EDITION 3: PARTNERSHIPS

Advancing Agricultural Decarbonization

From Field to Food Value Chain

Report 2026

BASF
We create chemistry



Table of Contents

At a Glance 4

Introduction

Food Value Chain Decarbonization Starts in the Field 5

Our Approach to Climate-Smart Agriculture 6

Tools and Technologies Enabling Decarbonization 8

Projects 12

From Barley Fields to Climate-Smart Brewing
Malting Barley Production in Italy 14

From Nitrogen Efficiency to Verified Climate Impact
Fertilizer Use in China 20

From Vineyard Data to Lower-Impact Grape Production
Wine Grape Production in Italy 26

From Lower Methane to Benefits Across the Rice Value Chain
Rice Production in Japan 32

Conclusion 38

Glossary 40

References 43



From Field to Food: What It Takes to Decarbonize

Long before food reaches a factory, retailer or consumer, its carbon footprint is already taking shape in the field. There, farmers have to balance the need to reduce greenhouse gas (GHG) emissions with productivity, crop quality and resilience. Decisions made today, on farms and across the value chain, will shape food production for decades to come.

At BASF Agricultural Solutions, we believe science is the foundation for meaningful progress. Through our Global Carbon Field Trials Program, we evaluate how different farming practices can reduce climate impact while maintaining productivity under real-world conditions. The challenge now is to translate this evidence into broader application. Long-term partnerships across the value chain are essential to support farmer adoption, enable food companies to address Scope 3 emissions and translate proven approaches into measurable action.

The ongoing projects featured in this publication with Birra Peroni Srl, Yunnan Yuntianhua Co. Ltd., Leone Alato Group, and NEWGREEN Inc. demonstrate how decarbonization can be implemented in practice. They address challenges ranging from methane emissions and nitrogen use efficiency to lower-impact grape and barley production. While each starts from a different point, they share one lesson: there is no one-size-fits-all pathway to agricultural decarbonization. Lasting progress depends on identifying what works within a specific crop, geography and value chain, and working with partners to apply these approaches at a broader scale.



Marko Grozdanovic
Senior Vice President responsible for Global Strategic Marketing & Sustainability
BASF Agricultural Solutions

This is where we can make a meaningful contribution. Working closely with farmers, food companies and other value chain partners allows us to connect field level realities with broader sustainability and business needs. We build on this shared understanding with more than 100 years of agricultural expertise and a broad innovation portfolio to develop practical solutions from field to food.

For the love of farming,
the biggest job on Earth.

COVER PHOTO: ADOBE STOCK / LZF

Decarbonizing agriculture starts with trust

BASF Agricultural Solutions is contributing to agricultural decarbonization through a connected approach: creating transparency on environmental impacts, translating insights into better agronomic decisions and providing innovations that improve agronomic performance.

Productivity and sustainability must go together

Climate-smart agriculture creates lasting value when emission reductions are achieved while maintaining crop yields, crop quality and farmer viability. For food value chains, environmental progress and agricultural performance must move together.



Different value chains need different solutions

There is no one-size-fits-all pathway to agricultural decarbonization. Each value chain has its own emissions sources, agronomic challenges and market requirements. Effective solutions must respond to these specific conditions while remaining practical and economically viable for farmers.



Proven solutions need partnerships to scale

Many approaches to reduce agricultural emissions already exist. The challenge is implementing them at scale. This requires farmers, food companies, agribusinesses and technology partners working together to turn proven approaches into practical agronomic performance and sustainability benefits.

PHOTO: ADOBE STOCK / DIYANADIMITROVA

Food Value Chain Decarbonization **Starts in the Field**

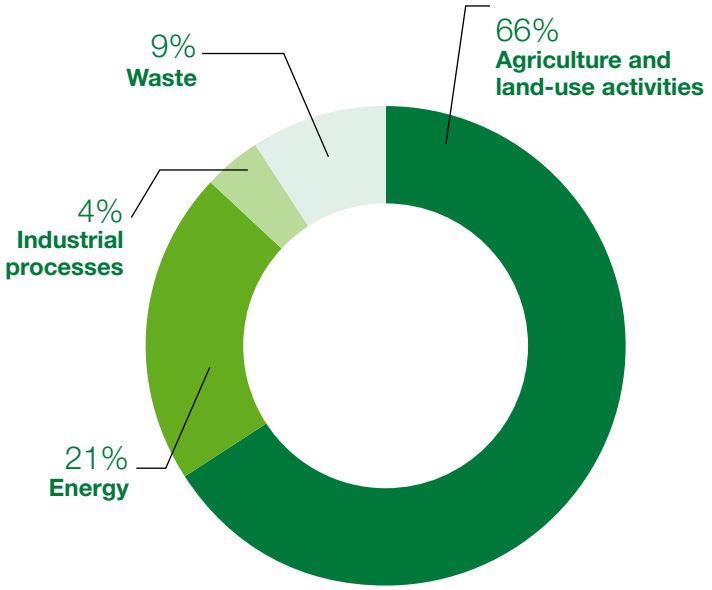
Decarbonizing food value chains has become one of the most important challenges facing the agricultural sector. Around one-third of global GHG emissions are linked to food systems, with approximately 66% of these emissions originating from agriculture and land use.[1] For food companies, this means that a significant share of their carbon footprint lies upstream, in the agricultural raw materials they source and the Scope 3 emissions associated with their production. As efforts to decarbonize food value chains gain momentum, there is a growing need for evidence on which approaches can reduce agricultural emissions while maintaining productivity and crop quality.

What works, however, differs from one value chain to another. Methane emissions from rice cultivation, nitrogen losses associated with fertilizer use and the environmental impacts of inputs in barley and grape production each require specific responses. Addressing these impacts depends on understanding where they occur and identifying measures that can be implemented effectively on the farm.

This is where agricultural expertise, environmental measurement and scalable solutions need to come together. BASF Agricultural Solutions works with partners around the world to connect these capabilities and apply them to the specific needs of different production systems. The collection of projects featured in this report illustrates how this approach is taking shape in Japan, China and Italy.

66%

of food system emissions are linked to agriculture and land-use activities[1]



Our Approach to **Climate-Smart Agriculture**



PHOTO: ADOBE STOCK / AITASIT

Food security and agricultural decarbonization need to advance together. Reducing emissions cannot come at the expense of the crop yields and quality that farmers and food value chains depend on. Understanding how climate performance relates to agricultural output is therefore essential. To assess this balance, BASF Agricultural Solutions uses greenhouse gas intensity (GHGi), which measures GHG emissions relative to the amount of crop produced. This provides a consistent basis for assessing climate efficiency and identifying opportunities for improvement across crops, regions and production systems.

Using GHGi as the measure of progress, our Global Carbon Field Trials Program evaluates climate-smart agricultural practices under real-world conditions. Individual trials in wheat, canola (oilseed rape), corn and rice demonstrated GHGi reductions of up to 30% while maintaining productivity. The results also showed that the most effective combinations of practices and technologies differed depending on crop and production context.

Specifically, improved nitrogen management, including the use of nitrogen stabilizers, can contribute to lower GHGi in corn (maize) and wheat. In rice, reducing the time that paddy fields remain flooded can lower methane emissions. In canola, high-performing germplasm can improve GHGi by increasing crop output relative to emissions.*

The next step is applying these insights beyond the trial setting. By combining a broad innovation portfolio with a deep understanding of crop production systems, we help connect field level evidence with implementation. The following pages show how environmental assessment, agronomic decision support and innovation work together across the projects featured in this report.

* **Learn more** about our work to reduce GHG emissions from farming.
Global Carbon Field Trials Report 2024
Global Carbon Field Trials Report 2025



Florian Feigs
Head of Global Sustainability
BASF Agricultural Solutions

“Results from more than 50 of our trials worldwide show that significant GHGi reductions are possible under real farming conditions. This evidence enables us to work with food value chain partners to turn proven approaches into viable solutions for their decarbonization needs.”

Tools and Technologies Enabling Decarbonization



Three connected capabilities enabling climate-smart agriculture. The sequence moves from insight to targeted action and field level improvement.

