Four Major Sources of Activity:**

Biological chemicals
**pheromones, hormones, growth regulators, enzymes, etc.

Plant and other extracts
**plant extracts, oils, etc.

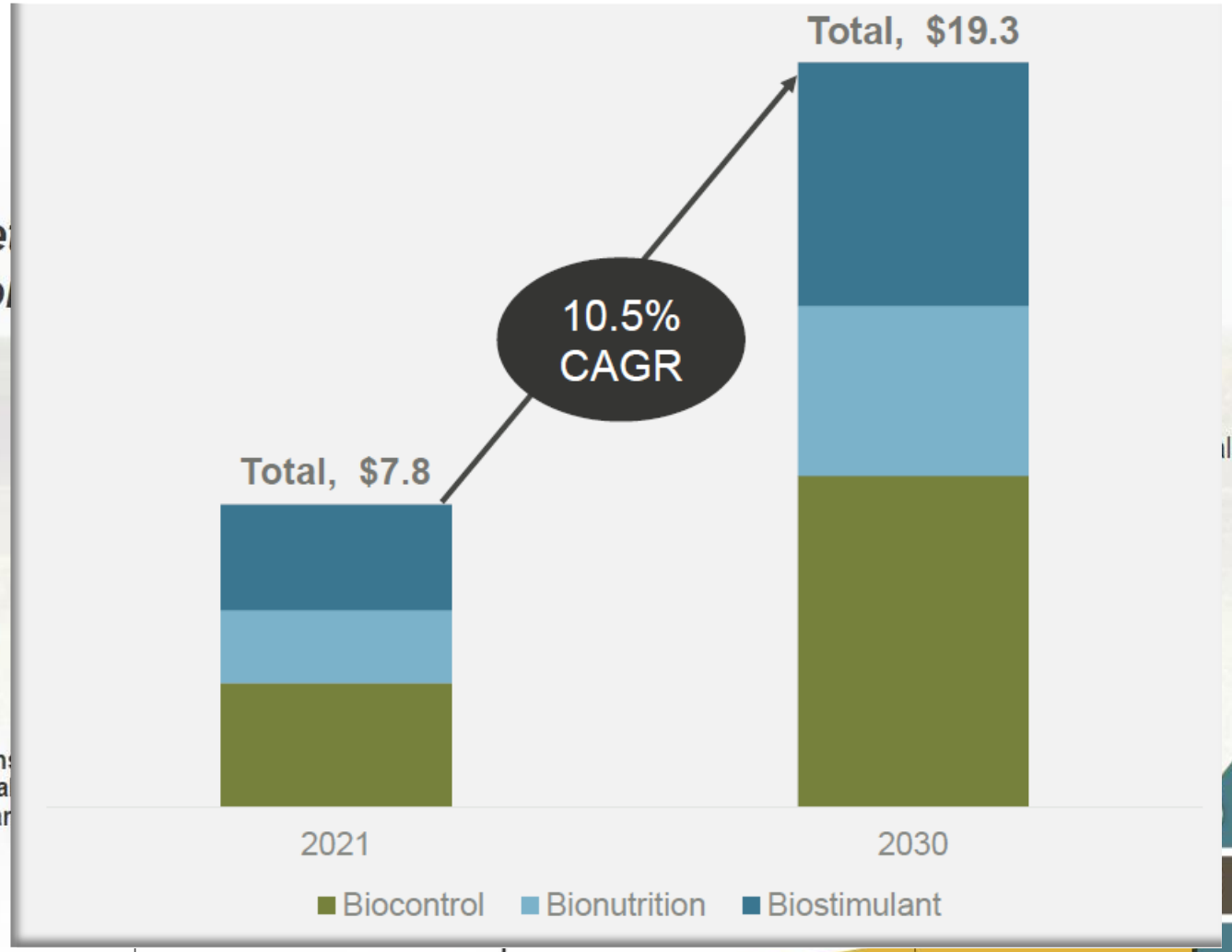
Microbial agents and their exudates
**bacteria, fungi, viruses, nematodes, protozoa

Macroscopic organisms
**Beneficial insects, mites, and nematodes

Historically, the primary goal of the biologicals sector was to **increase food availability** while **reducing the impact** of crop fertilization and crop protection on the environment. Biologicals have evolved, however, to become an integral part of **Integrated Pest Management** practices, helping boost overall efficacy of treatments and providing resistance management tools.

**PGR = Plant Growth Regulator; PIP = Plant Incorporated Protectant*
***This study excludes synthetic and purified natural products, such as abamectins and spinosyns that are registered as conventional pesticides*

The use and applications of the biological products will continue to expand in the market



Biologicals marke
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- RNAi
- Designer endophytes
- Nitrogen fixation in grasses (*Azospirillum*, *Azotobacter*)
- Mycorrhiza and bacterial-enhanced phosphorus & micronutrient uptake
- Microbiome solutions
- Topically applied protein and peptide elicitors of immune responses
- Biostimulants growth

