

THE NEW WAY — TO — SUPPLY NITROGEN TO CROPS

BlueN Technology

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THE CHANGE TO A NEW ERA

For the first time in history, **sustainability** is high on the agendas of governments, institutions, companies, and end consumers as a **priority** that is capable of actively transforming our economy on a global level.

Emphasis is no longer placed on **what is sold** but on **how it is produced**. Nowadays, it is no longer enough to put **biodegradable, recyclable, or reusable** final products on the market. Their transformation throughout the **distribution chain** must also adhere to these standards. In the case of agricultural products, this translates into a growing effort to adapt conventional agricultural practices toward a **new model of agriculture** that responds to the current needs of society and, consequently, those of the market.

In fact, **agriculture** is a key economic activity toward achieving a **sustainable society model**, as identified by the UN in the 2030 SDGs (Sustainable Development Goals). In this sense, the global regulatory framework tends toward an increasingly strict **control** over the type and use of **inputs** in agriculture through different directives, such as the new **CAP** and the **European Green Deal**. Europe will become the first climate-neutral continent in 2050 with its *"From farm to table"* strategy, among others.

“Agriculture is a key economic activity toward achieving a sustainable society model.”

AGRICULTURE IS LEADING THE EVOLUTION

Faced with this situation, agriculture seeks to **lead an evolution** in its production model through new and innovative **solutions** to face the **global challenge** of producing more food with fewer resources - for example, the demand for corn, wheat, and rice is expected to increase by 33% by 2050-, and in a **sustainable** way without compromising the possibilities of future generations.

The case of nitrogen is paradigmatic. Nitrogen is **essential** for crop growth and development. It is the first nutritional element and, after water, it is the most important element in agriculture, due to both its **economic** and **environmental impact**.

A nitrogen fertilization program adapted to the crop's nutritional needs significantly increases its **productive potential** and crops' final **quality**. That is why nitrogen has become a **strategic** element for farmers and one of the most widely applied fertilizers in agriculture.

However, conventional nitrogen application also incurs an **environmental cost** in the form of the emission of **greenhouse gases** or the **contamination of bodies of water** as the result of nitrate runoff or leaching. This situation has led authorities to regulate the use of nitrogen in agriculture in an increasingly **restrictive** way. One example is the designation of **protected areas** with strict NFU (Nitrogenous Fertilizer Unit) **limitations**. This regulatory trend is expected to **increase** in upcoming years.

Faced with this dilemma, Symborg developed **BlueN Technology**, a new technology created around an exclusive nitrogen-fixing bacterium, discovered and patented by **Symborg** which allows **100% sustainable** nitrogen to be supplied directly from the air. It is an answer to the agricultural sector's need to find **sustainable alternatives** for nitrogen fertilization programs that comply with the levels of **productivity** and **profitability** that the market demands.

In the words of **Félix Fernández**, Symborg co-founder and one of the leading researchers responsible for the development of BlueN Technology, *"We are facing a **paradigm shift in terms of agricultural practices**, and that is why we developed **BlueN Technology**, the new way to supply nitrogen to crops, accessible to farmers around the world."*

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FÉLIX FERNÁNDEZ

Symborg Co-founder and Head of Technological Surveillance and Competitive Intelligence

Félix Fernández, in addition to Co-founder and Head of Technological Surveillance & Competitive Intelligence at Symborg, is a Doctor of Agricultural Sciences. He has conducted extensive research in the field of applied **agricultural microbiology**, which has led him to participate in diverse projects and discover **new species** of microorganisms of agricultural interest, such as the mycorrhizal-forming **"super fungus" *Glomus iranicum* var. *tenuihypharum***. Félix also played a fundamental role as Head of R&D in the agronomic discovery of the nitrogen-fixing bacterium ***Methylobacterium symbioticum***, the active compound of BlueN Technology.

Today, **thousands of farmers** from different parts of the world **apply the knowledge** generated by Félix Fernández to their crops.



A UNIQUE SPECIES

The beneficial interactions between certain microorganisms and plants are some of the most important lines of **innovation** in agriculture. Not only have they proven to be a novel way to improve **plant growth**, control pests and diseases, or maximize productive potential, but they also do it in a sustainable and environmentally friendly way.

