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Vol 42 • Issue 4 – July/August 2025

Fertilizer Focus

The Werra project

- Clean ammonia
- Asia market
- Water solubles

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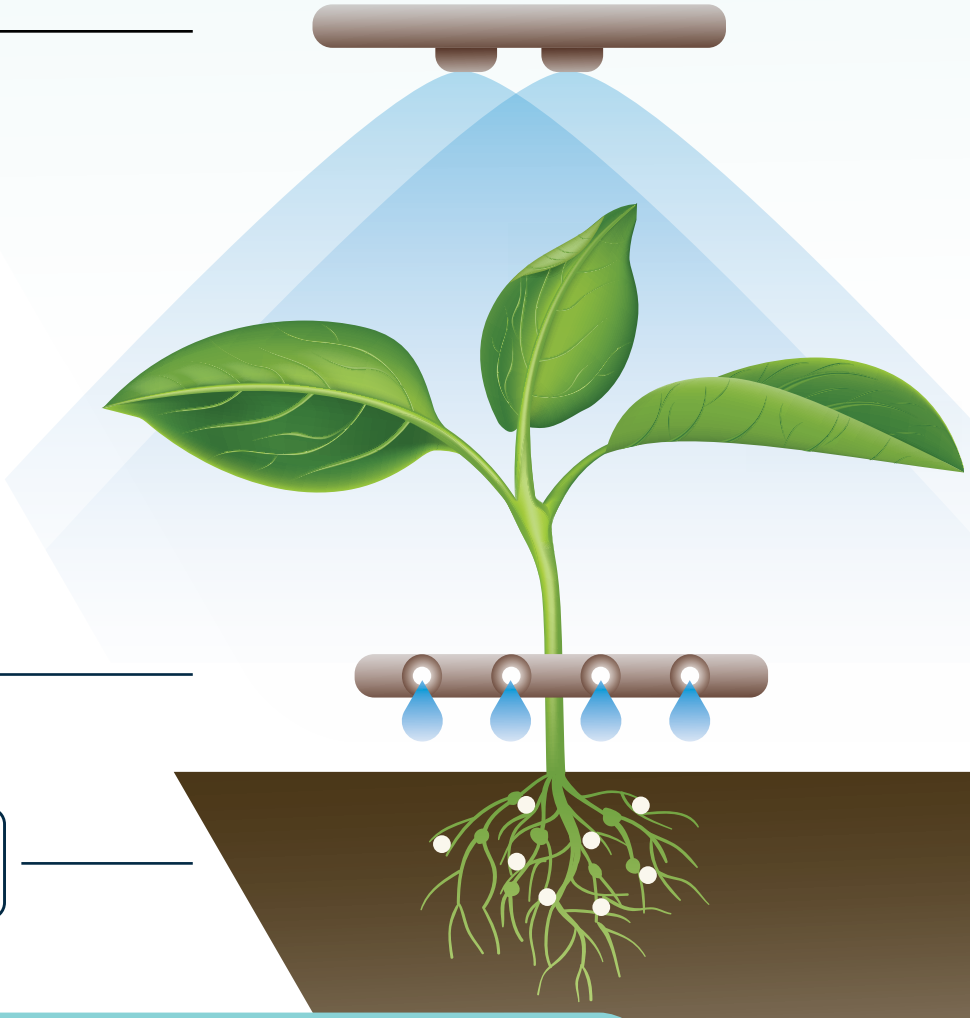

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The future of clean ammonia

Written by
Stef Worsley, *Editor, Fertilizer Focus Magazine,*
Argus Media, UK

Welcome to the July/August 2025 edition of Fertilizer Focus! In this issue, Michael Freeman – in his series on the history of modern fertilizers - takes a look at the impact of science on farming, specifically in the way that it was able to boost the yields of the crops grown on the world's finite area of cultivatable land.

The main feature article in this edition is on The Werra 2060 project. In the face of geopolitical uncertainty, which includes global supply chain disruptions and trade conflicts, ensuring a stable supply of agricultural products is of paramount importance for the European agricultural sector. Through the Werra project, K+S is helping to achieve this.

Meanwhile, we feature an article on water innovations in water soluble fertilizers. As food demand grows, nanotechnology offers a game- changing alternative to inefficient conventional fertilizers. Water-soluble nanofertilizers enable precise, controlled nutrient delivery—boosting uptake, reducing leaching and supporting sustainable, high- efficiency farming without harming the environment.

We have a special focus section on “Clean ammonia” in this edition. Firstly, Morten Stahl, from Natural Hydrogen Ventures discusses the pragmatic approaches to hydrogen transport and infrastructure. Hydrogen is often touted as a cornerstone of the clean energy future, but all hydrogen – whether ‘green’ from renewables, ‘blue’ from gas with carbon capture, or natural/ geological hydrogen sourced from the ground – faces the same thorny issue: how to move it from where it is produced to where it is needed.

Nadja Håkansson, from thyssenkrupp then looks at Unlocking ammonia’s potential in the energy transition. For more than a century, ammonia has been essential to modern industry, primarily as the nitrogen vector for global food production. Today, however, ammonia is being redefined. As the global economy pivots toward net-zero targets, this familiar molecule is emerging at the intersection of industrial decarbonization and clean energy logistics.

Ginkgo Agriculture then offers an insight into the field of microbial nitrogen-fixation. Over the past 50 years, the goal of developing nitrogen-fixing bacteria for non-leguminous crops has cycled in and out of favour – met alternately with hope, then scepticism. Such swings are understandable. If we are successful, the benefits to growers, the environment and the global food system are enormous. Yet, the field has struggled to prove it can be done.

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I hope you enjoy the issue. ■

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History of the modern mineral fertilizer industry
Volume 3: 1950-2000 (Part 6)

The science of farming

This is the third and final volume of the history of the modern mineral fertilizer industry by Michael Freeman, which takes a look at the evolution of fertilizers over the past two centuries (Please refer to all editions of Fertilizer Focus in 2022 for volume 1 and editions in 2023/24 for volume 2).

