

BIOSTIMULANTS

OVERVIEW

Sustainability Challenge

Modern agriculture faces conflicting pressures all at once: **feed more people, cut emissions, and remain profitable.**

First, the system remains structurally reliant on **synthetic fertilizers and pesticides**, which are closely tied to **fossil energy**. Their manufacture and use are **energy-intensive** and contribute meaningfully to agricultural **GHG emissions**; two-thirds of nitrogen's climate impact happens after application. On farms, nitrogen breaks down into nitrous oxide (N₂O), which has 273 times the warming potential of CO₂.

Synthetic fertilizers account for ~5% of global GHG emissions, more than global aviation and shipping combined ¹

Second, the marginal efficiency of chemical inputs is deteriorating. In many regions, a **share of applied nutrients does not reach the crop** and is instead lost through **leaching, volatilization, and runoff**. This drives persistent externalities - **water pollution and eutrophication, degradation of soil biology**, and a reinforcing loop where weaker soils require **more inputs** to sustain yields.

Third, **climate stress** is turning **yield volatility** into a strategic risk. **Drought, heat, salinity intrusion, and extreme weather events** can trigger severe yield losses, while conventional input regimes often deliver **limited robustness**. At the same time, agricultural production would still need to increase by 70 percent (nearly 100 percent in developing countries) by 2050 to cope with a 40 percent increase in world population. ²

Soil degradation translate directly into yield impact. Compaction alone can lead to **>35% yield reductions** in impacted areas ³. Meanwhile, soil organic content has been declining steadily, a direct consequence of intensive management practices that prioritize short-term output over long-term soil health. Together, these factors have contributed to a long-term decline in productive capacity.

Soil pollution adds a slow-moving but persistent constraint. Nitrates, pesticides and other residues can persist for decades, which create long-term liabilities for land value and crop quality.

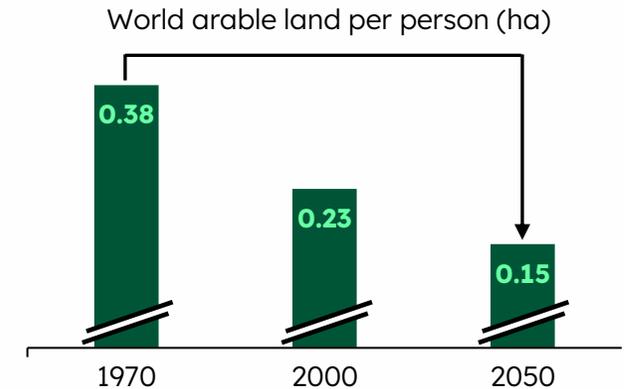
Market and regulatory pressure are converging. Retailers and food processors are tightening sustainability requirements for suppliers, while the **Common Agricultural Policy (2023-2027)** now conditions subsidies on stricter environmental standards (**GAEC requirements**) and dedicates **25% of direct payments to eco-schemes**. Together, these forces are pushing growers to adopt solutions that protect yields and reduce environmental footprint.

EU agriculture is losing an average of €28bn annually due to extreme weather, with projections indicating that losses could **exceed €40bn per year by 2050** under current emissions trends. ³

Meanwhile, intensive fertilization has systematically degraded soils through biological degradation, acidification, and microbiome collapse.

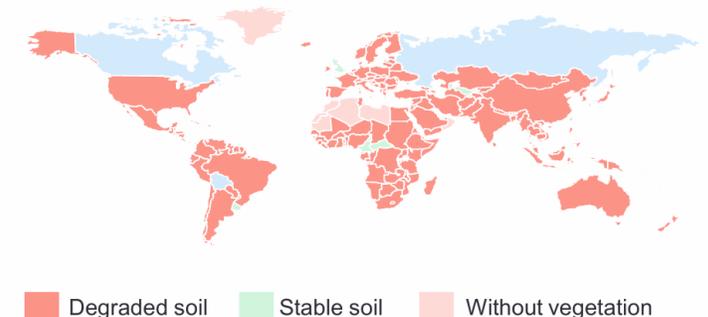
This **dual crisis** positions **biostimulants** as essential: **scalable solutions** that simultaneously enhance **climate resilience** and **nutrient - use efficiency**.

