To grow plants or plant holobiomes?

The agricultural challenge of tomorrow

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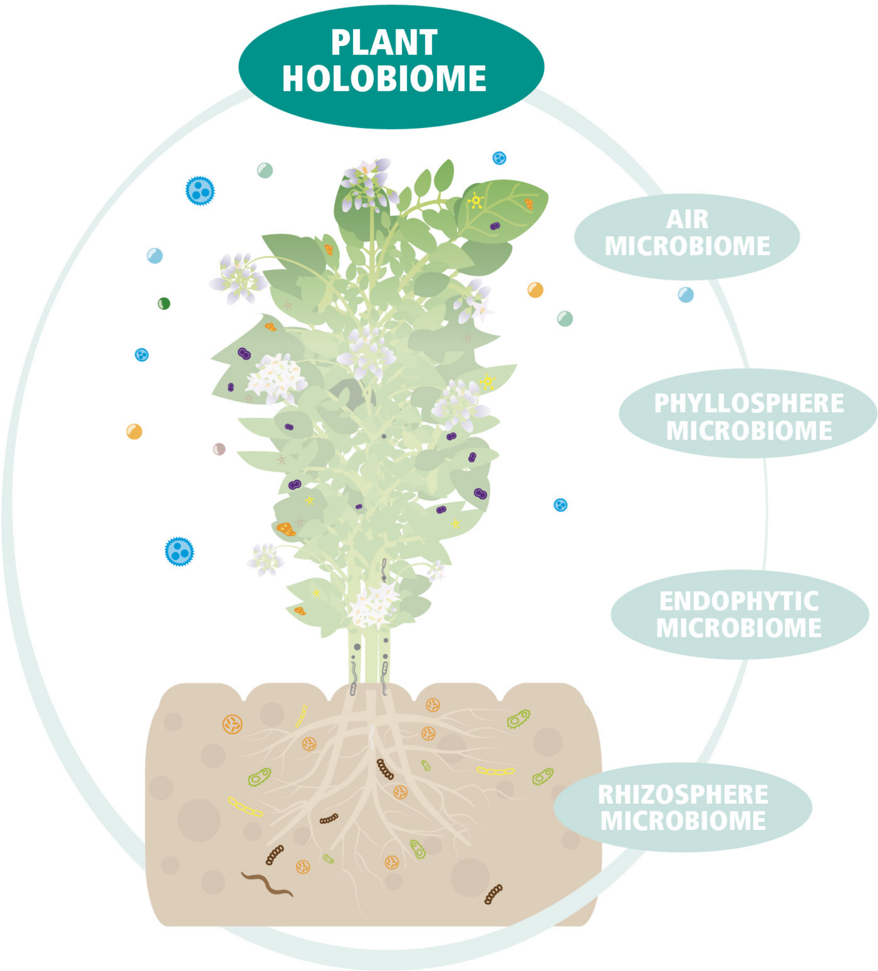

From plants to holobiomes

There is an enormous diversity of microorganisms directly or indirectly interacting with plants, with hundreds of thousands of different species and strains. Each one of these microorganisms houses its own genetic information, which is different from the plant's.

This complex gene system, formed by the microbial community, is normally called the plant's **microbiome** and it is crucial to its nutrition and plant development. The main source of microbial diversity from which a plant selectively obtains its **microbiome** to meet its needs is the rhizosphere, a small soil space near the root containing thousands of microorganism cells (over 30,000 different species).

In turn, the seeds (plant embryos) transport plant genes and constitute intrinsically the plant microbiome receptacle, so a plant is riddled both inside and out by a diverse set of microorganisms.

Together, **the plant genome** and **its microbiome** form the **plant holobiome**, a **selective genetic unit**. Consequently, a plant should not be considered an individual at a genomic level, but rather a gene entity that also includes its associated microbial genome, **the holobiont**.

The holobiome, or how plants have developed strategies to optimise plant growth.

The plant microbiome is selected by the plants with the sole purpose of to grow.

In fact, plants establish beneficial relationships with microorganisms which, along with the production of salicylic acid and phenol substances exuded by the roots, mark the selection and efficacy of their microbiome.

From an ecological perspective, we know that **the holobiont** responds to biotic and abiotic stresses. Indeed, the different microbial relations established through mineralisation services, nutrient supply, pest and disease protection and tolerance to abiotic stress largely depend on the holobiont. **In a successful ecosystem, such as the plant rhizosphere**, microbiome communities **adapt to the environment**, **interact** and **collaborate with plants in mutual benefit**. The plant provides nutrients to the microbiome and vice-versa, forming **balanced holobionts** that can protect themselves from stress and pathogenic agents.

