



syngenta
Biologicals

Biologicals Solutions and Regenerative Agriculture

VIVA™

Innovation
powered by nature



syngenta
Biologicals



Biologicals' four benefits to Regenerative Agriculture



Healthier soils

Biologicals can help improve the biochemical activity of the soil, contributing to its capacity to function as a vital living ecosystem that sustains the life of plants, animals, and humans.



Reduced greenhouse gas emissions

The integration of biological inputs in crop management can help contain emissions through a more efficient use of resources and an increase in productivity.



Better water management

Biologicals for water use efficiency help farmers optimize the use of agricultural water, making the most of this precious resource.



Increased farm productivity and profitability

Biologicals can help crops be more productive and face the abiotic and biotic stresses that jeopardize their yield and quality, therefore protecting farmers' incomes and limiting the expansion of agricultural land.



Biologicals Solutions for Regenerative Agriculture: VIVA™

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Rethinking Agriculture

The availability of food for the whole world depends, directly or indirectly, on agricultural production.

The increase in crop productivity achieved over the last century has alleviated poverty and malnutrition around the world, and, at the same time, has made it possible to limit the conversion of habitable land for agricultural purposes to feed a growing population.

However, this success was only temporary. The combined effects of global warming, scarcity of resources and population

growth, which reached 8 billion in 2022, now make it necessary to **rethink the way we produce food.**

Guaranteeing enough healthy food for the entire world population, and, at the same time, limiting the consumption of resources and safeguarding the health of plants, soil and ecosystems: this is the challenge that modern agriculture is facing, a challenge that requires a rigorous approach and globally coordinated measures.

To drive change, the United Nations



has dedicated a goal of the Sustainable Development Goals (UN-SDGs) to food production, number 2, which aims to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture".

However, as a confirmation of the central role that agriculture occupies in our society, and its transversal impacts, the goals connected to the production of food among the UN-SDGs are the majority,

and are distributed among objectives of an environmental, social and economic nature.

In this complex and interconnected panorama, **all the players in the food chain will have to find effective and innovative solutions to face the challenge that awaits us.**

Solutions leveraging both on the imperative of ecosystems conservation and on the answers provided by scientific innovation.

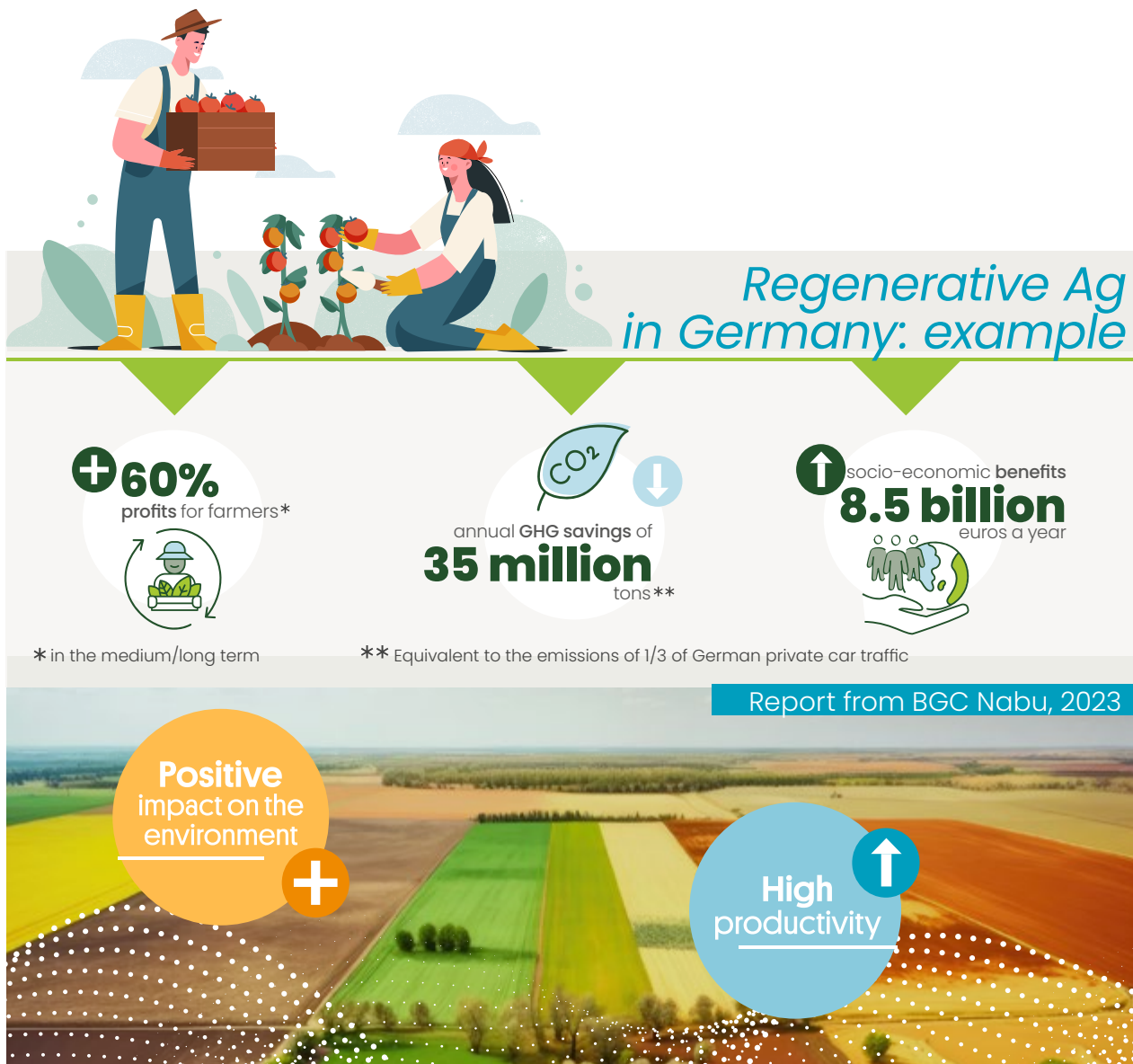
What is Regenerative Agriculture?