1	**Measure** Creating transparency on emissions, water use, and other environmental impacts.	**AgBalance®** **YouSustain**
2	**Decide** Translating insights into better agronomic decisions throughout the season.	**xarvio®** **Hort@ DSS**
3	**Improve** Applying innovations to improve performance in the field.	**Our broad portfolio, incl. nitrogen management solutions**

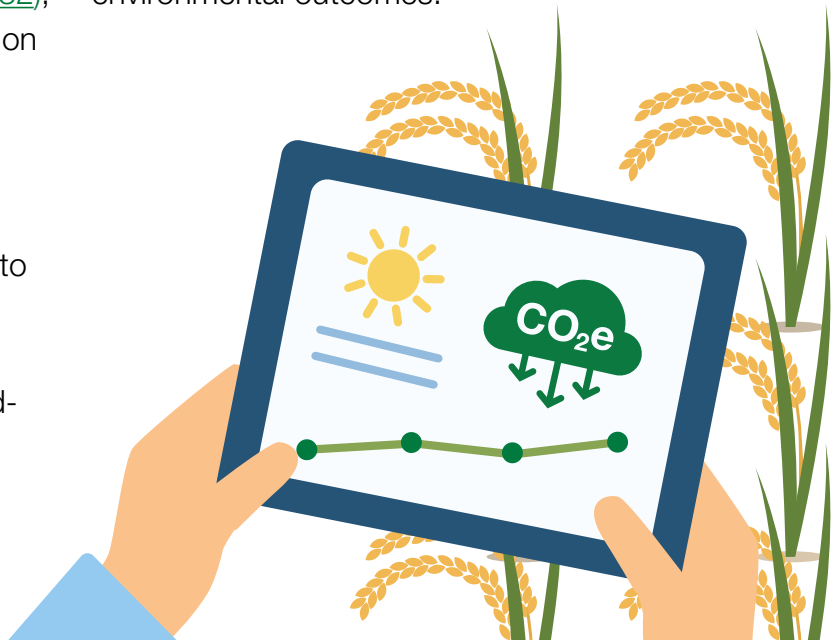
1 Measure:
Creating transparency through sustainability assessment.

The first step toward decarbonizing the food value chain is creating transparency on environmental impacts. Understanding where GHG emissions occur, and which processes drive them, helps identify opportunities for improvement without compromising productivity. As food companies seek to reduce Scope 3 GHG emissions and improve the sustainability performance of their supply chains, they need robust methods to assess, compare and report environmental performance across crops, regions and production systems.

AgBalance® and YouSustain are Life Cycle Assessment (LCA) tools that quantify the environmental impacts of crop production, enabling carbon footprint assessments, scenario comparisons and benchmarking. AgBalance® covers more than 30 crops, with a focus on broad-acre and commodity crop systems. Externally validated by GUTcert, it supports carbon footprint calculations according to ISO 14067 and ISO 14044.

AgBalance® can be used as a stand-alone tool or embedded within xarvio® FIELD MANAGER for BASF's Global Carbon Farming Program. In the NEWGREEN project (page 32), AgBalance® helps quantify methane emission reductions associated with lower-emission rice cultivation practices.

YouSustain focuses on horticultural and specialty crop systems and is integrated into Hort@'s Decision Support System (DSS). Independently validated by RINA Services, the tool can support LCA studies in accordance with ISO 14044 and the Product Environmental Footprint (PEF), covering multiple environmental impact categories. Widely used across Southern European farming systems, YouSustain supports environmental assessments in malting barley fields within the Birra Peroni project (page 14) and vineyards within the Leone Alato project (page 26), connecting agronomic decisions with measurable environmental outcomes.



2 Decide:
Translate insights into better agronomic decisions.

Once environmental impacts have been identified, the next step is translating them into better agronomic decisions in the field. That is the reason why AgBalance® and YouSustain are closely connected to DSS such as Hort@ and xarvio®.

Both xarvio® and Hort@'s DSS combine weather information, field observations and predictive models to support crop management decisions. By supporting farmers to evaluate risks and optimize crop management, these valuable systems transform complex data into practical guidance that supports productivity, resource efficiency and sustainability outcomes.

In the project with NEWGREEN, xarvio® has created the tailored xarvio® HEALTHY FIELDS for RiTA solution, named after the Japanese concept rita (利他), meaning "altruism" or "acting for the benefit of others." It supports farmers to advance low-methane rice production using Water-Saving Dry Direct-Seeded Rice (WS-DDSR). In projects such as Leone Alato and Birra Peroni, Hort@'s DSS enables farmers to make more informed agronomic decisions, optimize resource use and maintain productivity and product quality.





3 Improve:
Applying innovations to improve performance in the field.

As a third step, our broad innovation portfolio can be applied to address specific challenges in the field. The examples highlighted in this report form part of this broader offering, which includes seed and trait technologies, biological and chemical crop protection, nitrogen management solutions and long-standing agronomic expertise.

Improving nitrogen use efficiency, for example, represents a significant opportunity to reduce the environmental footprint of agricultural production systems. On average, crops recover only around 50%[2] of the nitrogen applied through fertilizer, with the remainder potentially lost to the environment through atmospheric emissions, leaching or runoff. At the same time, nitrogen fertilizer use is a major source of nitrous oxide (N_2O) emissions, a greenhouse gas with a potency approximately 273 times higher than carbon dioxide.[3]

BASF's nitrogen stabilizers are designed to reduce these losses, leaving more nitrogen available for crop uptake. In the Yunnan Yuntianhua (Yuntianhua) project (page 20), BASF's urease inhibitor, Limus®, is used as a key component of the company's solutions to reduce ammonia losses from nitrogen fertilizers. By improving nitrogen availability for crops, Limus® can support productivity and environmental performance while providing a basis for GHG emission reductions that can be monitored and verified.



Across Fields and **Value Chains**

A collection of projects showing how agricultural decarbonization takes shape around the world.





PHOTO: ADOBE STOCK / HAMMAD



How do you reduce emissions across the beer value chain?

A decade of collaboration in Italy between Birra Peroni and Hort@ shows how informed decisions in malting barley production can deliver measurable environmental outcomes. Through Hort@'s DSS and YouSustain, the project achieved a 37% reduction in CO_2e emissions and a 41% reduction in water use since the project began.

Read more >

Can improved fertilizer use contribute to climate change mitigation?

In China, Yuntianhua and BASF are reducing fertilizer-related emissions through Limus® urease inhibitor technology. In its first three years, the project generated more than 250,000 tonnes of CO_2e emission reductions verified according to ISO 14064, demonstrating what can be achieved through improved nitrogen management.

Read more >

What if climate resilience could be grown, one vineyard at a time?

Across its vineyards in Italy, Leone Alato Group is using Hort@'s DSS and YouSustain to translate field data into more sustainable grape production. Over ten years, the project reduced crop protection use by around 20% on average per year, while recent assessments show GHG emission reductions of 15–25% across most estates, achieved without compromising productivity or grape quality.

Read more ›





What if rice could grow with less water and fewer emissions?

In Japan, NEWGREEN and BASF are rethinking how rice is grown by combining selected lower-emission rice cultivation practices with xarvio® HEALTHY FIELDS for RiTA, a DSS developed for the project. The collaboration aims to reduce methane emissions and water use while maintaining productivity and creating new opportunities across the rice value chain.

Read more ›

From Barley Fields to **Climate-Smart Brewing**



AT A GLANCE

Partners

BIRRA PERONI 1846 · CAMPUS PERONI · BASF We create chemistry

Solutions Used

HORT@ From research to field · You Sustain.net

Why This Project Matters

Producing high-quality malting barley increasingly requires farmers to manage several objectives at once: stable yields, consistent grain quality, efficient input use and lower environmental impact. For breweries, these decisions matter because barley quality directly affects the reliability of malt supply and the standards required for brewing. Reducing the environmental footprint of beer production therefore starts in the barley field, where more targeted agronomic decisions can support both crop performance and sustainability outcomes.

Building a Collaborative Ecosystem

In 2018, Birra Peroni founded Campus Peroni, its Center of Excellence dedicated to advancing quality, innovation and sustainability in the agricultural and cereal sectors. The initiative was established in collaboration with CREA (Council for Research in Agriculture and the Analysis of Agricultural Economics). Campus Peroni serves as a platform that brings together farmers, agronomists, research institutions, universities, technology providers and industry partners across the Italian barley sector. Through this multi-stakeholder approach, it promotes science-based agronomy and sustainable farming practices that support soil health, the responsible use of inputs and the protection of ecosystem functions. The ultimate goal is to produce high-quality Italian malting barley while creating shared value along the barley value chain. Since 2016, Hort@ has been a strategic partner, contributing its expertise in DSS and sustainability assessments through the Campus Peroni project “Future Barley.”