Current information on plant microbiomes mainly refers to the bacterial community. However, new studies have revealed that microorganisms operate in interactive networks and can possess microbial centers. Certain key species reside within the networks that are critical for plant-microbe interactions. It has been discovered that **microbial communities with high connectivity provide a stabilising configuration that can prevent pathogen attacks in certain plants**. Before these basic discoveries were made clear, **several works clearly indicated greater efficiency when the bacteria were applied as a consortium to control pathogens transmitted through the soil**. Some researchers reported that control of *Rhizoctonia solani* in sugar beet in soils infected by this fungus was due to a set of hundreds of *Pseudomonas spp*, accounting for the majority of the antagonist bacteria isolated from the soil.

Holobiome managing will improve agriculture

Conventional (intensive) agriculture development, to guarantee high production and profitability, has been characterised by mono-crop cultivation, the use of genetically improved and more productive varieties and high water, nutrient and pesticide consumption. These practices inevitably led to the loss of microbial biodiversity and wealth in beneficial microorganisms, leading to an imbalance in favor of opportunist and oxidative microorganisms, thus accelerating degradation processes in microbial activity and chemical, physical and biological properties in agricultural soils. The consequence is a decrease in production potential and in crop performance.

Due to all of the aforementioned, the use of efficient microorganisms and knowing how they interact with plants and with each other, within the intensive agricultural system, should be considered a useful and necessary strategy to help overcome the challenge of intensive agriculture. To this end, knowledge of soil microbiology, both in qualitative (mechanisms and processes) and quantitative (critical concentrations and space-time action) aspects should be the modern tactic of modern agronomists.

The first thing to do is look at the rhizosphere of the crops with a group, associative and interactive perspective, like a unique set of microbiomes. Soil is one of the most dynamic ecosystems that exist. It is an ideal terrain to understand the activity generated by interactions between the aforementioned microorganisms, their competition for resources, possible symbioses, etc.

This new knowledge of the **rhizosphere, which provides genetic variability to plants**, and of the **holobiome as a selective genetic unit**, opens up new horizons for crops that depend less on chemical consumables or that have greater tolerance to pests and diseases caused by vectors or climate change.

Symborg researches holobiomes to attain more profitable and sustainable crops.

Symborg managed to transfer holobiome knowledge to the precision industrial agriculture.

The company is researching to better understand the precise genes of microbes in a community and their vital needs, in order to **develop products that take action on microbial relations, improving the physiological state of plants, their defences against pathogens and to improve agricultural production.**

Such is the case with products based on the microorganism *Glomus iranicum var. tenuihypharum*, a mycorrhizal fungi discovered, selected and patented by Symborg thanks to its features, which make it especially effective under extreme conditions, such as intensive agriculture. This microorganism forms a symbiosis with crop roots and develops them further, exploring a greater amount of soil and boosting their capacity to absorb water and all sorts of nutrients.

However, studying holobiomes has allowed the company to go even further: in such an inter-connected system, **inoculation of selective biodiversity for intensive agriculture systems** can guarantee the abundance of vital functional groups, adjuvants for crop nutrition, microorganisms that solubilise nutrients, nitrogen fixers and hormone producers, which are essential for health and growth of crops.

What's more, a balanced microbiome **can become the perfect barrier against pathogens, which cannot develop due to the physical presence of adversary microorganisms that act as antagonists, or due to the lack of nutrients that are essential for their growth.** A soil that suppresses pathogens, with an optimum microbiome, can be built over time, maintaining diversity and soil health, decreasing toxins and mono-crop cultivation, adding specific suppressor microbes, etc.

Thus, to meet the needs of modern agriculture, Symborg has developed products based on **groups of microorganisms, selected thanks to their efficacy in forming stable microbiomes. These products are inoculated in** impoverished soils after prolonged periods of intense agriculture and collaborate to establish a microbiome in the rhizosphere of the crops, guaranteeing **selective biotization of tired soil**, **its biological regeneration** and formation of an **effective holobiont.**

In-depth knowledge of the plant holobiome means that Symborg can offer products that **create ideal conditions for optimum plant development,** with selective microorganisms and microbial consortiums that collaborate in **important tasks, such as nutrition, plant physiology and responses to biotic and abiotic imbalances, such as pests and diseases. In conclusion, this leads to the production of more profitable and sustainable crops.**