Ongoing Global Decline in Arable Land, With Soil Degradation Concerns



Source : EY Parthenon Analysis for Ardabelle

Estimation of the level of soil degradation at a global level



Source : EY Parthenon Analysis for Ardabelle

¹Gao, Y. & Cabrera Serrenho, A. (2023). *Nature Food*.

²Bruinsma, J. (2010). *FAO Resource Outlook to 2050*.

³fi-compass (2025). *Insurance and Risk Management Tools for Agriculture in the EU*. EIB.

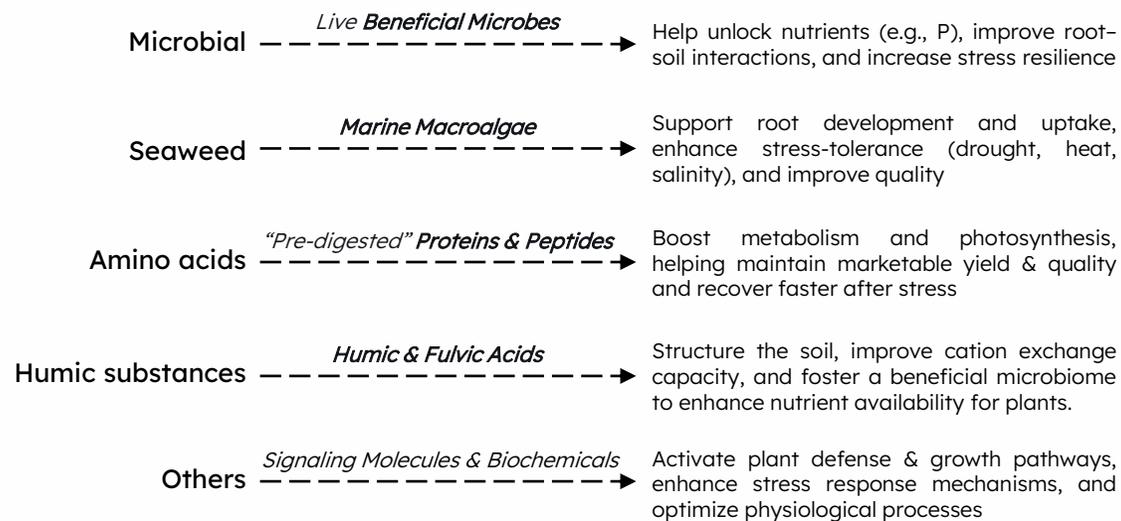
The Solution Pathway

Biostimulants sit **between fertilizers and crop-protection**. They do not replace NPK; instead, they are layered **on top of standard fertilizer programs** and integrated into **crop management systems** to help crops perform better with fewer inputs. In a world of higher climate volatility, tighter regulation and volatile energy-linked fertilizer costs, they offer a pragmatic route to protect yield while reducing exposure to the conventional input model.

Unlike fertilizers, which **supply nutrients**, biostimulants work by **activating natural plant and soil processes**. Their role is to improve how the plant uses what it already has access to: more efficient interaction between plants and their root microbiota, stronger root systems, more efficient uptake, better stress responses and - critically for growers - more stable yields and quality under sub-optimal conditions.