In 2014, determined to provide the world with a **biological alternative** to conventional nitrogen, Symborg's team began to study a *Methylobacterium* genus with great potential as a **nitrogen fixer**. This led to the development of **BlueN Technology**, a true innovation in the field of agricultural nitrogen. Félix commented, *"We knew that the conventional nitrogen supply would be subject to **regulations** due to its associated environmental impact, so we decided to create a **sustainable alternative** for farmers. Farmers are the driving force of our research."*

In successive tests in phytotrons, crop chambers, or the Symborg Experimental Farm, a very unique species emerged, which we would end up calling ***Methylobacterium symbioticum***. *"We needed to find a bacterium that was **compatible** with the current fertilization protocols and, of course, capable of maintaining the **production levels** of precision agriculture. And, do you know what? We found one."* stated Félix.

Methylobacterium symbioticum is a unique species of nitrogen-fixing bacteria, and unlike other known species, it is an **endophyte**, that is, it lives inside the plant. The leaf is its preferred habitat, specifically inside the **photosynthetic cells**, in the areas closest to the chloroplasts where it mainly feeds on methanol, a **waste** product of photosynthesis. This characteristic gives it an advantage over its competitors that live in the soil since ***Methylobacterium symbioticum*** carries out its activity in a **low competition** environment with little **energy expenditure** for the plant.

What's more, unlike other groups of bacteria such as Rhizobiales, ***Methylobacterium symbioticum*** has **general hosts**, that is, it exerts its nitrogen-fixing action in all types of crops. Félix emphasizes the significance of this fact: *"What is revolutionary about *Methylobacterium symbioticum* is not only its great capacity to provide nitrogen to the crop; **what is truly groundbreaking is its universality**. It works in all kinds of crops around the world, and it does so from the leaf. It has more protection than any other bacteria in the rhizosphere."*

The last step was to directly consult with farmers on how to introduce ***Methylobacterium symbioticum*** into their **fertilization protocols**. *"We verified, with a **single application** at the **beginning** of the crop cycle, that the bacterium provides a **constant** and **sustainable** nitrogen cycle throughout the entire crop cycle"* said Félix and he added, *"In addition, it is **compatible** with the vast majority of **herbicides, fungicides, and insecticides**."*

*We really realized that we were looking at a technology that could **change everything**. We call it BlueN technology."*

“We needed to find a bacterium that was compatible with the current fertilization protocols and the market's levels of production. And, do you know what? We found one.”

HOW DOES BLUEN TECHNOLOGY WORK?

Through foliar application, *Methylobacterium symbioticum* enters the plant through the **stomata** of the leaves and penetrates the **photosynthetic cells**, in the areas closest to the **chloroplasts**. This unique feature allows *Methylobacterium symbioticum* to:

Effectively colonize the plant

Methylobacterium symbioticum colonizes the plant, establishing itself in a **low competition** environment and protecting it against external threats.

Intensify photosynthesis

Methylobacterium symbioticum is capable of intensifying photosynthesis thanks to vesicles called **chromophores** that **reflect light** toward the **chloroplast**.

Activate biological nitrogen fixation

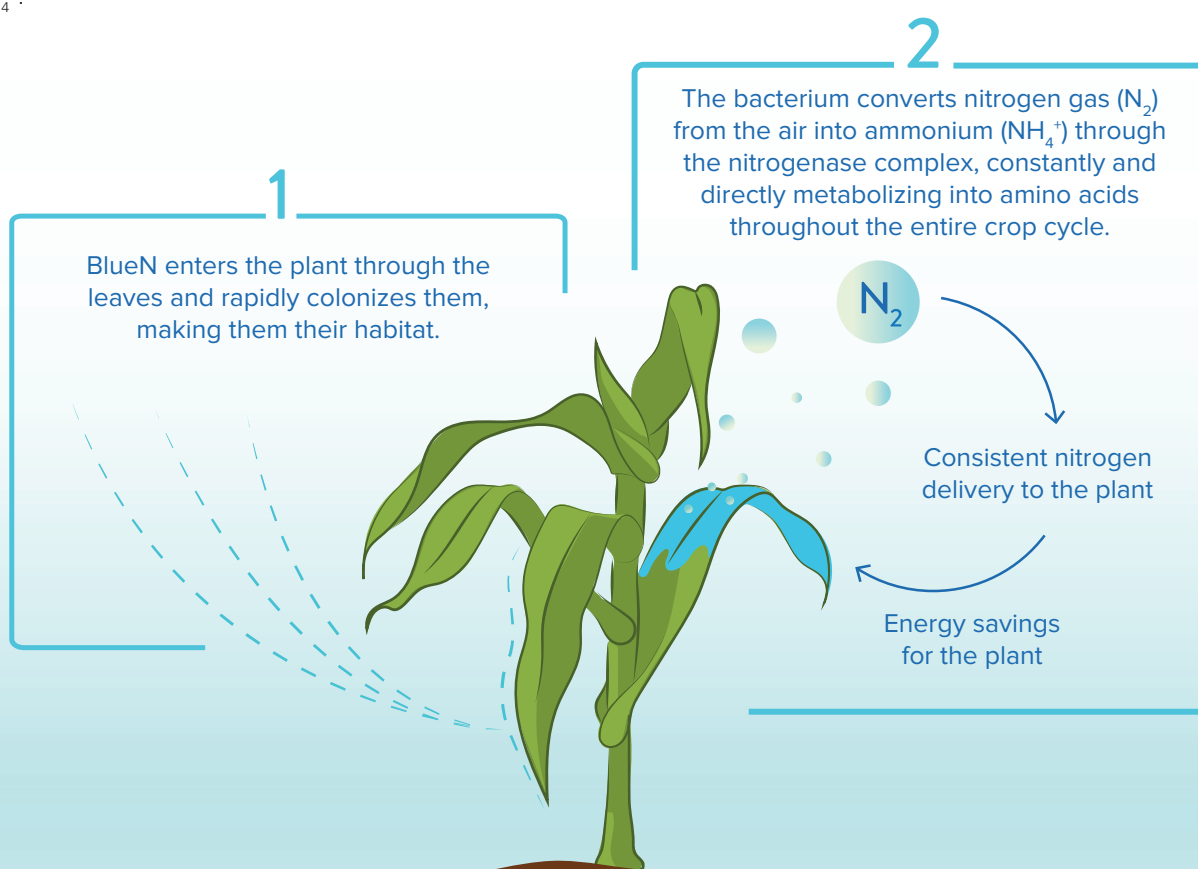
Methylobacterium symbioticum uses elements from plant **waste** and **surpluses** derived from **enhanced photosynthesis** to activate biological nitrogen fixation.