In the two centuries that passed between 1800 and 2000, the world's population grew from one billion to eight billion. This kind of development was forecast by the Rev. Thomas Malthus in 1798 when he wrote that the supply of food would not be able to expand in line with population growth and that famine would be the inevitable result. In making this judgement Malthus, who was no scientist, failed to anticipate the impact of science on farming, specifically in the way that it was able to boost the yields of the crops grown on the world's finite area of cultivatable land. The emergent supply of mineral fertilizers in the mid-19th century made it easier to replace the phosphorus and potassium removed from the soil in harvested crops, and the advances in ammonia production technology at the start of the 20th century made it possible to expand applications of fertilizers containing nitrogen. The industrial production of nitrogen provided the answer to the concerns that has been raised by Sir William Crookes in 1898 over the urgent need for a new source of nitrogen fertilizers to supplement the limited amounts available from natural nitrate deposits

and as a by-product from coke processing.

The use of mineral fertilizers in farming was built up in the first half of the 20th century in Europe and North America and a handful of countries in other regions. There were various ways of increasing crop yields, but fertilizers had the advantage of being easy to explain to farmers, especially if they had already been using farmyard manure and other natural materials to maintain soil quality. There was a ten-fold increase in mineral fertilizer nutrients between 1900 and 1950, and another ten-fold increase between 1950 and 2000 as the practice spread to the big agricultural producers in Asia and Latin America, driven by the Green Revolution, and only Africa was lagging behind on the path of agricultural progress to feed fast-expanding populations.

Reducing fertilizer application

However, it started to become clear in the closing decades of the 20th century that the expansion of mineral fertilizer application would not continue forever. As early as the 1960s, Japan recognised that its farmers were using too much nitrogen and was able to implement a 25% reduction over four years. The escalation of fertilizer prices in the 1970s and early 1980s forced established users in Europe and North America to become more efficient in the purchasing and use of fertilizers, resulting in permanent reductions in the amounts being consumed. The habit of applying excessive quantities of nutrients in Central Europe and the FSU came to an end in the late 1980s when central planning was replaced in these countries by market economics.

Perhaps the most significant move to control the level of fertilizer consumption has taken place in China, now established as the world's biggest consumer of mineral fertilizers. Having come to recognise the economic cost and the environmental damage caused by excessive fertilizer use, the Ministry of Agriculture announced in 2015 its goal of reducing the amount of fertilizer being used in major crops and of eliminating future growth. According to the data published by China's National Bureau of Statistics, the country's nutrient consumption fell by 7.7mn t (-13%) between 2015 and 2020, and it has continued to fall since then.

There remains considerable potential for fertilizer application to expand, especially in South and West Asia, Latin America and Africa, but some rationalisation of nutrient relationships is likely to take place in countries that have already become big users of nitrogen. Growth prospects in the mature regions of Europe, North America and East Asia are limited. More attention is likely to be paid in the future to improving the efficiency of nutrient use, taking advantage of the techniques and new products that are being becoming available to achieve this objective. ■

Table 1. Peak years for fertilizer nutrient use in selected regions and countries

	N	P_2O_5	K_2O
North America	2019	1978	1980
West Europe	1986	1986	1986
Central Europe	1988	1984	1975
USSR/FSU	1987	1987	1987
China	2013	2014	2019
Japan	1967	1979	1979

Data: Extracted by author from IFADATA

Hammer, Dr Armand (1898-1990)

Born in New York, to a family that had emigrated from Russia, Armand Hammer studied medicine at Columbia College, obtaining a medical degree in 1921. Before starting to practice, Hammer travelled to the Soviet Union and stayed there for the rest of the decade, organizing deals to provide food and medicine to the new state in return for various trade concessions. One of his negotiating partners was Vladimir Lenin, a connection that proved to be invaluable to Hammer in his dealings with the Soviet Union in later years.

In 1957, Dr Hammer acquired control of Occidental Petroleum (Oxy) and proceeded to move into US fertilizer production by building a phosphate complex in northern Florida. After the massive Soviet grain import purchase in 1972, Hammer proposed a deal that was intended to improve fertilizer supply to the country's agriculture. The USD20 bn agreement signed in 1973 called for the Soviet Union to supply 1.5 mn t/y ammonia for Oxy to sell in the US, as well as 1mn t/y each of urea and potash, and for Oxy to deliver 1 mn t/y super phosphoric acid (SPA) from its Florida plant to the Soviet Union where it would be transformed into ammonium polyphosphate liquid fertilizer. Oxy would also assist in the construction of ammonia capacity at Togliatti and the 2,500km pipeline to deliver ammonia to Odessa port, as well as storage and handling capacity at the shipping terminal. The contracts were intended to last for 20 years, commencing in 1978.

The Werra 2060 project

Securing raw materials through innovation

Written by

Katharina Menzler, *Communications Manager,* ***K+S AG, Germany,***
Dr. Heike Thiel, *Product Manager,* ***Korn-KALI,*** and
Kristina Tschachtschal, *Head of Media & Education,* ***K+S Minerals and Agriculture GmbH, Germany***

Responsible mining operations face increasing demands in ecological, economic, and social terms. This applies to the German fertilizer producer K+S as well. Through its Werra 2060 transformation project, K+S AG is shaping the future of potash production.

Werra 2060 ensures a secure supply of raw materials in Europe, innovative environmental protection measures, and advanced fertilizers for agriculture. Through technical innovations, K+S is setting a milestone in the further development of "Made in Germany" potash production. The Werra 2060 project aims to secure production at the Werra sites until 2060.