We define regenerative agriculture as an **outcome-based** approach, that is to say, oriented towards obtaining specific agronomic and ecological results. Some of these objectives are:



At the same time, we identify **principles and practices** that are functional to achieving these goals. According to the principles of regenerative agriculture, **traditional practices** such as minimal or no-tillage, the use of cover crops, or crop rotation meet with **innovative solutions and technologies** in accordance with the specific needs of crops and land, to tailor an approach that is simultaneously beneficial to humans, the environment and the entire value chain.

This strategy supports the UN-SDG Objective n.2 in its promotion of a "sustainable agriculture", with the idea that **only by safeguarding the well-being of the environment and of the crops themselves it is possible to obtain results that are sustainable in the long term from an economic, social and environmental point of view.**



Regenerative agriculture requires rethinking not only the way of cultivating the land, but also the systemic agronomic strategy and the use of external inputs for crop nutrition and protection. The latter are still considered, but managed in the principle of **precision application**: administered in a targeted way, minimizing waste, and leveraging on the most innovative technologies to optimize treatments on the basis of the single crop or area.

In this context, an important help is provided by **Biologicals**, innovative products that **valorize the action of molecules and organisms present in nature** with the aim of improving crop performance and soil quality. These solutions are designed on the basis of a **deep knowledge of the chemical and biological mechanisms underlying the physiology of plants** and their interactions with the environment, to ensure their **health and productivity** while respecting ecosystems.

Biologicals are made up of three main categories: **biostimulants, biocontrol, and nutrient use efficiency**

The role of Biologicals in Regenerative Agriculture

products. Biostimulants improve the natural physiological processes of crops to increase their **quality, resilience to climatic stress and efficiency in the use of resources**, also benefiting the **microbial activity of the soil**. Biocontrol help plants to face and overcome the pitfalls posed by **weeds or parasites**. **Nutrient use efficiency products** – considered biostimulants or biofertilizers in some markets – improve macro- and micronutrient availability and uptake to promote growth, increase resilience or enhance yield.

Biologicals are not born as alternative solutions to traditional inputs, but to be used in synergy with them and to optimize their use. In particular, Biostimulants improve the health and nutrition status of plants; by doing so, they allow crops to better react to adverse climatic events, or, depending on the type of product, to make the best use of the available resources, minimizing the waste of nutrients.

Products in the Biocontrol category, on the other hand, exploit molecules and substances present in nature to implement highly targeted, specific and low-impact crop defense strategies. An example is the use of pheromones, chemical substances used by parasites for signals between individuals, used to alter reproductive behavior in areas of agricultural interest without harm to the surrounding environment. Lastly, nutrient use efficiency products can effectively support fertilization, by helping plants optimize the nutrients at their disposal and prevent yield reductions that may be caused by nutrient loss.