How the Solution Works

Hort@’s DSS supports the barley farmers of “Future Barley” throughout the growing season by turning field data, weather information and agronomic models into practical recommendations. The system supports decisions on crop protection and nutrient management, allowing interventions to be better timed and more targeted. Features such as predictive models, prescription maps and satellite-guided applications contribute to more efficient input use while maintaining the quality standards required for malting barley.

Meet Our Partner

Birra Peroni Srl was founded in 1846 and is part of Asahi Group. It is one of the leading players in the Italian beer industry, with a strong national footprint that includes three breweries in Rome, Bari and Padua, a sales office in Milan and a malthouse, SAPLO, in Pomezia.

Why is sustainable barley production complex in practice?

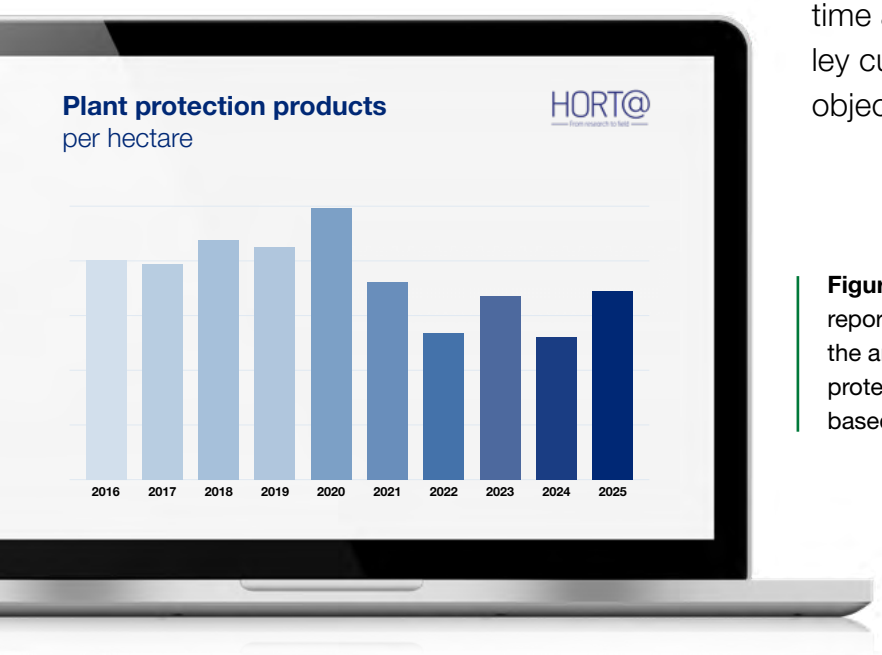
Making barley production more sustainable requires turning innovation into solutions that work in practice. The challenge is not simply to develop innovative digital tools, but to make them accessible, economically viable and scalable for farmers and across the supply chain. For more than 10 years, Hort@ has worked alongside Birra Peroni to put this into practice, turning scientific research and agronomic data into practical solutions for farmers.



Giuseppe Piacentino
Head of Sales and Marketing
Hort@ Srl

-17%

crop protection product use enabled by Hort@'s DSS since project start



YouSustain is used to assess the environmental performance of these practices. It measures how changes in barley management influence indicators such as GHG emissions and use of plant protection products, connecting digital farming with measurable sustainability outcomes across the brewing value chain.

The data generated through YouSustain are consolidated into an annual sustainability report, enabling Birra Peroni and its malthouse SAPLO to monitor progress over time and connect improvements in barley cultivation with broader sustainability objectives.

Figure 1: Illustration based on a report provided by Hort@, showing the annual development of plant protection product use per hectare based on project data.

From Data to Impact

Over the past decade, with Hort@'s support, the project has covered more than 30,000 hectares of barley cultivation and contributed to the production of more than 139,000 tonnes of high-quality malting barley. In the 2024/2025 season alone, the DSS recorded more than 8,000 accesses, showing how digital farming has become embedded in day-to-day barley cultivation.

Sustainability assessments from YouSustain show that the use of plant protection products decreased by 17% in the 2024/2025 season compared with the average of the first three years of partnership. The results demonstrate how targeted agronomic decisions can help optimize inputs while supporting efficient, high-quality malting barley production. Such improvements enabled by Hort@'s DSS can also contribute to reducing GHG emissions and the water use associated with agricultural operations.

From Barley Fields to Climate-Smart Brewing



1

Collaborative Ecosystem
Campus Peroni provides a common platform to advance quality, sustainability and innovation along the barley value chain.



2

Hort@'s DSS
Field data, weather information and agronomic models are translated into field-specific recommendations.



Smarter Crop Management
Farmers use field-specific recommendations to apply inputs more precisely, improving efficiency while maintaining grain quality.

3



4

YouSustain
Environmental performance is assessed and quantified, providing transparency on emissions, water use and input efficiency.



Creating Value Across the Brewing Value Chain
Farmers benefit from more efficient input use and further climate-related resilience. Birra Peroni obtains further information to advance more sustainable barley cultivation.

5



-41%

water use over
10 years of collaboration

YouSustain data also show that, between the 2022/2023 and 2024/2025 seasons, participating barley farmers achieved an average reduction of 26% in CO_2e emissions and 12% in water use. Looking across the program's ten years, reductions reached 37% in CO_2e emissions and 41% in water use associated with agronomic inputs per hectare.



Figure 2: Screenshot from Hort@'s DSS, showing how water content and precipitation data help farmers guide irrigation decisions, applying water only when it is needed.

Creating Value Across the Value Chain

The collaboration delivers benefits across the barley-to-beer value chain. For farmers, the DSS supports more informed agronomic decisions, helping maintain productivity and grain quality while making more efficient use of agricultural inputs.

For Birra Peroni and its malthouse SAPLO, the collaboration supports a reliable supply of high-quality Italian malting barley while creating greater transparency on the environmental performance of its agricultural supply chain. The measured reductions in the use of plant protection products and GHG emissions show how farm-level improvements can contribute to broader sustainability objectives across the brewing value chain.

More broadly, the project demonstrates how food and beverage companies can work with farmers, researchers and technology partners to promote quality, innovation and sustainability across the agrifood system.

Scaling Impact

The Campus Peroni “Future Barley” project has evolved from a digital farming initiative into a structured model for more sustainable barley production. Since 2016, the project has expanded from 20 participating farms to more than 800 farms in the 2024/2025 season. By combining farmer engagement, decision support and environmental assessment, it provides a practical pathway for extending this approach across a growing network.

+800

participating farms in the season 2024/2025, up from 20 at the project’s start

In Conversation with Our Partner

What has been your biggest takeaway from the project?

Scale follows trust. To engage an increasing number of farming businesses, it is essential to provide high-quality digital tools that can genuinely support farmers in their day-to-day crop management.