Production focus: Efficient use of resources

The Werra 2060 transformation project is a central component of K+S's corporate strategy, and it is being driven forward in partnership between the company and employee representatives. Extending the operating life of the Werra integrated plant with its three sites, Wintershall, Hattorf, and Unterbreizbach, until 2060 will ensure long-term job security and value creation in the region. The company's implementation of new mining methods will also play a key role in reducing its environmental impact. Over the past decades, K+S has already significantly reduced the environmental impact of potash production through high investments and efforts, therefore blazing the trail for the responsible use of natural resources. The Werra plant produces approximately 50% of all potassium and magnesium-based fertilizers in the EU, thereby making a significant contribution to ensuring Europe's supply of raw materials. To ensure the continuity of this endeavour, K+S is investing EUR600 mn in its largest German site.

The project is safeguarding the independence of potash in Europe

"With the Werra 2060 project, we are ensuring the future of our integrated plant until at least 2060 and safeguarding the independence of potash supply in Europe on competitive terms," explains Dr. Josef Wiebel, Head of the Agriculture customer segment at K+S.

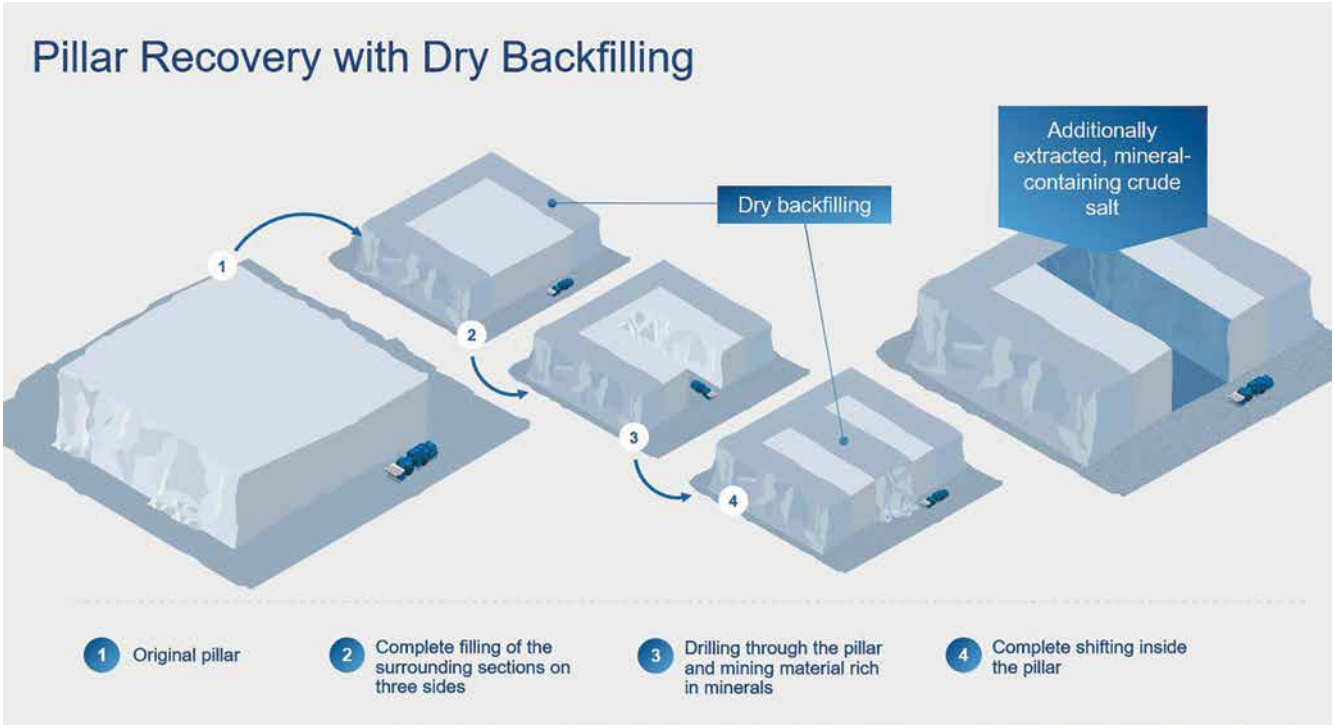
In the face of geopolitical uncertainty, which includes global supply chain disruptions and trade conflicts, ensuring a stable supply of agricultural products is of paramount importance for the European agricultural sector. The production changeover will result in significantly higher volumes of Korn-KALI, a unique multi-nutrient fertilizer. Consequently, this product will be available in other markets worldwide in the future.

Underground innovation: Dry processing and a new mining method

The Werra 2060 project is breaking new ground in production and extraction at the Werra integrated plant. This is made possible by technical innovations from K+S. These innovations will be implemented at several sites in the coming years. By 2027, the Wintershall factory will have converted to a dry processing method. K+S relies on the electrostatic separation process (ESTA) to sort salt minerals without using water. This proven technology has been significantly improved within the company. Therefore, downstream hot leaching and flotation processes, which are energy and production water-intensive, will no longer be required. The Unterbreizbach factory is being developed into a processing plant that will specialize in granulating fine-grain potash from the Wintershall factory. Granulation operations will continue throughout the project, ensuring the Unterbreizbach site's long-term future until 2060. Meanwhile, the hot leaching process will be discontinued. Mining at Unterbreizbach is expected to continue until 2040, when the

(left) Agronomic advisory service; *(right)* The Werra river

Figure 1. Technical animation of the Secondary Mining Process



reserves are depleted. In the future, a new mining method based on experience gained over several years at the neighbouring Unterbreizbach mine will be used at the Hattorf-Wintershall mine: secondary mining with dry backfilling. This method will allow K+S to recover valuable areas while simultaneously transferring solid production residues from ESTA to the mining cavities. This process allows part of the raw salt in the pillars to be mined and processed further.