Biostimulants

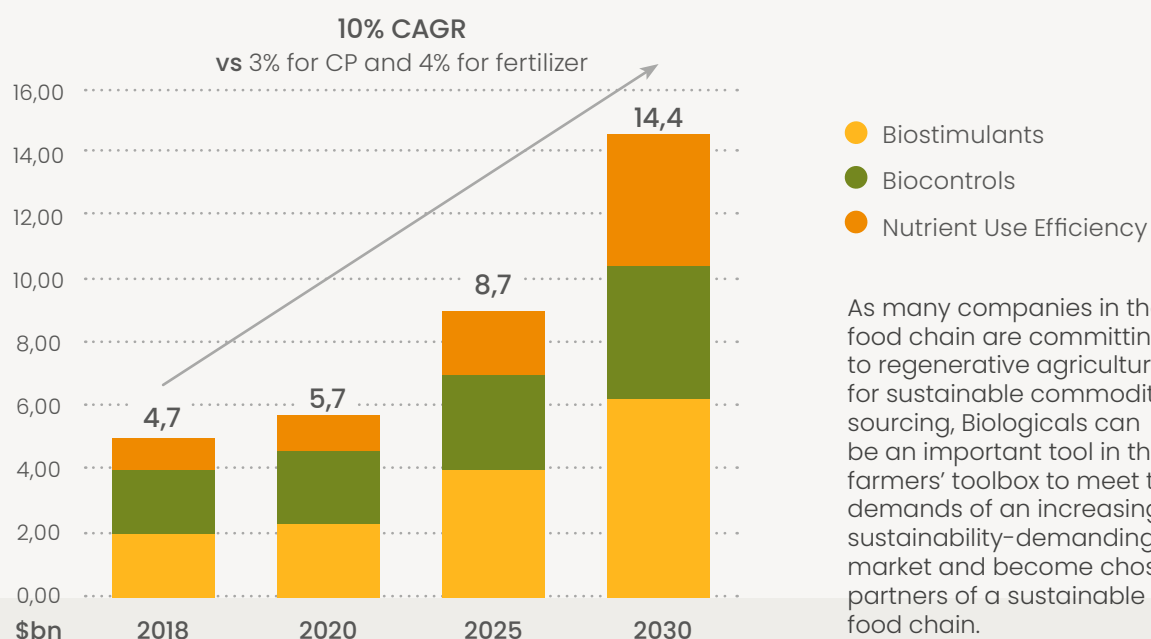


Biocontrol



Nutrient Use Efficiency

Market perspectives reflect farmers' increasing interest in Biologicals.





**VIVA™ for
Regenerative
Agriculture**

Healthy soils are the foundation of life on Earth

VIVA™ answers to the need of an efficient soil management. Thanks to its distinctive formulation of biologically active ingredients, it **revitalizes and improves the structure and biochemical activity of the rhizosphere**, while maximizing the farmer's profit and awareness.

Soils do not only provide the basis for plant growth and production but are also responsible for multiple ecosystems services that go from control and improvement of water quality, conservation of human health and mitigation of climate change. Yet, this finite and crucial resource for life on Earth is not to be taken for granted: an increasing percentage of soils on our planet are unhealthy and progressively degrading, jeopardizing our life quality and that of generations to come.

Soil is the complex system where lithosphere, atmosphere, hydrosphere and biosphere intersect. It is the major source of our food, feed, fibers, fuels and materials, and provides a habitat for humans and other terrestrial living organism. As such, it is one of the essential components of the land we live on, and its role in the support of important ecosystem, economic and societal services is pivotal. But, more subtly, **soil is also the ecosystem whose health and balance impacts the most on the quality of our everyday lives**, as it has a strong influence on the safety and security of our water reservoirs and on the nutritional value of crops, as well as on their productivity. In addition, its management can either exacerbate or mitigate the effects of climate change on other soil-related ecosystems.

