

PHOTOSYNTHESIS IS INEFFICIENT

A Bristol-based start-up, Glaia, hit the news recently promoting a biostimulant based on carbon nanomaterials (“carbon dots”) that it says can improve photosynthesis and increase crop yields.

It already has one commercial product, [Fragaria Plus](#), which is applied to the plant via a foliar spray to “unlock the real potential of photosynthesis in strawberry plants”. Glaia claims that growers could see increased strawberry yields of 20% or more.

The company [reports](#) that it has also deployed the product in field trials in tomatoes (8% claimed yield increase) and lettuce (25% yield increase) and there are [media stories](#) that it is working on another product for cereals, including wheat.

The technology is presented as a high-tech solution to the problem of photosynthesis inefficiency: “By turning to naturally-occurring carbon-nano materials”, it says on its website, “we discovered we could directly target photosynthesis in plants of all shapes and sizes.” Glaia [says](#) its carbon dots increase the flow of electrons in photosynthesis, allowing plants to produce more energy and sugars through photosynthesis.

The company claims that, due to its foliar spray application method, no changes to existing practices will be needed. In wheat, applications are likely to coincide with spring fungicide applications when photosynthesis will be at its peak.

What’s the claim?

The central claim is that Glaia’s carbon-based particles make photosynthesis more efficient. More specifically, the company claims that its product helps plants make better use of sunlight by increasing electron flow in the chloroplast, which

in turn increases the production of energy and sugars through photosynthesis. This is presented as leading to stronger growth and higher yields.

The company bases its product around a broader framing claim: that photosynthesis is inefficient, with only around 1% of sunlight converted into biomass and that this inefficiency is therefore a promising target for technological intervention.

The claims are embedded in a wider sustainability narrative, which emphasises population growth, climate change and tightening input constraints to create a sense of urgency. Within this framing, improving photosynthesis is positioned as a technological solution capable of delivering higher yields without increasing resource use.

Taken together, the implied message is that the world is missing out on high yields because crops are inherently poor at using sunlight and that Glaia’s spray can unlock some of this unused potential without requiring changes to farm management.

Is photosynthesis really inefficient?

In a process that has driven life on Earth for billions of years, plants convert sunlight, water and the carbon dioxide in the air to make glucose – a form of sugar that can be used for growth and repair – and oxygen.

It is correct that only a small fraction of total incoming sunlight is ultimately converted into plant biomass under field conditions. However, presenting this as a simple inefficiency that can be easily ‘fixed’ overlooks the biological reality of how plants function.

Photosynthesis is not a single process but a highly complex system comprising around [170 interdependent biochemical steps](#), involving tightly coordinated reactions in the chloroplast – a specialised structure in green plant cells, which contains chlorophyll and in which photosynthesis takes place. It depends not only on light and carbon dioxide, but also on water availability, nitrogen, micronutrients, temperature and plant physiology as a whole. Even today, researchers [acknowledge](#) that photosynthesis “*still holds many unanswered questions*”.

Crucially, photosynthesis does not operate in isolation. It is deeply integrated with other plant processes, including respiration, nutrient uptake, growth regulation and stress responses. Mechanisms that may appear ‘inefficient’ from a narrow energy-conversion perspective, such as dissipating excess light energy, often serve essential functions, such as [preventing damage](#) under fluctuating environmental conditions (a mechanism known as photoprotection).

As a result, altering one part of the system can have unintended consequences elsewhere. [Research shows](#) that altering photoprotection to improve plant photosynthesis may affect the ability of plants to assimilate carbon over long time periods and to produce biomass.

In addition, increasing carbon fixation in plants can alter their composition, with [evidence](#) that higher CO₂ levels can reduce protein, micronutrient and vitamin content in staple crops such as rice. This raises questions about whether simply increasing biomass or yield would be enough to meet the sustainability challenges the world is facing.

Ultimately, photosynthesis is a process that has evolved (and may still be evolving) in response to external pressures evolved over millions of years and is not yet fully understood by humans. Claims that it has been successfully tweaked, with no unintended effects in other parts of the plant – either short or long-term – should be viewed with caution.

In the words of [Professor Weiner of the University of Copenhagen](#).

“large investments in attempts to make ‘better’ plants by improving basic physiological processes are not likely to succeed because natural selection has been optimizing these for millions of years”.

There is an element of truth to this, though natural biological systems are not generally optimised to meet the demands of modern agriculture with its strong focus on yield and ‘feeding the world’ sentiments.

Global food insecurity is also not driven only by production levels but also by poverty, waste, distribution, conflict, land access and dietary patterns. Technologies aimed at increasing yields may therefore address only part of the challenge.

Will ‘better’ photosynthesis improve yield?

Glaia claims its products have increased yield in the crops they tested by up to 25%. However, there is no evidence that this research has been published and no independent research into Glaia’s technology exists. Because of this, the likelihood of such results being reproduced in a real-life scenario is difficult to predict.

Crop yield is shaped by many factors besides carbon capture from sunlight. In a [review](#) published in 2019, scientists from North Carolina State University stated:

“Considerable research in the 1970s and 1980s showed that carbon input was not limiting for crop growth and yield. Instead, the availability and uptake of water and nutrients were found to be critical for increasing grain yield and that conclusion still applies today.”