Raw material production inevitably has an environmental impact. Fortunately, the transformation of potash production in the Werra region will significantly reduce these environmental impacts in the future. The innovative combination of dry processing and secondary mining offers three significant environmental benefits: First, compared with previous wet processing methods, the dry ESTA process requires significantly less energy, and neither the product nor the residues need to be dried. This significantly reduces steam requirements, enabling CO_2 emissions at the Wintershall and Unterbreizbach sites to decrease by around 50%. Due to the advancement

(above) The Wintershall production site; *(right)* Korn-KALI

of ESTA technology, wet processing methods will no longer be necessary for fertilizer production at these sites. Overall, the amount of production water that needs to be disposed of at the Werra plant will be reduced by around 50%. The new secondary degradation process allows solid residues from potash production to be returned to the mine. Rather than being disposed of on the tailings pile, the residues will be used as backfill material in the mine. This will reduce tailings pile operations at the Wintershall site by around 90% starting in 2028.

Future-oriented product portfolio with Korn-KALI

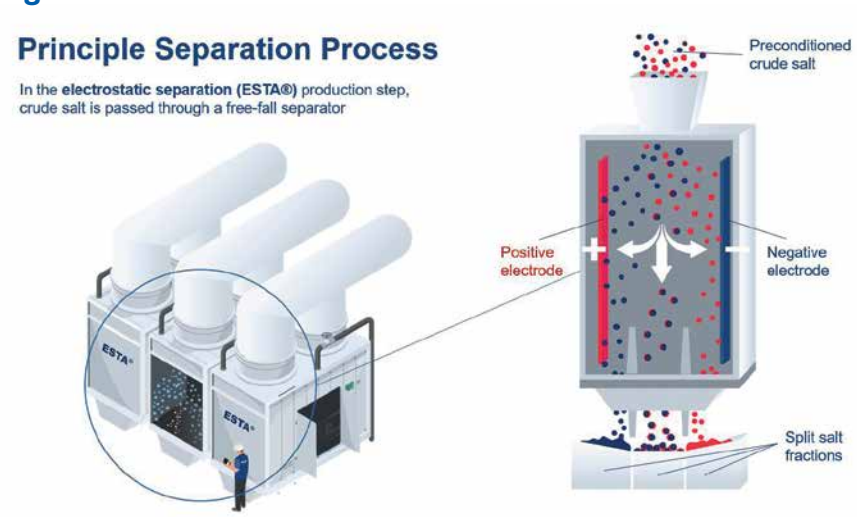
Through the transformation of its potash fertilizer production, K+S is creating a future-oriented product portfolio, living up to its claim of being a pioneer in environmentally friendly, sustainable mining. This applies to Korn-KALI, a multi-nutrient fertilizer that has been used successfully for many years in countries such as Germany, Poland, and France. Korn-KALI is a potassium and magnesium fertilizer combining potassium chloride (38% K_2O) and kieserite (6% MgO). Due to its high sulphate content (12% SO_3), it provides an ample supply of sulphur for most crops. These nutrients are fully water-soluble, making them directly available to plants regardless of soil pH. The product's uniform grain size distribution makes it easy to spread on the field. Korn-KALI is recommended as a potash fertilizer for crops that can tolerate chloride and require other nutrients. Korn-KALI has

KALI Academy and digital tools

K+S understands transformation as both technical and ecological innovation and an educational mission. Through its *#allset* campaign, the company focuses on dialogue, further training, and partnerships with farmers, advisors, and dealers. The KALI Academy provides practical knowledge on plant nutrition, and, as a new addition, interactive online courses. Additionally, the updated KALI TOOLBOX app offers 3D representations of common deficiency symptoms and allows for the precise calculation of fertilizer quantities.

"At a time when agriculture is facing increasingly complex challenges, we are demonstrating how we are working together with the industry as a partner to develop sustainable solutions," explains Kristina Tschachtschal, Head of Media and Education at K+S.

Figure 2. Technical animation of the ESTA Process



been reformulated using innovative processing technology. Starting in the 2025/26 fertilization season, it will contain 38% K_2O, 6% MgO, and 12% SO_3, corresponding to 4.8% sulphur. This composition continues to provide farmers with a high-quality nutrient combination that is directly available to plants, improving nitrogen efficiency and ensuring stable yields, especially under increasingly strict regulatory conditions in the fertilizer sector.

"Plants can only reach their full yield potential if they are supplied with the proper nutrients," emphasizes Prof. Dr. Jóska Gerendás, Head of Agronomy and Advisory at K+S. Studies demonstrate that this combination of three nutrients improves nitrogen uptake and supports protein synthesis, both of which are key success factors in modern agriculture.

Powerhouses for healthy plant growth

The German deposits contain potassium-rich minerals and valuable nutrients, such as magnesium and sulphur, in the form of the unique mineral, kieserite. These deposits enable K+S to produce a wide range of specialty fertilizers. The nutrients in these products are highly concentrated, fully soluble in water, and readily absorbed by plant roots and leaves. Magnesium is an indispensable but often underestimated macronutrient for plant production. Magnesium (Mg) has numerous positive effects on ecological and physiological processes that influence plant growth, yield, and quality. Due to its roles in carbohydrate production and transport as well as root growth—all of which influence nutrient uptake from the soil—Mg is essential and of central importance. Under climate change conditions, Mg is a particularly valuable plant nutrient when plants suffer from drought, strong radiation and heat stress. Sulphur optimizes plant growth and is present in an effective sulphate form (SO_4). It is essential for protein synthesis, improves nitrogen utilization, and helps plants develop defences. Sulphur has been shown to significantly increase the yield of oilseeds and legumes. Onions, leeks, and garlic require sulphur because it is contained in the compounds that give them their characteristic flavour.

Plants absorb sulphur exclusively in the form of sulphate anions from the soil. Typically, fertilization with sulphate ensures an adequate sulphur supply for the entire growing season, covering the demand in spring. This is important because evaporation usually exceeds precipitation in spring and summer, which prevents leaching. Magnesium and sulphur influence the yield and quality of plants. In grain crops, for instance, magnesium is transported from green plant organs, mainly flag leaves and husks, to the grain beginning at the start of the flowering period. There, it is primarily needed for filling the grain with assimilates and is also stored as a reserve for the seedling.