Until recent history, and especially until the proposal of specific measures aimed at protecting soils such as the Soil Monitoring Law in the EU, **the importance of this resource has not been translated into appropriate measures for its protection**. This resulted in dramatic figures from FAO attesting that **33% of the Earth's soils are already degraded and over 90% could become degraded by 2050 due to erosion, loss of organic matter, contamination, compaction, increased salinity and other harmful factors**. Furthermore, soil is a finite resource, as the rate of its erosion is much higher than the one of its formation, and its loss cannot be recovered within a human lifespan. This means that sustainable management of soils, that is to say, **the ability of harnessing the potential of soils so that they are able to preserve its functions and services while minimizing the environmental impact, is a transversal challenge** – a challenge that becomes incredibly pressing when it comes to agriculture and food production. It is not without reason, in fact, that **soil health is among the objectives of Regenerative Agriculture**, and soil-respectful practices

are among the key elements of this agricultural approach.

In agriculture, **keeping the soil healthy means securing its quality and productivity for generations to come**, by preserving its physical structure, keeping its chemical composition in balance, and

enhancing the diversity of the beneficial microorganisms that live below ground. In a healthy soil, **the balance between physical, chemical and biological aspects increases nutrient availability and cycling, maintaining the soil vital, fertile, and ensuring productivity and**



crop quality over years. Furthermore, adhering to soil health practices can also have a role in **climate change mitigation** through an improved carbon sequestration capability of the soil.

Pursuing soil health, for farmers, not only means preserving a crucial element of the agricultural ecosystem and **contributing to the greater framework of Regenerative Agriculture**, but also **gaining an important, long-term competitive advantage.** For this

reason, agricultural solutions aimed at improving the health of the soil and the rhizosphere – the portion of soil surrounding crop roots – are particularly praised, and, among those, **biologicals solutions play an important role.** The diverse and synergistic combination of their components can act favorably on soil health parameters, for example by improving enzymatic activity in the soil to enhance nutrient cycling, or influencing microbial biomass and diversity.

VIVA™: Improves the rhizosphere fertility

An important instrument to help improve soil health parameters, with consistent effects on the activity of soil enzymes, VIVA™ enhances the abundance and total biomass of beneficial microorganisms and promotes microbially mediated nutrient cycles, with consequent yield increase.

The rhizosphere is the narrow zone of soil that is in direct proximity to plant roots, a highly dynamic region that hosts a diverse variety of microorganisms living in strict association and interacting with the plant's root architecture. **Their activity in the soil is crucial for plant metabolism and health**: not only do they release substances in the rhizosphere that are immediately absorbed by the roots with consequent beneficial effects, but they are also involved directly in plant nutrition. In fact, microorganisms have a role in nitrogen fixation from the atmosphere, that is to say, the first step of the crucial process via which inert, gaseous nitrogen is transformed in a plant available chemical form. Furthermore, they also allow for other fundamental processes for plant life and health such as nitrification, phosphate mineralization, and iron and manganese solubilization.

VIVA™, composed of molecules of vegetal origin, has a beneficial action on the development of microbial



flora in the rhizosphere. Trial results show the impact of the application of VIVA™ on microbiome functionality, including effects, trends, and major changes, and provide evidence for the abundance enhancement of beneficial microorganisms and their total biomass. Additionally, **treatment effect on soil enzyme activities has been investigated.** Soil enzyme activities have the potential to provide a unique integrative biological assessment of soils because of their relationship to soil biology, ease of measurement, and rapid response to changes in soil management. Trials showed a clear consistency of treatment effects on soil enzyme activities: in particular, **the active ingredients in the product have the effect**

of promoting enzymatic nutrient cycles, specifically enhancing **phosphorous cycle** (another indispensable element involved in the energetic metabolism of the plant) through an increase in phosphatase activity and in P-solubilizing fungi. Importantly, 80% of the trials where a significant enzymatic activation has been observed also showed a significant improvement in the agronomic performances.

Thanks to its ability to positively influence the biological activity of soil, VIVA™ also contributes to improving soil structure, creating the optimal balance between micro and macropores of the soil that is essential to the exchange of water and gases and to a correct water retention. This guarantees ideal conditions for root development and enhanced capacity for roots to absorb nutrients in the rhizosphere.