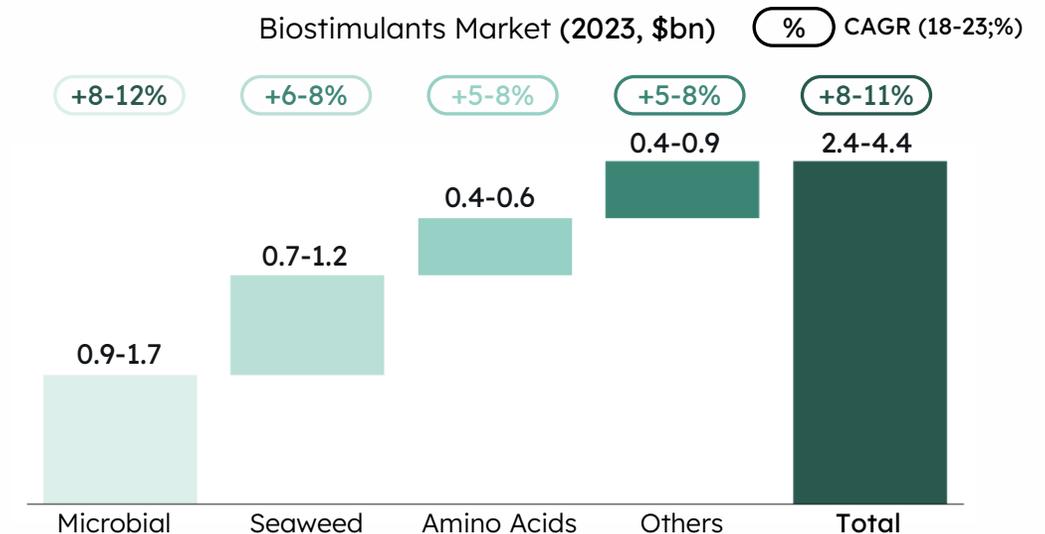
That positioning matters commercially: it makes the category easier to adopt as it **fits existing agronomic practices, being inserted into cropping systems**, redesigned to get the best out of these new inputs.

In practice, the category includes several families of products with distinct modes of action:



The environmental benefits cascade through the value chain. Upstream, improved nutrient use efficiency can reduce synthetic fertilizer needs, lowering embedded emissions. In-field, healthier soils and stronger root systems can **improve resilience** and **reduce yield volatility** under climate stress without escalating chemical treatments. **Downstream**, many biostimulants products are biodegradable and generally lower - toxicity, reducing risks of persistence and accumulation associated with certain conventional chemistries.

Seaweed-based biostimulants are one of the most established parts of the biostimulants market. They are made by extracting bioactive fractions from marine macroalgae, yielding a naturally complex mix—typically including **polysaccharides, polyphenols** and **phytohormone-like compounds**—that can modulate plant signaling and metabolism. Unlike fertilizers, they do not add nutrients; they are used to help crops **use water and nutrients more effectively**, strengthen **rooting and uptake**, and improve tolerance to **abiotic stress** (drought, salinity and heat), with the practical aim of stabilizing yield and quality in more volatile growing conditions.



Source : EY Parthenon Analysis for Ardabelle

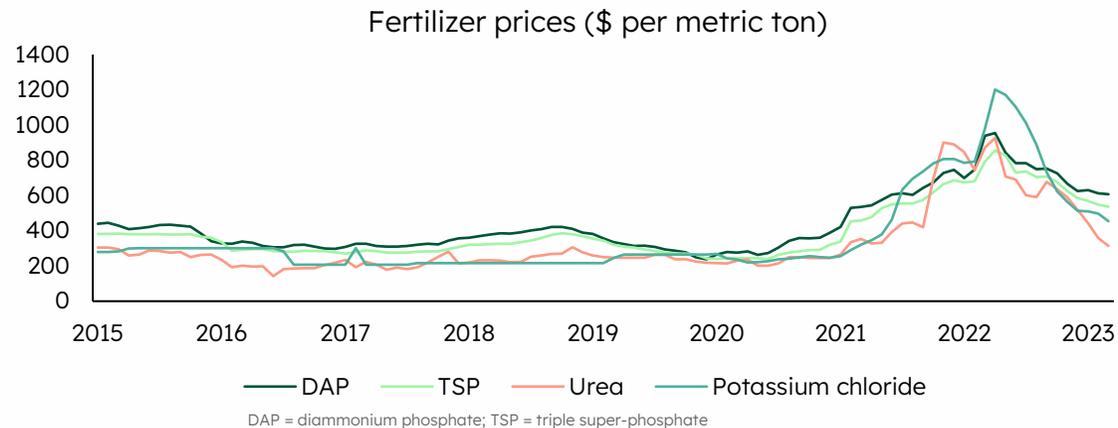
Market Overview

The global market is expanding at a **double-digit pace**, **outgrowing conventional crop inputs**. **Europe** remains the most **mature and institutionalized** region, supported by **harmonized regulation** and **downstream pull** from food and consumer brands embedding **sustainability criteria** into sourcing.