About K+S

Headquartered in Kassel, K+S AG has been one of the leading suppliers of mineral products for over 130 years. With approximately 11,000 employees, production sites on two continents, and a global distribution network, K+S AG plays a key role in ensuring global food security, maintaining industrial supply chains, and ensuring road safety in winter.

Innovations in water soluble fertilizers

Written by

Karan Chechi, *CEO and Founder,* ***TechSci Research, India***

Water-soluble fertilizers (WSFs) are advanced nutrient solutions that dissolve completely in water, ensuring efficient delivery to plants through methods such as fertigation, where fertilizers are applied via an irrigation system, and foliar application, which involves direct spraying onto leaves. The high solubility enhances nutrient availability, significantly improving nutrient use efficiency (NUE) compared with conventional fertilizers.

According to a review article in The Indian Journal of Agricultural Sciences, WSFs are particularly advantageous in horticultural crop production. These fertilizers enable precise application tailored to the specific nutritional needs of crops at various growth stages, thereby enhancing yield and quality. Additionally, research published in Plant Science Today highlights that integrating WSFs with drip irrigation systems have led to substantial conservation of both water and fertilizers, reinforcing sustainable agricultural practices.

According to TechSci Research, the global water-soluble fertilizers market was valued at USD22,151.88 mn and is projected to grow at a compound annual growth rate (CAGR) of 7.34%, reaching an estimated USD47,439.38 mn by 2035.

WSFs are redefining modern agriculture by significantly boosting crop yields. For instance, a study on lowland rice revealed that WSF application resulted in a 113.5% increase in grain yield and a 79.8% increase in straw yield compared to untreated controls. These findings highlight the transformative potential of WSFs in revolutionizing farming practices, improving resource efficiency, and ensuring global food security. As awareness of these benefits continues to grow, the demand for WSFs is poised to surge, driving further innovations and shaping the future of sustainable agriculture.

Transforming Indian agriculture

India's agricultural landscape is undergoing a paradigm shift, fuelled by the rising adoption of WSFs. Introduced in the late 1990s, WSFs have moved beyond niche horticulture to become essential across diverse crop segments. Consumption surged from 10,000 t in the early 2000s to over 300,000 t in 2021.

WSFs, when integrated with micro-irrigation systems such as drip irrigation, enable precise nutrient delivery, significantly enhancing water-use efficiency—particularly vital in drought-prone states such as Maharashtra, Gujarat and Rajasthan. Government initiatives such as the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), or the Prime Minister's irrigation scheme, have further accelerated this trend by subsidizing micro-irrigation and promoting balanced fertilization.

States such as Andhra Pradesh and Karnataka are driving demand with expanding high-value horticulture cultivation. At the same time, WSFs align seamlessly with India's sustainability goals of reducing nutrient runoff, preserving soil health, and supporting the precision agriculture ecosystem with tools such as soil sensors and GPS mapping.

Historically, India has imported nearly 90% of its WSFs, sourcing 350,000 t valued at USD23.4 mn (INR2,000 Crore) in FY 2023–24. However, a breakthrough by a Nagpur-based R&D firm in indigenous WSF technology promises to curb this dependence, making advanced fertilizers more affordable and accessible to Indian farmers while boosting national self-reliance.

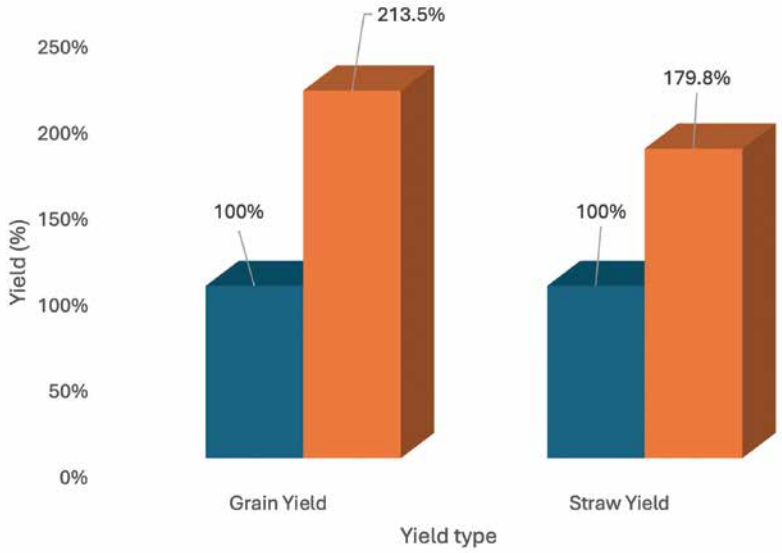
Cutting-edge innovations

As food demand grows, nanotechnology offers a game-changing alternative to inefficient conventional fertilizers. Water-soluble nanofertilizers enable precise, controlled nutrient delivery—boosting uptake, reducing leaching and supporting sustainable, high-efficiency farming without harming the environment. Depending on their composition and function, nanofertilizers can be classified into several categories:

- ***Controlled-Release Nanofertilizers:*** Designed with granular structures, these fertilizers release nutrients gradually over weeks or months, improving nutrient retention and reducing application frequency.

- ***Targeted-Delivery Nanofertilizers:*** These fertilizers ensure nutrients are delivered directly to plant roots or specific tissues, enhancing absorption and minimizing wastage.
- ***Plant Growth-Stimulating Nanofertilizers:*** Engineered to stimulate physiological and metabolic processes in plants, these fertilizers improve resilience and productivity.
- ***Water and Nutrient Loss-Controlling Nanofertilizers:*** These formulations prevent excessive nutrient loss by reducing volatilization and leaching, preserving soil health.
- ***Hybrid and Nutrient-Loaded Nanofertilizers:*** These fertilizers incorporate inorganic and organic components for enhanced effectiveness.