Inoculants combined with synthetic fertilizers

Bt – first foliar microbial blockbuster

Companies close, downs diversified… biologica relegated to niche mar

1940's

First nitrogen fixers (*Rhizobia*) sold as seed inoculants

Influx of startup companies

Market consolidation and optimizations

$19B

$380M

1890's **1980's** **2000's** **2010** **2021** **2031**

Regulation & Policy

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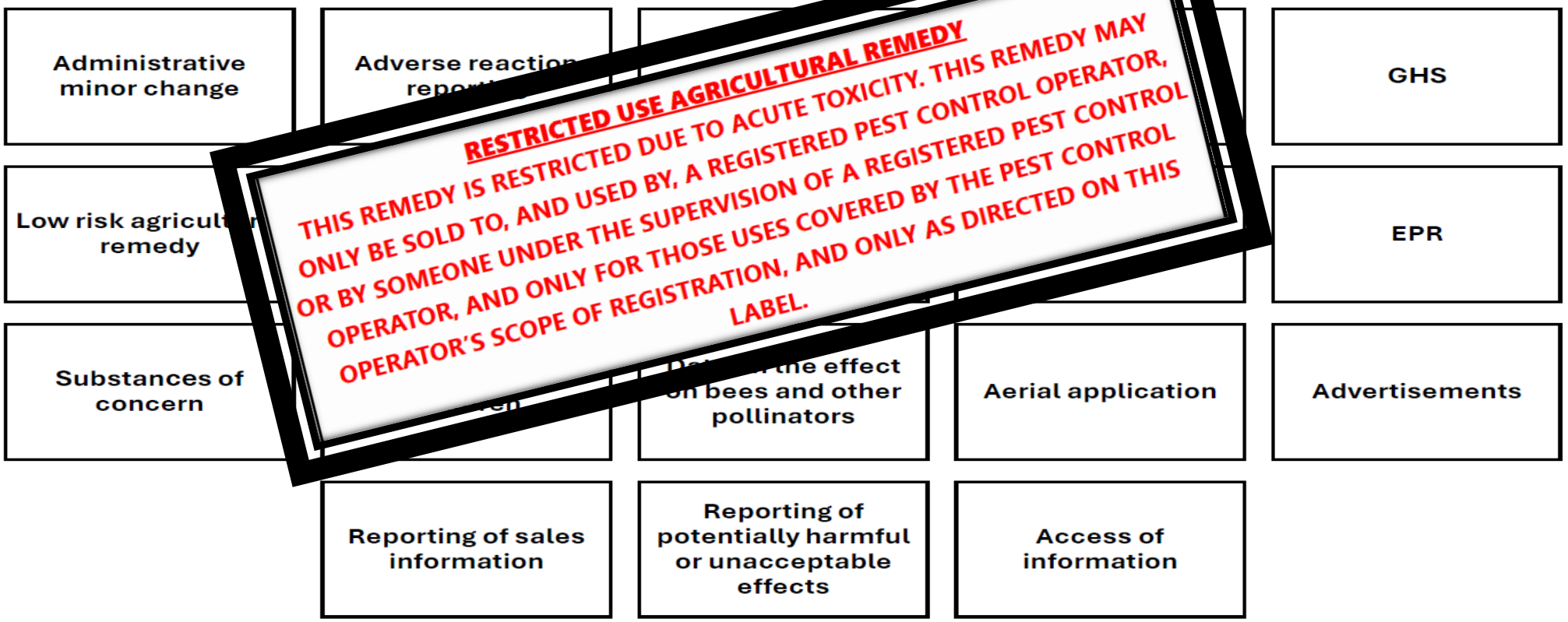
Changes to the Act (Act 36 of 1947) – August 2023

WHAT IS NEW?



Digital Agriculture

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Current Themes (NOW): Precision & Efficiency

The immediate focus of digital agriculture is on optimizing existing farm operations to improve yield and resource efficiency.

- **Precision Agriculture:** Using IoT sensors (soil moisture, temperature) and GPS mapping for highly targeted application of water, fertilizer, and pesticides, reducing waste.
- **Data-Driven Decisions:** Utilizing farm management software and basic data analytics to inform real-time decisions on planting, irrigation, and harvesting.
- **Mechanization & Automation**: Implementation of drones for aerial monitoring and imaging, and early-stage automation in irrigation systems.
- **Connectivity**: Bridging informational gaps by providing farmers with real-time market prices, weather updates, and basic guidance through mobile apps and platforms.

Emerging & Future Themes (FUTURE): Autonomy & Sustainability

The future will focus on fully integrated, autonomous systems that are inherently sustainable and resilient to climate change.

Autonomous Systems & Robotics: Widespread use of AI-driven robots for tasks like planting, weeding, and selective harvesting, reducing labor shortages and increasing accuracy.

Advanced AI & Predictive Analytics: Moving beyond descriptive data to predictive models that forecast weather extremes, optimize climate control in controlled environments, and identify pest infestations before they spread.

Regenerative & Climate-Smart Practices: Integration of technology to support sustainable practices such as carbon utilization, remote sensing for environmental impact assessment, and the development of climate-resilient crops.

Supply Chain Traceability: Utilizing blockchain technology to ensure full transparency and fair pricing from farm-to-table, enhancing consumer trust and market access.

Novel Farming Environments: Expansion of data-driven vertical farming and smart greenhouses, allowing for food production in unconventional locations and reducing transport costs.

Thank you

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