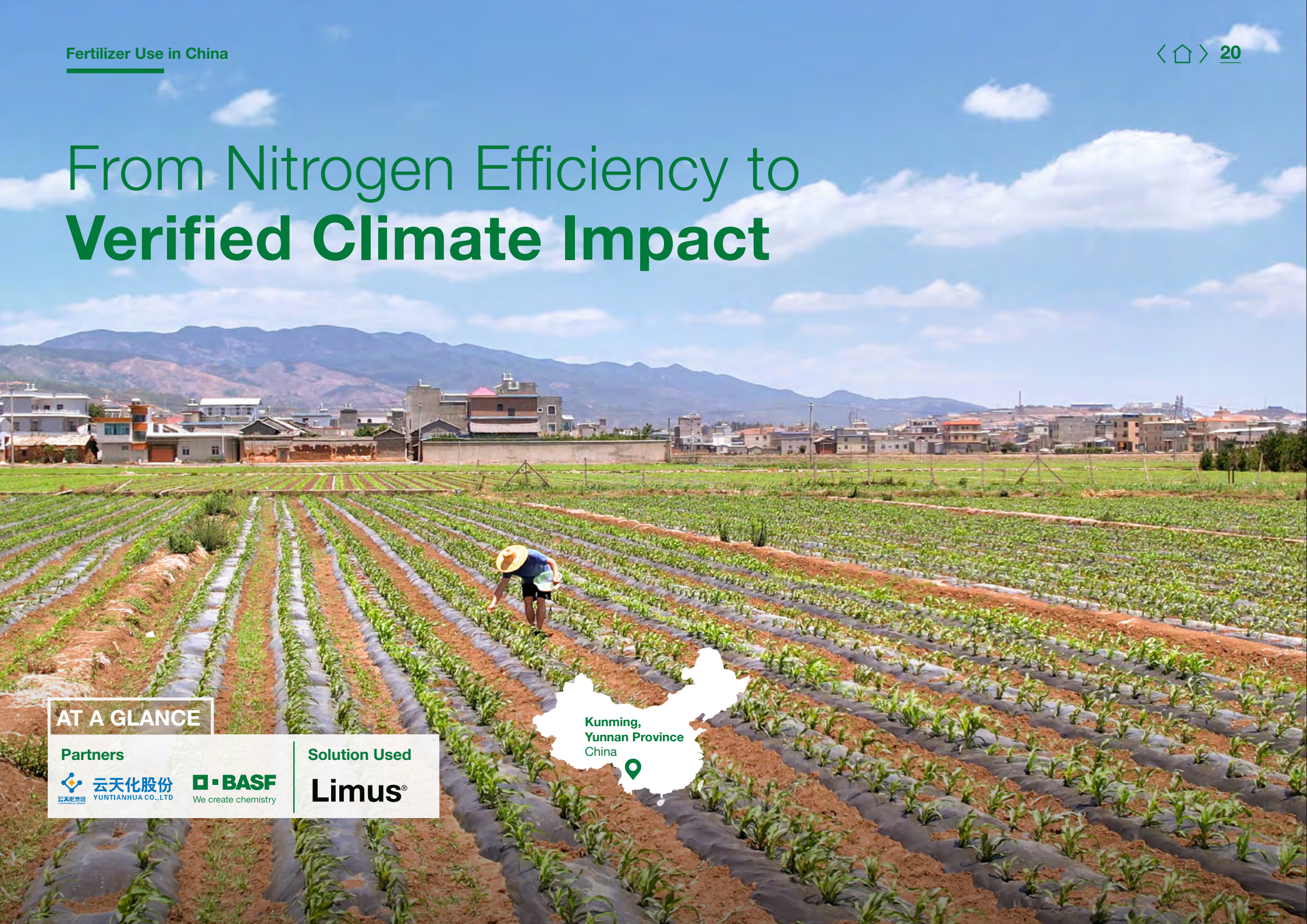
Looking ahead, what will be most important for advancing sustainable barley production in Italy?

Quality, sustainability and innovation need to continue to strengthen farmers’ competitiveness and resilience. Achieving this requires long-term commitment across the value chain. The Campus Peroni experience shows how a collaborative ecosystem can turn this shared ambition into tangible progress.

Massimo Fortunato
Sustainable Development Manager
Birra Peroni



From Nitrogen Efficiency to **Verified Climate Impact**



AT A GLANCE

Partners

云天化股份 YUNTIANHUA CO.,LTD

BASF We create chemistry

Solution Used

Limus®

Why This Project Matters

Nitrogen mineral fertilizers are essential for modern agriculture, supporting crop productivity and global food production. However, nitrogen losses remain a major challenge in agriculture. Normally, about 15% of the nitrogen in urea fertilizer is lost as ammonia-nitrogen,[4] potentially affecting soil, water, air quality and biodiversity. These losses not only increase the environmental footprint but also reduce fertilizer efficiency, leaving less nitrogen available for crop uptake. For fertilizer companies seeking to reduce emissions across their value chains, improving nitrogen use efficiency represents one of the most significant opportunities for reducing GHG emissions.

Building a Collaborative Ecosystem

To advance its sustainability efforts and support the transition to lower-carbon agricultural value chains, Yuntianhua launched a pilot project with BASF in 2023. The project combines Yuntianhua's manufacturing, distribution, and farmer engagement capabilities with BASF's patented urease inhibitor Limus® and its independently validated methodology according to the ISO 14064 standard for quantifying GHG emission reductions. Together, the partners have created a framework that enables the climate benefits of improved nitrogen use efficiency to be externally verified and scaled across agricultural value chains.

15%

of the **nitrogen** in urea fertilizer **is lost as ammonia-nitrogen[4]**

Did you know?

According to an AgBalance® product carbon footprint analysis[5] for the average urea fertilizer use in China, in-field emissions from fertilizer use (3.5 kg CO_2e/kg urea) are about twice as high as the average emissions from fertilizer production (1.8 kg CO_2e/kg urea). This is why reducing in-field emissions is a very important factor in decarbonizing the fertilizer value chain enabled by urease and nitrification inhibitors.

Meet Our Partner

Yunnan Yuntianhua Co. Ltd. is one of China's largest fertilizer producers, active in phosphate mining, fertilizers and specialty chemicals. Headquartered in Kunming, the company supplies markets across China and globally.

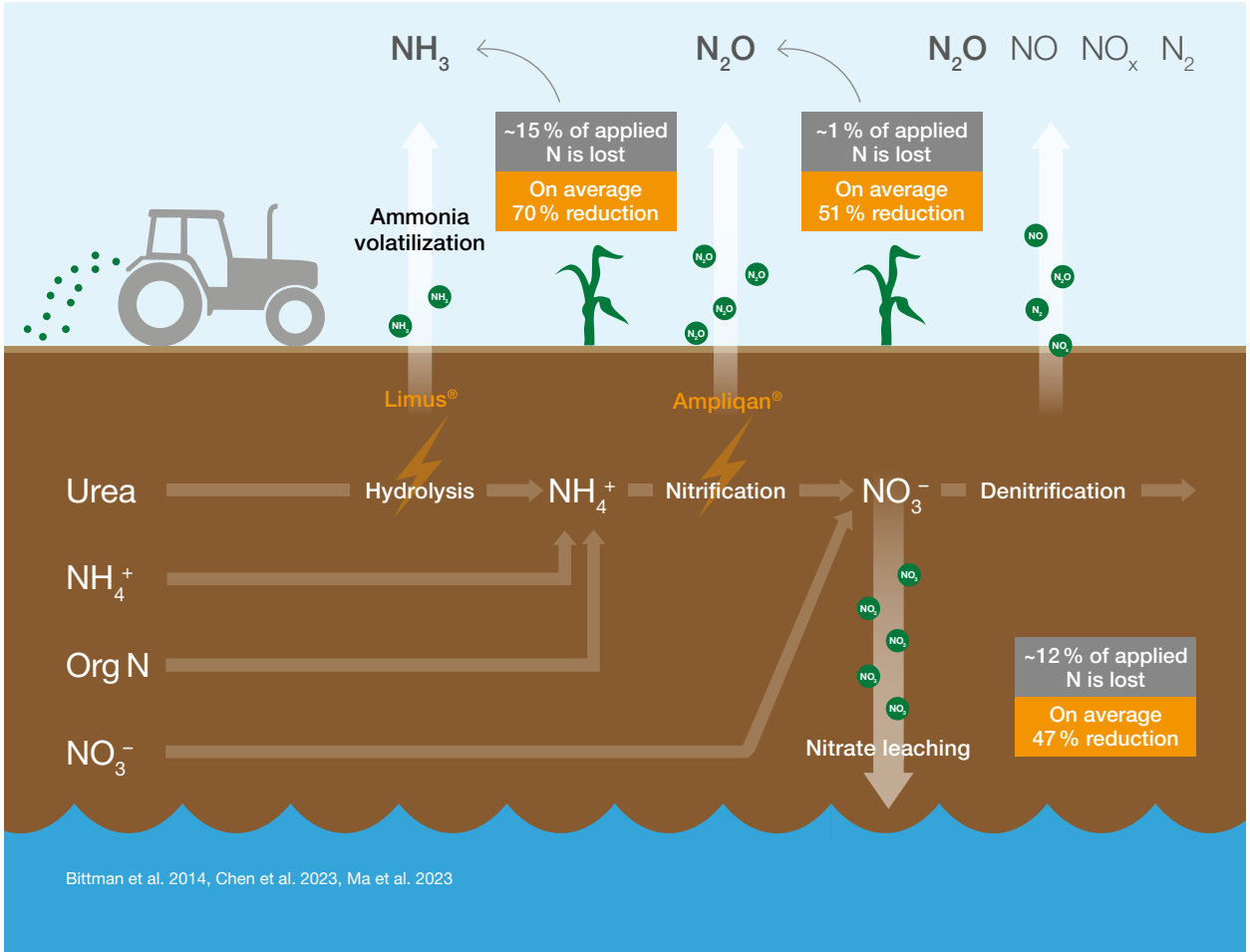
What makes reducing fertilizer-related emissions challenging?