Figure 1. Impact of Water-Soluble Fertilizers on rice yield



Nanotechnology enables the use of diverse materials to improve fertilizer efficacy. Nanofertilizers come in various advanced forms, each tailored to optimize nutrient delivery and boost sustainability. Carbon-based nanofertilizers, like carbon nanotubes and graphene, enhance nutrient uptake and improve soil structure. Zeolite-based types act as nutrient reservoirs, releasing potassium and nitrogen gradually while improving soil health. Polyurethane-based fertilizers encapsulate macronutrients in a polymer matrix, enabling controlled release and minimizing leaching. Nanocapsule fertilizers, made from biopolymers or silica, ensure slow, consistent nutrient delivery and reduce volatilization. Nanogels, with their moisture-retaining, sponge-like structure, are ideal for arid regions, slowly releasing nutrients and curbing erosion. Nanoemulsion-based fertilizers, composed of ultra-fine droplets, drastically increase nutrient bioavailability and plant absorption. Collectively, these innovations represent a revolutionary shift in fertilizer technology - offering precision, efficiency and eco-friendly solutions for modern agriculture.

Incorporating advanced nanomaterials allows for fertilizers tailored to specific soils and crops, driving precision agriculture. Nanofertilizers boost nutrient efficiency, reduce environmental harm, enhance crop yield, and protect soil health through controlled-release mechanisms—making them a smart, sustainable upgrade to conventional fertilization practices.

Nanofertilizer research

Several studies have highlighted the effectiveness of nanofertilizers in improving agricultural outcomes:

- ***Nano-Hydroxyapatite with Urea:*** Research shows that integrating nano-hydroxyapatite with urea leads to slow and sustained nutrient release, optimizing nitrogen and phosphorus uptake.
- ***Zeolite-based nanofertilizers in wheat cultivation:*** A study demonstrated that wheat plants treated with zeolite-based nanofertilizers exhibited improved growth and higher nutrient absorption rates.
- ***Graphene-based fertilizers in rice production:*** Experimental trials suggest that graphene derivatives enhance nutrient retention and contribute to increased rice yields.

Despite their potential, nanofertilizers face challenges such as high production costs, regulatory concerns, and scalability issues. Overcoming these hurdles through continued research and collaboration will be key to unlocking their role in sustainable agriculture, improving efficiency, reducing environmental impact, and ensuring long-term viability.

As the world shifts toward sustainable farming practices, biopolymer-coated WSFs are emerging as a key solution. These fertilizers offer a controlled-release mechanism that aligns nutrient delivery with crop needs, minimizing environmental impact while improving agricultural productivity.

The problem with conventional fertilizers

Traditional fertilizers, though effective in boosting yields, suffer from inefficiencies such as nutrient leaching, volatilization, and surface runoff, which lead to environmental degradation and reduced productivity. In response to these challenges, the European Union and Japan have set ambitious goals to reduce fertilizer usage by 20% by 2030, highlighting the need for more sustainable fertilizer technologies.

Biopolymer coatings enhancing nutrient release - Biopolymer-coated WSFs are designed to deliver nutrients gradually, matching the crop's uptake patterns. These fertilizers are coated with biodegradable, non-toxic biopolymers such as chitosan, cellulose nanocrystals, and alginate, which function as a matrix that controls nutrient release. This design reduces application frequency, improves nutrient efficiency, and enhances soil health by promoting microbial biodiversity and improving water retention.

Research has shown that chitosan-based coatings, for example, can release nutrients for up to 30 days, while polyvinyl alcohol (PVA) composites reinforced with cellulose nanocrystals have proven to be both effective and biodegradable.

The role of Polymer Coating Technology (PCT) - Polymer-coated fertilizers, especially those using biopolymers, reduce nutrient losses and enhance bioavailability. The release rate and pattern are controlled by the coating's properties, which interact with environmental factors like soil texture, moisture, and temperature. This ensures continuous nutrient delivery, reducing operational costs and supporting consistent crop growth.

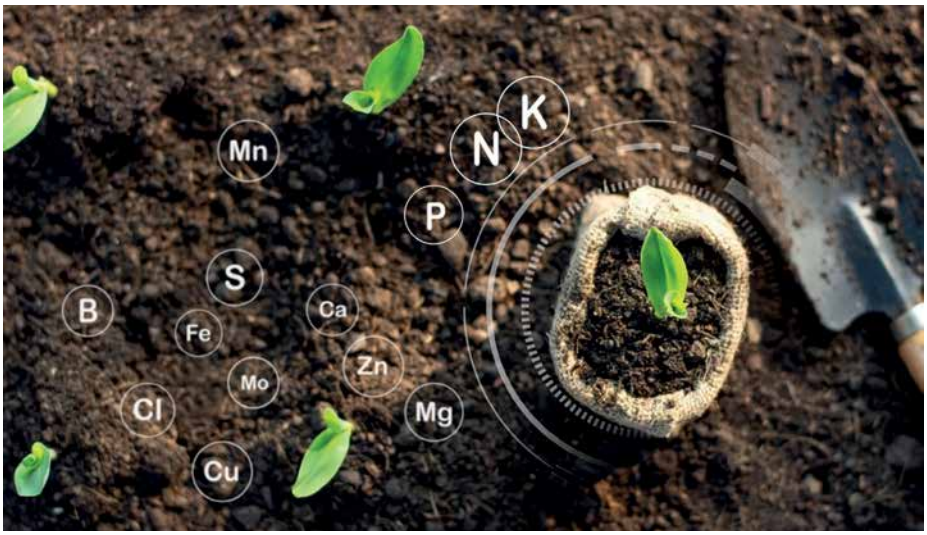
Biopolymer-coated WSFs are transforming fertilizer management, bridging the gap between productivity and environmental responsibility. With their reduced greenhouse gas emissions, prevention of eutrophication, and improved soil health, these fertilizers are pivotal in the transition to climate-resilient agriculture. As global policies increasingly support sustainable practices, biopolymer-coated slow-release fertilizers are poised to revolutionize the future of farming.