Furthermore, transcriptomic analyses have been performed on VIVA™ to better understand how the product influences DNA transcription into RNA, which is the first step towards the synthesis of proteins. Such analyses showed a **balanced action of VIVA™ on various physiological processes of the plant, such as vegetative growth, perception and hormonal signaling, as well as metabolic activities.**

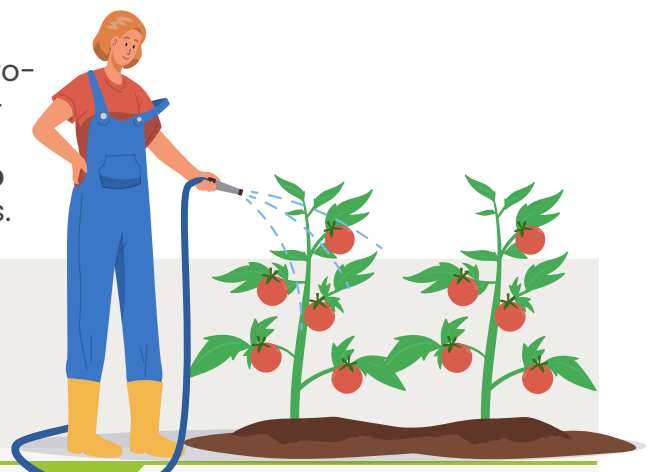
These positive results have been reinforced by microphenotyping analyses that showed the effects of the application of VIVA™ on plant structure traits:

+ 38% in measured biomass
(vs untreated plant)

+ 64% of the leaf area
(vs untreated plant)

For farmers, all efforts in protecting and improving soil health not only bring beneficial results such as **enhanced crop yield**, but also consist of a **long-term investment to keep soil fertile** for present and future generations.

As such, this solution can give a significant support to the Regenerative Agriculture outcomes, especially (but not limiting to) in regard to the health of soils and its inhabitants:



Protection and restoration of soil health
as it contributes to enhancing soil health parameters, with particular attention to soil enzyme activity, benefitting the fertility of the rhizosphere



Protection and restoration of biodiversity in ecosystems
as it enhances the abundance of beneficial microorganisms below ground and their total biomass.

Soil Health

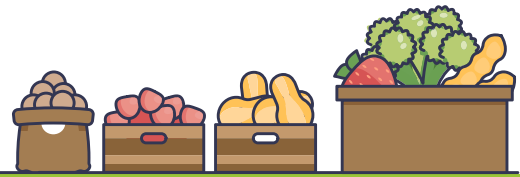
The Soil Health project

The effects of VIVA™ on soil and the rhizosphere, as well as the “science behind”, were assessed by means of an ambitious, cross-field research named **“Soil Health Project”**. In this framework, agronomic traits, functionality of soil microbiome and enzyme

activity after treatment were evaluated by means of carefully designed field trials and innovative analytical approaches in collaboration with important research institutions.



On the field



Crops	Total average Marketable Yield Increase (%):	Crops	Total average Marketable Yield Increase (%):
Fresh Tomato	7,05%	Peach	10,12%
Processing Tomato	9,75%	Table Grape	8,91%
Melon	8,82%	Potato	9,29%
Strawberry	9,32%	Corn	6,0%
Pepper	9,13%		

Cultivating Sustainability

Sustainable practices and use of products such as Biologicals are good enablers of regenerative agriculture, but this is still not enough! First and foremost, a culture of sustainability must be cultivated along the whole supply chain, leading to a deeper awareness of the issues that we are facing, their repercussions on a global scale, and what tools can be used to address them. In addition, Biologicals such as TALETE™, although actually simple to use, require training and technical assistance for an optimal result configured on the precise needs of the customer. For this reason, we devote ourselves to providing farmers frequent technical trainings on the use of Biologicals solutions in the framework of Regenerative Agriculture. From region to region, a special focus is put on the management of the local key



crops and the main pain points for farmers, in order to close the knowledge gap that often hinders the adoption of new sustainable practices and products. In addition, we guarantee a system of continuous, widely distributed on-field support, with a technical support team composed of experienced specialists in the field of Biologicals, competent in the agronomic field and, at the same time, trusted advisors

for customers from plantation to harvest. These figures, combining excellent technical, commercial and human skills, have a strategic role in creating a link between the technology and its use, contributing to the goal of spreading Regenerative Agriculture practices, in order to create strategies that combine environmental and economic sustainability while respecting margins.

Bibliography

<https://sdgs.un.org/goals/goal2>

The Case for Regenerative Agriculture in Germany—and Beyond, January 2023

Zheng et al., Sci Rep. 2018, 8(1), 14762.

<https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soils/soil-health>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2610104/>



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