Aligning a complex value chain, from fertilizer producers and distributors to retailers and farmers, is not an easy task. This is why creating a trusted framework to quantify emission reductions was a key first step. Through our partnership with Yuntianhua, we have shown how this can be doable and scalable, combining innovation, farmer engagement and certified outcomes to deliver on climate action.



Lynette Tan
Global Key Account Manager,
Nitrogen Management
BASF Agricultural Solutions

Figure 3: Nitrogen inhibitors help retain more nitrogen in the soil for crop uptake. Urease inhibitors like Limus® slow the breakdown of urea into ammonia. Nitrification inhibitors like Ampliqan® slow the conversion of ammonium into nitrate, so less nitrogen is lost through nitrate leaching and emissions of the GHG nitrous oxide.



How the Solution Works

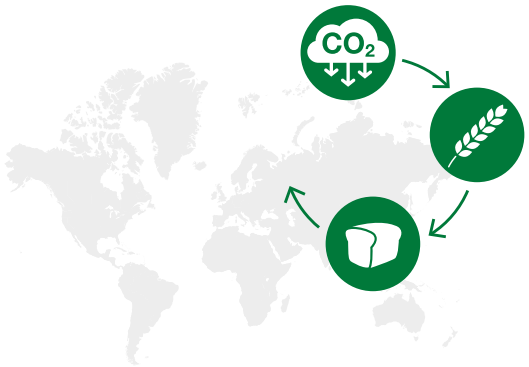
When conventional urea is applied, a portion of its nitrogen is rapidly converted to ammonia and lost to the atmosphere. To reduce these losses, Yuntianhua combines its urea fertilizer with Limus®. This helps retain more nitrogen as ammonium in the soil, making it available for crop uptake. By reducing ammonia volatilization, the solution improves nitrogen-use efficiency while lowering associated GHG emissions. The resulting reductions in ammonia losses and associated nitrous oxide emissions are quantified using BASF's independently validated methodology.

From Data to Impact

Over the first three years of implementation, the project has generated more than 250,000 tonnes of verified CO_2e emission reductions, demonstrating how improved fertilizer management can deliver measurable climate benefits at scale. These emission reductions are registered in the GHG CleanProjects® Registry, providing transparency, credibility and confidence in the project's reported climate impact.

Long-term partnership

BASF and Yuntianhua have extended their collaboration through 2030, reinforcing their shared ambition to drive long-term transformation across the fertilizer value chain. Read the press release



250,000

tonnes of verified CO_2e emissions reduction by Limus® are equivalent to the amount of wheat for around **800 million loaves of bread,** based on an AgBalance® scenario. That equals nearly **two slices for every person worldwide.**[6]

Corn field in China, part of our nitrogen management project with Yuntianhua.



PHOTO: ADOBE STOCK / VOLODYMYR_SH

From Nitrogen Efficiency to Verified Climate Impact



1

Innovative Fertilizer Solution
Limus® urease inhibitor reduces ammonia losses and nitrous oxide emissions while improving nitrogen use efficiency.



2

Efficient Nitrogen Use in the Field
By keeping more nitrogen available to the crop, Limus® helps improve nutrient efficiency while maintaining yield performance.



Data-Driven Measurement
Robust data collection and monitoring turn nitrogen efficiency gains into measurable climate benefits.

3



4

Verified Emission Reductions
Emission reductions are independently quantified, verified to ISO 14064 standards and registered in the GHG CleanProjects® Registry.



Creating Value Across the Food Value Chain
Farmers benefit from more efficient nutrient use. Food industry partners can reduce supply chain emissions and support their sustainability commitments.

5

Creating Value Across the Value Chain

For Yuntianhua, the project provides a credible mechanism for demonstrating the climate benefits of its fertilizer solutions. To support adoption, the company complements the technology with large-scale farmer engagement efforts, including field demonstrations and outreach activities. In 2025, the company organized more than 450 outreach and demonstration events, helping stakeholders better understand how improved fertilizer management can increase nitrogen use efficiency while reducing emissions.

For farmers, improved nitrogen use efficiency helps maximize the value of applied fertilizer. In addition, Limus® offers greater flexibility during fertilizer application by reducing the need for immediate soil incorporation or irrigation after application. This can help save time and labor while maintaining crop productivity.

For distributors and retailers, urease inhibitors provide a differentiated solution that supports decarbonization in the fertilizer industry. For food companies and downstream value chain partners, verified emission reductions can potentially provide a credible mechanism for tracking and demonstrating progress toward climate goals.

Scaling Impact

The next phase of the project focuses on strengthening farmer education and increasing awareness of efficient fertilizer management practices.

Building on the success of the first three monitoring periods, the upcoming fourth monitoring period will expand the framework to include emissions reduction claims associated with optimized nitrogen application practices.

By 2030, Yuntianhua aims to reduce cumulative greenhouse gas emissions by more than 1 million tonnes of CO_2e through the implementation of the project, demonstrating the potential of improved nutrient management to deliver climate benefits at scale.

In Conversation with Our Partner

What have you learned from bringing lower-emission fertilizer solutions to scale across China's agricultural sector?

Scaling lower-emission fertilizer solutions requires more than technology alone. While Limus® provided the technical foundation, our field demonstrations and farmer outreach programs were essential for building trust and demonstrating value in farmers' fields. Our close collaboration with BASF was equally important, bringing together technical expertise and a practical pathway to implementation that helped accelerate adoption across China.

Zhengwen Bai
Director, Nitrogen Fertilizer Department
Yunnan Yuntianhua Co. Ltd.



From Vineyard Data to **Lower-Impact Grape Production**



Annone Veneto, Italy

AT A GLANCE

Partners

LEONE ALATO

BASF We create chemistry

Solutions Used

HORT@ From research to field

You Sustain.net

Why This Project Matters

Viticulture plays an important role in Italy's agricultural landscape, but like many farming systems, it faces growing pressure to reduce its environmental footprint while maintaining productivity and grape quality. With the carbon footprint from Italian viticulture estimated at 1.3 to 2.7 t CO_2e per tonne of grapes[7], decisions made throughout the growing season can play an important role in addressing this challenge. These range from disease and pest management to irrigation and input use. At the same time, changing weather patterns are increasing the risk of drought, heat stress and pest and disease pressure that can affect both productivity and grape quality.

As sustainability expectations from consumers, customers, investors and regulators continue to increase, agricultural businesses face growing pressure to demonstrate environmental performance and resilience. This requires not only agronomic expertise, but also reliable data and tools that can translate field activities into measurable sustainability outcomes that can be monitored, reported and communicated across the value chain.

1.3–2.7t

CO_2e per tonne of grapes[7] produced in Italy

How the Solution Works

Since 2016, Leone Alato Group has partnered with Hort@ to integrate sustainability into vineyard management. The solution combines Hort@'s DSS and YouSustain, connecting day-to-day agronomic decisions with long-term sustainability performance measurement.
The DSS supports vineyard managers with field-specific agronomic guidance throughout the growing season. By integrating weather data, crop models and field observations, it helps optimize crop protection, irrigation and nutrient management in response to real-time conditions. Features such as predictive models, prescription maps and satellite-guided applications enable more targeted interventions and more efficient use of agricultural inputs.

Meet Our Partner

Leone Alato Group is a leading European agri-food company managing 27 farms across Italy and Romania, covering approximately 16,000 hectares across four core activities: arable crops, viticulture, renewable energy and forestry.

What makes decision-making in vineyards particularly challenging from a sustainability perspective?
Many of the decisions that influence a vineyard's environmental footprint are made long before harvest. Their effects, however, become visible over the course of the season and often over several years. Through our long-term partnership with Leone Alato, we aim to build the knowledge and evidence needed to make these decisions more informed and sustainability progress more measurable over time.



Manuel Salamone
Vineyard Technical Area Manager
Hort@ Srl



Figure 4: Screenshot from Hort@'s DSS dashboard showing risk indices for key grapevine diseases to support disease monitoring and vineyard management decisions.