Fertilizing the future

Some of the recent ground-breaking advances in WSFs include:

India's breakthrough in indigenous Water-Soluble Fertilizer production (March 2025) - A Nagpur-based R&D company has made a landmark achievement in developing indigenous technology for manufacturing WSFs, reducing India's dependence on imports. This breakthrough is crucial for high-value crops like fruits and vegetables, enhancing nutrient efficiency and water conservation. Until now, India lacked domestic production for key WSFs such as calcium nitrate, mono ammonium phosphate (MAP), MKP, and NPKs, leaving farmers vulnerable to price fluctuations. The new technology uses locally available minerals and has received backing from the Department of Science & Technology and the Ministry of Mines under the 'S&T-PRISM' scheme.

This innovation is poised to revolutionize the fertilizer ecosystem in India, helping control costs, reduce government subsidies, and boost farm resilience. For example, in banana farming, WSFs have led to a 35% reduction in water usage, with profits rising by INR98,000 per hectare. Tomato farmers have also seen a 32% drop in water usage and profit gains of INR77,000 per hectare. The move toward domestic WSF production aligns with India's push for self-sufficiency, saving foreign exchange while promoting sustainable farming.



Incorporating advanced nanomaterials allows for fertilizers tailored to specific soils and crops

Haifa NWE unveils Haifa soluble DUO at HortiContact, The Netherlands (February 2025) - Haifa North West Europe (NWE) unveiled Haifa Soluble DUO at the HortiContact event in Gorinchem, The Netherlands. This innovative water-soluble fertilizer optimizes calcium intake without excess nitrogen, chlorides, or sulphates. It offers two formulations: 10-0-35+10 CaO and 3-0-9+34 CaO, each combining nitrate nitrogen, potassium, and calcium for better nutrient uptake. Designed for fertigation, Haifa Soluble DUO promises sustainable nutrient management, improving plant health, resilience, and productivity. This advancement aligns with the growing global adoption of fertigation techniques and the demand for sustainable farming solutions.

Haifa group strengthens its presence in India (January 2025) - Haifa Group has launched Haifa India Fertilizers and Technologies Private Limited to tap into India's growing demand for precision fertilizers. The new subsidiary will offer advanced WSFs and digital tools to optimize nutrient management for Indian farmers. Haifa has been a trusted name in India's WSF market since 1996, particularly for high-value crops such as grapes and pomegranates. This move strengthens Haifa's commitment to India's agricultural growth and sustainability, aiming to improve yields, soil health, and fertilizer efficiency. The company's global expertise will empower Indian farmers, driving economic growth and eco-friendly practices. ■

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EUROPE

EU plans measures to support exports in CBAM sectors

The European Commission has said that it intends to present plans by the end of the year to reduce the risk of carbon leakage for goods exported from the EU in sectors covered by the bloc's carbon border adjustment mechanism (CBAM).

The proposal will be designed to provide equal treatment for all goods, "whether produced and sold in the EU, imported into the EU or exported", the commission said. The measure would be set up for a "defined period" and then reviewed in light of the planned 2026 revision of the EU emissions trading system (ETS). No further details were provided.

Industries have long raised concerns about risks to competitiveness for products in CBAM sectors exported from the EU, given that they must still pay carbon costs while the mechanism only applies an effective carbon price on goods imported into the bloc.

German industry federation BDI warned earlier this year that CBAM provides "no answer" to the problem of exports, while European cement and steel associations have called for export provisions under the mechanism.

But there are concerns that introducing export protection measures could put CBAM at odds with World Trade Organisation (WTO) rules. Russia has already raised a CBAM dispute at the WTO, contending that the calculation of existing free ETS allocations for industry — which includes the value of exports — counts as an "alleged export subsidy" in contravention of the General Agreement on Tariffs and Trade 1994, the Agreement on Import Licensing Procedures, and the Agreement on Subsidies and Countervailing Measures.

While deeming the measure an "important step", non-governmental organisation Bellona Europa criticised the lack of information in the commission's initial proposal, which it said "was not presented with sufficient detail and does not provide a clear pathway for a long-term solution to the risk of carbon leakage from exports".

"If rebates are the chosen path, they must be conditional on effective and serious decarbonisation commitments," Bellona said.

The commission launched a separate consultation on whether to extend CBAM's scope to some downstream products to limit carbon leakage from the measure. It is seeking views on whether CBAM causes carbon leakage downstream, and whether extending its scope could reduce this risk or incentivise the take-up of low-carbon EU goods.

It also asks respondents whether such an extension would increase costs for EU manufacturers or consumers, the extent of the administrative burden it would entail for EU importers, or non-EU producers and exporters, as well as the potential costs of related reporting requirements.

The consultation also seeks views on whether CBAM in its current form poses circumvention risks, including via widely varying embedded emissions under the same goods categories, or resource shuffling, where companies choose to export their cleanest products to the EU without reducing their overall emissions. The consultation closes on 26 August.

Atome gets USD50mn funding for green fertilizer project

London-listed developer Atome has secured USD50mn of concessional finance from the Green Climate Fund (GCF) to advance development of its Villeta green fertilizer project in Paraguay.

The funds will be distributed through International Finance Corporation (IFC), the World Bank's private sector investment arm, and come in addition to a package of senior debt financing that will be provided by a consortium of development finance entities, Atome said.

Concessional finance is a below-market rate type provided by multilateral institutions and development banks to accelerate projects in developing countries. It can be delivered through mix of instruments such as loans, grant and equity investment, according to the World Bank.

The funds will "meaningfully lower the overall cost of capital" for the Villeta project and help advance it "confidently towards a Final Investment Decision in the coming months," said Atome's chief executive Oliver Mussat.

The firm has delayed project timeline a number of times, having cited delays during the engineering phase. In February, Atome signed a preliminary agreement for a USD115mn equity investment in Villeta from French clean hydrogen infrastructure fund Hy24. The firm will deploy a 120MW electrolyser at the plant to produce renewable ammonia, aiming to reach a final output of 260,000 t/yr of green fertilisers to be delivered to Norwegian firm Yara. Production is expected to start in 2027.