Methylobacterium symbioticum captures nitrogen (N_2) from the air and converts it into ammonium (NH_4^+) through the nitrogenase complex. This complex breaks the bond between the nitrogen atoms, constantly reducing it to ammonium NH_4^+ .

The reduced ammonium (NH_4^+) is directly **metabolized** in the plant in the form of the **amino acid glutamine** thanks to the action of the enzymes glutamine synthetase and glutamate synthase (GS/GOGAT).

The plant can **activate and halt nitrogenase activity** depending on its ability to metabolize ammonium, giving the plant the ability to obtain nitrogen throughout the crop cycle and minimize damage from excess or insufficient nitrogen.

“The bacterium captures nitrogen from the air and converts it into ammonium through the nitrogenase complex.”



BlueN provides nitrogen throughout the crop cycle in an effective and controlled way

WHAT BENEFITS DOES IT?

BlueN technology, used as a nitrogen biofertilizer, allows you to evolve your nitrogen fertilization program, achieving greater efficiency in the use of nitrogen in your crops.

More profitable crops

BlueN technology increases the crop **yield** per **unit of nitrogen** applied thanks to a more efficient supply of nitrogen that responds to crops' needs throughout the crop cycle. With a more efficient nitrogen supply, BlueN technology lets you **optimize** your nitrogen fertilization program according to your crops' needs.

The nitrogen fixed through BlueN technology does not result in nitrogen losses due to leaching, runoff, or denitrification. *Methylobacterium symbioticum* fixes and supplies nitrogen from within the plant. Unlike conventional fertilization, **each gram of fixed nitrogen** is converted into **biomass and crop**.

BlueN Technology increases the **profitability** of your crops in **conventional and organic agriculture**. It also helps you protect the economic return of your production in **areas with nitrogen restrictions**.

Better nourished crops

BlueN Technology increases the **quality** of crops by providing them with a constant and sustainable nitrogen flow.

In this way, the plant maintains an **optimal nutrient balance** throughout the crop cycle, improving its quality parameters and minimizing damage due to excess or insufficient nitrogen.

More sustainable production

BlueN technology provides farmers with a **100% sustainable** source of nitrogen obtained from atmospheric nitrogen to:

- Increase the **sustainable value** of their production.
- Protect production levels with respect to **present and future nitrogen legislations**.
- Reduce dependency on soil nitrogen and the negative effects of **soil degradation**.

With BlueN technology, now you can improve the quantity and quality of your crops **minimizing the impact on the environment**, and reducing greenhouse gas emissions or the leaching of nitrates into aquifers or other bodies of water while maintaining the **profitability** of your **production**.

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Now you can improve the quantity and quality of your crops, minimizing the impact on the environment.”

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BlueN Technology is available, depending on the geographical area,
under the brand names of Utrisha™ N, BlueN