Complementing this agronomic decision support, YouSustain tracks the environmental performance across key sustainability dimensions, including water, soil, biodiversity, air quality and energy use. The resulting data are consolidated into an annual sustainability report, enabling Leone Alato Group to benchmark performance against historical results and regional references.

From Data to Impact

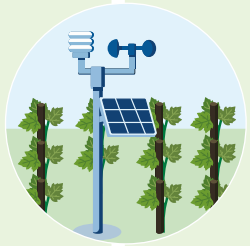
Hort@'s DSS has enabled Leone Alato to reduce crop protection use by approximately 20% on average per year, despite already highly optimized management practices. In years when disease pressure is lower, predictive models have supported even greater reductions, with treatment applications decreasing by up to 30–40%. Data from YouSustain show that GHG emissions across most Leone Alato estates have declined by 15–25% over the past three years compared with the 2017–2019 baseline period. Although viticulture remains highly dependent on weather conditions, the results demonstrate how digital farming can support the decarbonization of perennial crop systems while maintaining productivity and grape quality.

Figure 5: Illustration from YouSustain showing the environmental performance of a vineyard parcel. The radar chart presents six impact categories: health, air, water, soil, biodiversity and energy, while the bar chart shows their average total performance for each year.





From Vineyard Data to Lower-Impact Grape Production



1 Collecting Vineyard Data

Weather, satellite, field and soil data are gathered throughout the growing season.



2 Generating DSS Recommendations

Hort@'s DSS translates vineyard data into recommendations on irrigation, nutrition and disease management.



3 Optimizing Vineyard Operations

Targeted interventions improve resource efficiency while maintaining grape quality and vineyard performance.



4 Measuring Sustainability Performance

YouSustain quantifies environmental outcomes, including GHG emissions and input use, and tracks progress over time.



5 Creating Value Across the Wine Value Chain

Farmers improve input efficiency and reduce use of crop protection products. Leone Alato gains insights into environmental performance and sustainability progress.

Creating Value Across the Wine Value Chain

The collaboration creates value at both operational and strategic levels. For vineyard managers, the combination of DSS and sustainability measurement enables more informed decisions throughout the growing season and helps optimize the use of inputs and resources. It also reduces the administrative effort associated with sustainability reporting while strengthening resilience to changing growing conditions and maintaining grape quality.

For Leone Alato Group, the integration of agronomic and sustainability data provides a consistent view of environmental performance across multiple vineyards and estates, enabling performance benchmarking, supporting data-driven decision-making and translating sustainability ambitions into measurable progress toward its decarbonization goals. By linking agronomic practices with measurable sustainability outcomes, it helps establish a shared basis for collaboration, continuous improvement and sustainability ambitions across value chain partners.

Scaling Impact

What began as a vineyard-focused collaboration between Leone Alato and Hort@ more than a decade ago has evolved into a broader digital farming approach. Today, it supports decision-making across Leone Alato's crop portfolio, including durum wheat, common wheat, barley, corn and olives. Across Leone Alato's 23 farms, crops are continuously monitored for biotic stresses such as fungal diseases and insect pressure, as well as abiotic stresses including nutritional and thermal stress, enabling more timely and targeted interventions.

15–25%

GHG emissions reduction
across Leone Alato estates

In Conversation with Our Partner

What key lesson would you share with others embarking on a similar journey?

Over the years, we have learned the value of moving from reactive to proactive vineyard management. By anticipating challenges earlier and optimizing interventions, we can make better-informed decisions throughout the growing season. The experience has reinforced our belief that digital tools and trusted partnerships are essential for translating sustainability ambitions into measurable improvements in resource efficiency and environmental performance.

Dr. Giovanni Casati
Chief Agronomist and Enologist
Leone Alato Group



From Lower Methane to **Benefits Across the Rice Value Chain**

AT A GLANCE

Partners

NEWGREEN

BASF
We create chemistry

Solution Used

xarvio® HEALTHY FIELDS for RiTA

xarvio® Digital Farming Solutions
powered by BASF



Why This Project Matters

Rice is a staple food for more than 3.5 billion people with over 90% of global production taking place in the Asia-Pacific region.[8,9] However, conventional flooded rice cultivation requires significant amounts of irrigation water and is a major source of agricultural methane emissions, accounting for approximately 40% of such emissions in Japan.[10] These environmental impacts are compounded by an aging farming population and deteriorating irrigation infrastructure, placing additional pressure on Japan's rice sector.

Addressing these interconnected challenges has become increasingly important not only for agriculture, but also for food companies seeking to meet ambitious climate commitments. Yet reducing environmental impacts alone is not enough. Solutions must also maintain productivity, support farmer livelihoods and provide a credible foundation for collaboration across the value chain.

Building a New Model for Sustainable Rice Cultivation

To accelerate the adoption of lower-emission rice cultivation, NEWGREEN and BASF launched their collaboration in 2024 through a pilot carbon farming project that is currently undergoing validation and verification by SustainCERT, an independent certification body. Building on NEWGREEN's experience with WS-DDSR*, BASF developed xarvio® HEALTHY FIELDS for RiTA. The platform is tailored to the specific requirements of the project. It combines agronomic decision support with environmental measurement powered by AgBalance® in a single system.

*What is WS-DDSR?

WS-DDSR is a cultivation method that combines Dry Direct-Seeded Rice (DDSR) with water management practices that eliminate continuous flooding of rice fields. This method also supports farmland consolidation and mechanization, enabling more efficient and scalable operations. **You can find more information in our latest** Global Carbon Field Trials Report.

Meet Our Partner

NEWGREEN Inc. is a Japanese agricultural enterprise and a key player in Japan's rice trading and agri-tech sector, focused on making rice production more sustainable, resilient and economically viable.

What are the key challenges in decarbonizing the rice value chain?

Decarbonizing rice production is not only about reducing emissions. Farmers need confidence that new cultivation practices will maintain yields, remain economically viable and fit within their day-to-day operations. That is why we are working with NEWGREEN to make the transition easier for farmers.



Soichiro Fuji
Country Head,
BASF Agricultural Solutions Japan

How the Solution Works

xarvio® HEALTHY FIELDS for RiTA combines satellite imagery and field data to generate continuous insights throughout the growing season. Based on these insights, the DSS delivers field-specific recommendations, including guidance on weed control and optimal timing for crop protection applications. Combined with tailored in-field support, these recommendations support farmers in adopting lower-emission cultivation methods and improving water management. To reduce the risks associated with adopting a new cultivation approach, xarvio® HEALTHY FIELDS for RiTA also includes an outcome guarantee.

At the same time, the platform measures key sustainability indicators, including methane emission reductions and carbon footprint outcomes. These results can be translated into independently certified Verified Impact Units (VIUs) under Verra's VM0051 methodology, providing the verified data needed for Scope 3 emissions accounting and sustainability reporting across the rice value chain. The platform also streamlines data collection and documentation for farmers, reducing the administrative burden associated with carbon farming programs.