They added, *“by the early 1990s, it had become increasingly clear that increasing crop yield was not closely associated with rate of photosynthesis.”*

This is one of the main lessons from decades of work aimed at enhancing photosynthesis, especially in genetically engineered crops. Photosynthesis has, [since the 1970s](#), been presented as a promising route to large yield gains, yet no widely adopted commercial crop has emerged on the basis of ‘improved photosynthesis’ alone. Many approaches

have looked promising in laboratories, glasshouses, or small field trials, but real-world translation has repeatedly proved difficult.

In addition, [Glaiia states](#) on its website that its products have delivered yield increases in crops “already had growing conditions thoroughly optimised and traditional biostimulants applied.”

While presented as a strength, this raises further questions about how the product performs under real farming conditions. Results obtained in highly controlled or optimised systems do not necessarily translate to typical field environments, where water availability, nutrient limitations, weather variability, pests and disease all constrain yield.

It may also suggest that any observed benefits are conditional on near-ideal conditions, rather than robust across the range of stresses that crops experience in practice. Without multi-site, multi-season field data under commercial conditions, it is difficult to assess whether these reported gains would be consistent or economically meaningful for farmers and growers.

The relevant question is not simply whether a technology can produce a measurable yield increase under some conditions. Public and private investment resources are finite. New technologies should therefore be assessed not only on whether they work, but whether they deliver greater benefits than alternative approaches already available to farmers, including soil restoration, crop diversity, improved rotations and other sustainable practices.

What’s the alternative?

Many agricultural technologies are presented through a similar narrative framework. A complex challenge such as food security, climate resilience or sustainability is reduced to a single limiting factor.

A novel technology is then presented as a targeted solution capable of overcoming that constraint. Such framing can be useful for attracting investment and public attention, but it can also obscure the wider ecological, economic and social factors that shape agricultural outcomes. What makes claims of this kind particularly

Key questions

Farmers and growers interested in this product should be asking the following questions to assess the likelihood the product will deliver, as well as the possible risks of applying it in their fields.

Evidence and real-world applicability

- Have the reported yield increases been published in peer-reviewed studies, or independently verified?
- How many trials have been conducted, across how many sites, seasons and crop varieties?
- Were results consistent across different environmental conditions, including drought, heat, disease pressure and varying soil types?
- Were yield gains measured as total biomass or as harvestable, marketable yield?
- What is the cost-benefit for growers when product cost, variability in performance and risk are taken into account?

Risks

- Are there any unintended effects on plant metabolism, development, or stress responses over the short and long term?
- Do the carbon nanomaterials remain on the plant surface, or are they taken up into plant tissues, including edible parts such as fruits or grains?
- If uptake occurs, what levels (if any) are present in food products and have these been assessed for human consumption?
- What happens to these materials in soil after repeated application—do they degrade, persist, or accumulate?
- Are there any known effects on soil microbiology, ecosystems, or water systems?

significant is not just the scientific uncertainty around photosynthesis manipulation, but the broader message embedded in them: that farmers can increase yields without changing how they farm.

Agroecological approaches – including diversified crop rotations, the rebuilding of soil biology, intercropping, cover cropping, natural pest control, agroforestry and field margins – are supported by decades of evidence demonstrating meaningful, durable yield improvements, often alongside reductions in input costs and greater resilience to climate variability.

These approaches work precisely because they address the real limiting factors in crop productivity: soil health, water retention, nutrient cycling and biodiversity above and below ground.

The appeal of a foliar spray that promises yield gains without any corresponding change to farming practice or policy is understandable – particularly for farmers already locked into industrial supply chains and for policymakers more comfortable with technological solutions than with structural reform.

But it risks directing attention and investment away from the system-level changes that the evidence consistently shows are both necessary and achievable.

In summary

Glaia's technology is [presented as a breakthrough](#) that can “*unlock the real potential of photosynthesis and maximise global food production, one crop at a time*”.

However, these claims rely on a simplified view of plant biology and a limited evidence base that has not been independently verified or tested at scale.

They run far ahead of clear answers to basic regulatory questions: Are carbon nanomaterials biostimulants, nanostimulants or something else entirely? What data should we be requiring before they are marketed and, once they are out in the environment, what monitoring should be required?

They also run far ahead of what we don't know yet: Can the results be independently replicated? Do

gains persist across multiple seasons? What are impacts on food quality? Do carbon nanomaterials accumulate in soils and how might they affect soil biology?

For decades, photosynthesis has been promoted as an obvious target for improving crop yields, yet translating changes at the biochemical level into consistent, real-world gains has proved difficult. Crop productivity is shaped by a complex interaction of factors including water, nutrients, climate, pests and plant physiology and cannot be reduced to a single limiting process.

Glaia's claims also reflect a wider narrative in agritech: that high-tech, precision interventions can succeed where conventional agronomy has reached its limits. In this framing, complex biological and environmental constraints are reduced to a single bottleneck (such as 'inefficient photosynthesis') that a novel technology can supposedly 'fix'.

This narrative can be compelling, particularly when combined with urgency around food security and climate change, but it risks overstating both the simplicity of the problem and the effectiveness of the proposed solution.

At present, key questions remain unanswered. There is no publicly available, peer-reviewed evidence demonstrating that the claimed yield gains are robust, reproducible and economically meaningful under real farming conditions. In addition, the use of carbon nanomaterials raises questions about plant uptake, food-chain exposure and environmental persistence.

Company trials can provide useful preliminary information, but they are not a substitute for independent replication. Agricultural history is full of products that appeared highly promising in company trials but delivered more variable results under independent testing and commercial conditions.