South America is scaling in **large-acre crops**, where the economic case is now proven, as they deliver clear return on investment, with stress protection and nutrient efficiency. **North America** is growing steadily, often led by **premium crops** and **progressive growers**, while **APAC** is accelerating as policy priorities shift toward **chemical reduction** and **soil health**.

Biostimulants are shifting from nice-to-have to must-have, driven by different forces:

- **They now offer compelling unit economics and proven ROI** as they boost nutrient use efficiency, while providing a hedge against unstable fertilizer prices (see chart)
- **Climate volatility** has shifted from occasional risk to structural reality, making yield stabilization under heat and drought a prerequisite for protecting farm margins.



Maximum cost-in-use and total penetration

~\$9.4bn

Current cost-in-use total penetration

~\$2.3bn

Current penetration and Cost-in-use

~\$0.7bn

Overview of biological's potential white space in Spain (2024; \$b)

Source : EY Parthenon Analysis for Ardabelle

Whitespace in biologicals remains substantial, with ample runway for adoption as growers prioritize measurable gains in yield, quality and stress resilience. Bottom-up market analysis conducted with **EY-Parthenon** for Spain shows the gap between current and maximum cost-effective penetration across **biostimulants and biocontrol** exceeds **\$8 billion**, suggesting similar magnitude opportunities globally.

The opportunity spans **high-value specialty crops** (fruits vines, vegetables) and **broad-acre field crops** (cereals, oilseeds, row crops), with substantial penetration headroom driven by measurable performance gains. The market's evolution is being accelerated by high quality products accompanied by adapted advisory services that deliver field-validated protocols and documented ROI.

Where biostimulants contribute to a resilient food value chain

The Scope 3 Imperative

For global food majors, the path to net zero runs through the farm gate. Scope 3 emissions account for **up to 90%** of food and beverage companies' climate footprint, with **upstream agriculture** dominating that total¹. Decarbonization is inextricably linked to on-farm practice changes, making resilience and emissions reduction no longer separate goals but a **single operational challenge**

Biostimulants as The Biological Engine of Regeneration

While regenerative agriculture provides the framework, biostimulants provide the mechanism to execute it. These soil-based inputs actively restore ecosystem function by introducing beneficial organisms, such as mycorrhizal fungi and rhizobacteria, that rebuild the microbiome and improve soil structure. Critically, they convert microbial biomass into stable soil organic carbon, transforming "soil health" from aspiration into a measurable climate and production asset. As a deployable, scalable tool, biostimulants bridge the gap between policy targets and farm-level reality, delivering the **stress resilience** and **input efficiency** required to secure future supply.



Pernod Ricard

Piloting regenerative agriculture across **100% of vineyards**, with **25 global programs** focused on soil health, biodiversity and climate resilience to secure long-term terroir integrity and premium grape quality



Implementing a **100% regenerative potato acreage target by 2030**, utilizing soil health metrics to structurally de-risk supply against yield volatility

HEINZ

Deploys **soil health protocols** to "future-proof" tomato yields against abiotic stress, securing volume stability for core product lines.



Sustainable sourcing policy explicitly integrates **nutrient optimisation and soil conservation**, creating a structural "pull" for biological inputs in global citrus supply chains.

For downstream players, biostimulants have evolved from an agronomic niche to a **supply chain necessity**. They bridge the gap between ambitious top-down sustainability targets and the biological reality of farming, offering a scalable mechanism to **protect yields from climate shock** while simultaneously delivering the **verified Scope 3 reductions** demanded by investors and regulators.

¹ Quantis (2025). The Scope 3 Shift: Agricultural Co-ops and CPG Climate Strategy

Sources: Pernod Ricard, McCain, Bel, Heinz, Tropicana, Ardabelle Analysis