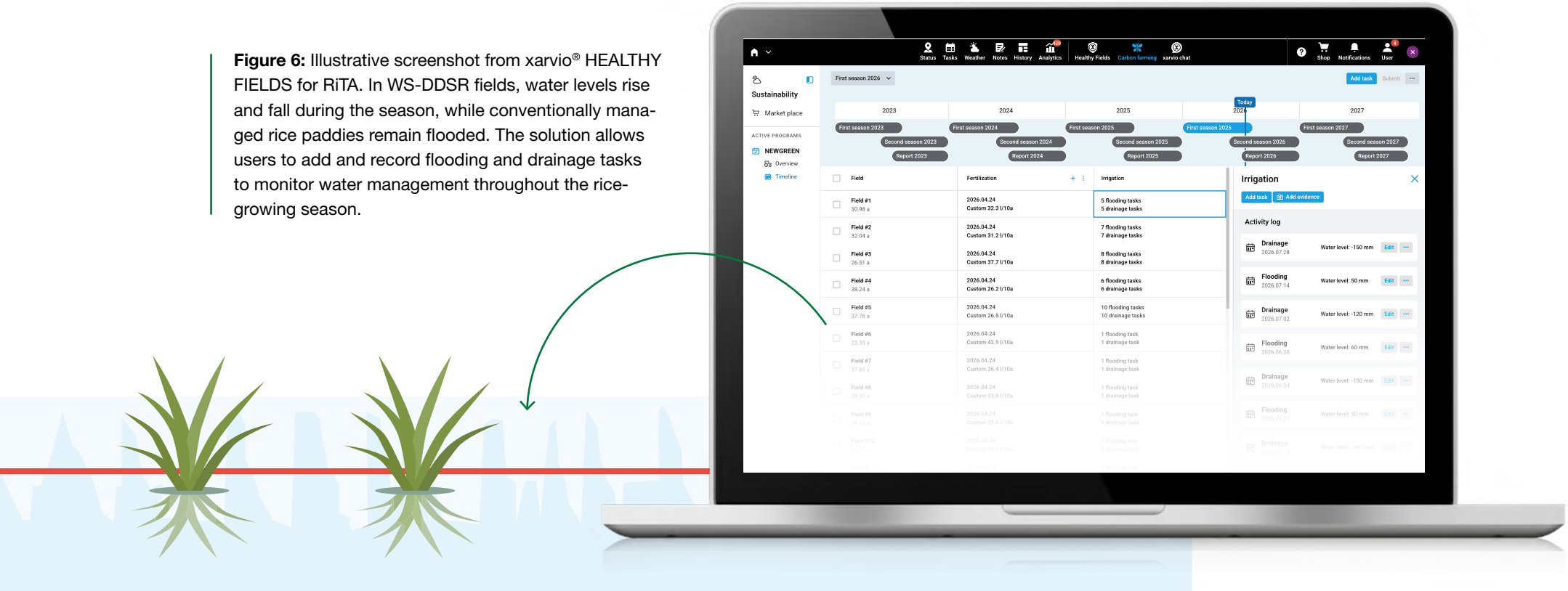
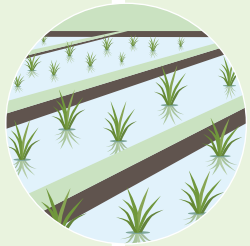


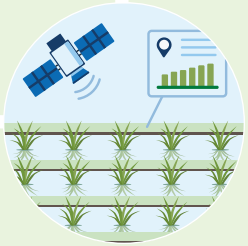
Figure 6: Illustrative screenshot from xarvio® HEALTHY FIELDS for RiTA. In WS-DDSR fields, water levels rise and fall during the season, while conventionally managed rice paddies remain flooded. The solution allows users to add and record flooding and drainage tasks to monitor water management throughout the rice-growing season.

From Lower Methane to Benefits Across the Rice Value Chain



1

Sustainable Cultivation
Farmers adopt WS-DDSR practices that reduce the flooding of rice fields.



2

Field & Satellite Monitoring
Satellite imagery and field data provide continuous insights throughout the growing season, supported by irrigation tracking.



Digital Decision Support
Field-specific recommendations powered by xarvio® HEALTHY FIELDS for RiTA help forecast risk and support optimal timing of farm operations.

3



4

Measurement, Reporting and Verification
Methane emission reduction, water use and carbon footprint are monitored, reported and verified.



Creating Value Across the Rice Value Chain
Verified Impact Units (VIUs) and premiums for low-methane rice can add value and support the decarbonization of the rice value chain.

5



In-field observations complement digital recommendations, helping farmers adapt cultivation practices to actual field conditions.



Figure 7: Illustrative screenshot from xarvio® HEALTHY FIELDS for RiTA, showing field status, crop growth stage and weed management recommendations for a selected rice field. The map highlights variations in biomass across the field, providing additional spatial information to support informed decisions.

Creating Value Across the Rice Value Chain

The collaboration creates value across the rice value chain. For farmers, the combination of agronomic support, environmental measurement and outcome guarantees helps reduce the risks associated with adopting new cultivation practices. At the same time, certified CO_2e reductions can create additional revenue opportunities through VIUs, potential premiums for low-methane rice and lower production costs associated with the reduced farm labor requirements of WS-DDSR systems.

For NEWGREEN, the collaboration expands its role beyond agricultural technology development by combining digital agronomic support, environmental measurement and carbon farming services. This enables the company to support farmers during the transition to lower-emission rice production, while linking verified environmental outcomes with carbon farming opportunities and emerging market demand.

For downstream rice buyers, the approach provides greater transparency and access to rice produced under verified sustainability frameworks, helping connect Scope 3 reduction efforts with measurable outcomes at farm level.

Scaling Impact

The collaboration is already moving beyond individual farms. NEWGREEN and BASF are exploring a strategic collaboration with Yamatane Corporation, one of the largest rice distribution companies in Japan, to accelerate the adoption of sustainable rice cultivation and distribution through the value chain.

Originally developed in Japan, the model has the potential to create a scalable pathway for lower-emission rice production and be adapted to other rice-producing regions facing similar challenges related to methane emissions, water use and climate resilience.

In Conversation with Our Partner

What have you learned through this collaboration?

Reducing field level emissions is only the beginning. Widespread adoption depends on maintaining or improving farmers' productivity and profitability, while providing them with continuous support throughout the transition. Working with BASF helped bring these elements together in a measurable, verifiable model that creates value across the value chain.

What has surprised you most?

We have seen strong interest from across the value chain, reinforcing our view that lower-emission rice production is becoming increasingly relevant to farmers, food companies and consumers alike.

Daiki Nakajo
Representative Director & COO
NEWGREEN Inc.



Scaling What **Works, Together**



The projects featured in this report are examples of how agricultural decarbonization can move from ambition to implementation. They are not the full story, but they offer a clear view of what is needed to create measurable progress across food value chains: credible data, practical solutions, farmer adoption and collaborations. From rice and barley to grapes, each project responds to a different set of agronomic, environmental and market realities. Together, they show that there is no one-size-fits-all pathway for this transition. Successful approaches must be tailored to each crop, region and value chain while remaining practical for farmers and relevant to business partners.

Sustainability, productivity and business value must advance together. Reducing methane emissions, improving nitrogen use efficiency, lowering input use and measuring environmental progress cannot happen at the expense of crop yields, product quality or farmer income. For food companies, this is equally important. Progress on Scope 3 emissions depends on changes in agricultural production, but those changes must also strengthen the reliability and resilience of supply chains.

The projects also show why measurement matters. Transparent data create the basis for understanding where environmental impacts occur, tracking progress over time and building trust across the value chain. Yet measurement is only powerful when it leads to action. Its value comes when insights are translated into better agronomic decisions, targeted interventions and solutions that farmers can implement in the field. This is where BASF Agricultural Solutions contributes, connecting transparency with implementation through agronomic expertise, sustainability assessment, DSS and product innovation.

Meaningful change in agriculture takes time: to understand local challenges, build trust with farmers, generate credible data, adapt practices and create the conditions for broader adoption. This is why we value long-term partnerships. They allow us to understand the realities of each value chain, learn together and adapt our approach as needs evolve.

We sincerely thank the partners featured in this report for their trust, openness and willingness to showcase our joint efforts. Looking ahead, one point is clear: no single organization can transform agriculture alone. We invite farmers, food companies, processors, retailers, agribusinesses and technology partners to work with us in advancing agricultural systems that are more productive, resilient and sustainable.

This is how we scale what works, together.



Marco Moorfeld
Vice President, Global Strategic Marketing Herbicide
BASF Agricultural Solutions

“Agricultural decarbonization is an opportunity to rethink how value is created and shared across the food chain, while giving farmers a stronger reason to adopt new approaches.”

Glossary

Terms are defined according to how they are used in this report.

Abiotic stress

Stress caused by environmental factors such as drought, heat, cold, flooding or nutrient deficiencies.

Ammonia (NH_3)

A volatile gas that is released from fertilizers, soils, and crop and animal residues, contributing to environmental pollution.

Ammonia volatilization

The loss of nitrogen as ammonia gas, reducing nutrient use efficiency and contributing to environmental pollution.

Biotic stress

Stress caused by pests and diseases.

Carbon farming

Agricultural practices that reduce greenhouse gas emissions or increase carbon sequestration while creating measurable and verifiable environmental benefits, such as improved soil health, greater water retention and enhanced biodiversity.

Carbon footprint

The total greenhouse gas emissions associated with an activity, service, product, organization or production system. It expresses the efficiency of that product or service with respect to its global warming potential.

Climate-smart agriculture

According to the Food and Agriculture Organization of the United Nations (FAO), this is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. FAO structures CSA around three core objectives, or pillars:
Productivity: sustainably increase agricultural productivity and incomes.
Adaptation: adapt and build resilience to climate change.
Mitigation: reduce or remove greenhouse gas emissions where possible.

CO_2e (Carbon dioxide equivalent)

A standardized unit to express the warming impact of a footprint in relation to that of carbon dioxide (i.e., CO_2).

Decarbonization

The process of reducing the carbon footprint associated with activities, products or value chains.

Decision Support System (DSS)

A tool that combines data, models, and agronomic expertise to support farming decisions, such as when to irrigate, apply crop protection products or fertilizers, and manage pest and disease risks. It is frequently offered as a digital service to farmers.

Digital farming

The use of digital technologies, data, and connectivity to support farm management decisions, improve productivity and/or profitability of the farm, and enhance sustainability outcomes, such as more efficient use of water and agricultural inputs, reduced greenhouse gas emissions and improved soil health.

Downstream buyers

Organizations or companies that purchase agricultural commodities or products further along the value chain for processing, manufacturing, distribution or sale.

Dry Direct-Seeded Rice (DDSR)

A rice cultivation method in which seeds are sown directly into dry fields reducing labor and water requirements.

Food supply chains

The network of organizations, activities, and processes involved in producing, processing, transporting and delivering agricultural products from farm to the end consumer.

Greenhouse Gas (GHG)

A gas that traps heat in the atmosphere, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), water vapor (H_2O gas), ozone (O_3) and chlorofluorocarbons (CFCs). Increasing GHG emissions warm the Earth's atmosphere and contribute to changes to climate.

Hort@

A BASF company that brings research and digital innovation into agricultural practice, including crop-specific decision support systems.

ISO 14064

An internationally recognized standard for quantifying, monitoring, reporting and verifying greenhouse gas emissions and reductions.

ISO 14067

An internationally recognized standard that specifies principles, requirements and guidelines for quantifying and reporting the carbon footprint of products.

Life Cycle Assessment (LCA)

A methodology used to evaluate the environmental impacts of a product, process or system across its life cycle. It can include impacts incurred from the production of a raw material to end use of a product or service delivery.

Methane (CH_4)

A greenhouse gas with a significantly higher short-term warming potency than carbon dioxide. Rice cultivation and livestock are the two major sources of methane emissions in agriculture.

Measurement, reporting and verification

A framework used to measure and document greenhouse gas emissions and emission reductions, report the results transparently, and verify the underlying data and methodologies to ensure they are credible and consistent.

Nitrogen inhibitor

An active ingredient added to nitrogen fertilizers to slow down the transformation of fertilizer-derived nitrogen in the environment, helping reduce nutrient losses and improve nitrogen use efficiency. These include inhibitors of urease (an enzyme that catalyzes the breakdown of urea into ammonia) and of nitrification (a multi-step biogeochemical process that oxidizes ammonia into nitrite and nitrate).

Nitrogen use efficiency

A measure of how effectively crops utilize nitrogen. It is typically reported as the agronomic output (e.g., yield, profitability) in relation to the use rate of applied nitrogen fertilizer.

Nitrous oxide (N_2O)

A greenhouse gas with a significantly higher warming potency than carbon dioxide or methane. In agricultural systems, N_2O is emitted into the atmosphere following nitrogen losses from fertilizers, soils and crop and animal residues.

Prescription maps

Digital maps that provide location-specific recommendations for the application of agricultural inputs such as fertilizer, irrigation or crop protection products.

Product Environmental Footprint (PEF)

A European Commission methodology for measuring and communicating the environmental performance of products across their life cycle.

Satellite-guided applications

The use of satellite data and positioning technologies to support precise field operations and input applications.

Satellite imagery

Images of the Earth's surface collected by satellites and used in agriculture to monitor crop growth, field conditions and management practices.

Scope 3 emissions

Indirect greenhouse gas emissions occurring across a company's value chain, including emissions associated with purchased goods, transportation, product use and agricultural production.

Upstream emissions

Greenhouse gas emissions generated during the production, processing and transportation of goods and services purchased by a company.

Urea

An organic compound containing nitrogen that is used in a variety of sectors, including chemical and cosmetic industries. In the agricultural sector, urea is widely used as a nitrogen source for fertilizer.

Urea fertilizer

A widely used and relatively low-cost nitrogen fertilizer type.

Urease inhibitor

An active ingredient that slows the transformation of urea into ammonia. This inhibitor helps reduce nitrogen losses to the environment and improve fertilizer efficiency.

Value chain

The full range of activities, organizations and stakeholders involved in producing, processing, distributing and consuming a product.

Verified Impact Units (VIUs)

Independently verified units representing quantified environmental outcomes, such as greenhouse gas emission reductions, generated through approved sustainability methodologies.

VM0051 methodology

A methodology of the Verified Carbon Standard program used to quantify, monitor, report and verify greenhouse gas reductions from improved rice cultivation practices.

References

Page 5

1 **Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N. and Leip, A.** (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. Nature Food, 2, 198-209. DOI: 10.1038/s43016-021-00225-9. View the article.

Page 11

2 **Cassim, B. M. A. R., Lisboa, I. P., Besen, M. R., Otto, R., Cantarella, H., Inoue, T. T. and Batista, M. A.** (2024). Nitrogen: From Discovery, Plant Assimilation, Sustainable Usage to Current Enhanced Efficiency Fertilizer Technologies: A Review. Revista Brasileira de Ciencia do Solo, 48, e0230037. DOI: 10.36783/18069657rbcs20230037. View the article.

3 **Greenhouse Gas Protocol** (2024). IPCC Global Warming Potential Values, Version 2.0. Updated with values from the IPCC Sixth Assessment Report. View the reference.

Page 21

4 **Intergovernmental Panel on Climate Change** (2019). 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use, Chapter 11: N_2O Emissions from Managed Soils and CO2 Emissions from Lime and Urea Application. View the PDF.

5 **BASF Agricultural Solutions** (2026). AgBalance® Scenario Analysis of Urea Use in a Modeled Wheat Production System in China: Comparison of Conventional Urea and Urea with Limus®. Functional unit: 1 kg urea; climate change impact excluding biogenic carbon. Analysis includes the GHG emissions from urea production and use (field emissions from fertilizer application). Internal assessment. Results reflect the assumptions and parameters used in the assessment. Actual outcomes may vary depending on soil, climate, fertilizer management and field conditions.

Page 23

6 **BASF Agricultural Solutions** (2026). Illustrative Conversion of an 85,415-Hectare Wheat Production Equivalent into Bread Loaves. Internal calculation based on the wheat production equivalent derived from the AgBalance® analysis, China's average wheat yield, a 72% flour extraction rate and defined assumptions for flour-to-bread conversion, production losses and loaf size. The calculation assumes 20 slices per loaf and uses a global population of approximately 8.2 billion.

The calculation is further supported by data from the following sources:

National Bureau of Statistics of China (2025). Announcement on National Grain Production Data in 2025. Average wheat yield: 5,939.8 kg/ha. View the official statistics.

Food and Agriculture Organization of the United Nations. Food Composition Tables for International Use: Cereals. Wheat flour extraction rate used in the calculation: 72%. View the FAO data.

United Nations, Department of Economic and Social Affairs, Population Division (2024). World Population Prospects 2024: Summary of Results. Global population: approximately 8.2 billion. View the UN report.

Page 27

7 **Frem, M., Petrontino, A., Fucilli, V., Sansiviero, C. and Bozzo, F**. (2023). Sustainable Viticulture of Italian Grapevines: Environmental Evaluation and Societal Cost Estimation Using EU Farm Accountancy Data Network Data. Horticulturae, 9(11), 1239. DOI: 10.3390/horticulturae9111239. View the article.

Page 33

8 **Asma, J., Subrahmanyam, D., and Krishnaveni, D**. (2023). The global lifeline: A staple crop sustaining two thirds of the world's population. Agriculture Archives: An International Journal. DOI: 10.51470/AGRI.2023.2.3.15 View the article.

9 **Chandio, A. A., Gokmenoglu, K. K., Ahmad, M., and Jiang, Y.** (2022). Towards sustainable rice production in Asia: the role of climatic factors. Earth Systems and Environment 6, 1-14. DOI: 10.1007/s41748-021-00210-z. View the article.

10 **Greenhouse Gas Inventory Office of Japan and Ministry of the Environment, Japan** (2024). National Greenhouse Gas Inventory Document of Japan 2024. Center for Global Environmental Research, National Institute for Environmental Studies. View the national inventory.

Published November 17, 2026

Visit agriculture.basf.com for more information.