EU fertilizer tariffs come into force for Russia, Belarus

The EU will enforce a swathe of new tariffs on Russian and Belarusian fertilisers, as well as on a range of agricultural products.

The tariffs now apply an additional EUR40/t on imports to nitrogen-based products under tariff code 3102 from Russia and Belarus. This includes urea, amsul, AN, CAN and UAN. They also add EUR45/t to the imports of DAP, MAP, NPKs, NP and some other grades.

The rates will increase from 2026 until 2028 to reach EUR315/t and EUR430/t for the two product groups, respectively. The new tariffs add to the EU's existing import tariffs, which are set at 6.5% for most fertilizer grades from Russia and Belarus.

The legal text also foresees the immediate application of the highest rates, if cumulative imports exceed 2.7mn t in 2025-26, 1.8mn t in 2026-27 or 0.9mn t in 2027-28. The new tariffs will also apply an additional 50% customs duty on over 145 CN codes, including live trees and other plants, dairy, coffee, meat, animal fats and plant oils, including palm and palm kernel oil.

The European Parliament adopted the additional tariffs in May. Parliament and EU states confirmed the commission's legal proposal, leaving unchanged the rates and phase-in period of the tariffs proposed by the commission at the end of January.

The EU imported a total of 4.7mn t of fertilizers from Russia and Belarus under the affected tariff codes in 2024, according to customs data. This made up about a third of total EU imports from third countries for those products.

GLOBAL

Global fertilizer affordability near three-year low

Global affordability for fertilizers has dropped to its lowest in nearly three years on a sustained increase in fertilizer prices — as strong global demand competes for limited supply — while crop values have dipped to the lowest since September 2020.

Nutrient affordability fell to 0.75 points in June, the lowest since September 2022, Argus data show. An affordability index — comprising a fertilizer and crop index — above one indicates that fertilizers are more affordable compared with the base year set in 2004. An index below one indicates lower nutrient affordability.

The fertilizer index fell in June owing to higher fertilizer prices for phosphates while an increase in urea prices in June added further support to the index.

The Israel-Iran conflict firmed market sentiment across all nutrients in June, which has also added some volatility to freight rates.

Phosphate prices saw the largest gains, with June prices at the highest since September 2022 on persistent demand from India in the absence of inflows of Chinese DAP supply.

DAP prices have kept moving up as tight supply has kept driving the market at both sides of the Suez Canal. Chinese suppliers have been sitting comfortably with limited supply availability, which enabled them to increase offers in the face of African and southeast Asian demand. In the west, buyers have been struggling to secure limited MAP supply, also supporting prices.

On potash, MOP prices have reached the highest in two years driven by geopolitical uncertainty and robust demand in all major markets, particularly in southeast Asia, where affordability levels have been supported by excellent palm oil prices.

Meanwhile, on the potash supply side, availability was expected to be reduced from three major producers — Uralkali, Belaruskali and Eurochem — as they underwent maintenance works. Together, these works were expected to reduce MOP output by 1.3mn t across the first half of the year, further underpinning prices.

Urea prices rose to the highest in four months as the Middle East conflict pushed prices up on output curtailment while strong fundamentals — driven by Indian demand — continued to support prices.

On the other hand, the crop index — which includes global prices for corn, wheat, rice and soybeans adjusted by output volumes — have fallen to a near five-year low.

NORTH AMERICA

Northern Nutrients announces new ownership structure and plant expansion

As part of this new strategic partnership, Shell Trading Canada has invested in expanding Northern Nutrients' current facility, resulting in the formation of a new joint venture. The expansion will result in a tripling of current capacity annually of sulphur focused fertilizers. Founded in 2016, Northern Nutrients has been at the forefront of bringing innovative solutions to the agriculture market for close to a decade. The company's state-of-the-art facility near Saskatoon produces enhanced nitrogen sulphur fertilizers using the Shell Thiogro Technology. Their flagship product, Arctic S, boasts an impressive composition of 11% nitrogen and 75% micronized elemental sulphur.

The collaboration between Northern Nutrients and Shell underscores their shared dedication to providing retailers & farmers with high-quality, and efficient fertilizer solutions. The expansion of the Saskatoon facility is expected to boost production capacity and meet the growing demand for innovative fertilizer products. The project is expected to create close to 60 full time construction jobs, as well as numerous full time positions in ongoing operations.

“Since local production of Arctic S began in 2022, the market response across North America has exceeded our expectations making now the perfect time to expand our production capacity, and Shell the perfect partner to do it with.” says Ross Guenther, CEO & co-owner of Northern Nutrients. Northern Nutrients Co-Owner Rob Owens adds “Bringing Shell Trading Canada on as a strategic joint venture partner makes sense on multiple levels to continue the momentum Northern Nutrients has built over the past few years.”

AUSTRALASIA

Fortescue sells Norwegian green ammonia site to Fuella

Australian mining and energy company Fortescue has sold rights for a 300MW renewable ammonia project to Norwegian start-up Fuella, which will merge it with its own nearby 260MW project into a 560MW proposal, Fuella said.

Fuella will take full responsibility for developing the combined project at Sundsmarka in Hemnes, Norway, it said. The firm has not outlined a timeline, which could mean it is still years away.

Merging the plans reduces their impact on the environment, lowers production costs, and lessens the need to develop more infrastructure, Fuella said.

The 2020-founded firm was among seven companies that won subsidy support in the pilot round of the EU's Hydrogen Bank for another of its Norwegian sites, a 130MW and 100,000 t/yr renewable ammonia project near Bergen, which has investment from German utility EnBW.

Fuella previously said its Korgen project would use a 260MW electrolyser to make 200,000 t/yr ammonia, while Fortescue's Hemnes proposal probably entails around 225,000 t/yr capacity, given it had secured a conditional 300MW power supply deal akin to its other Norwegian project, which has announced 225,000 t/yr capacity.

This suggest the combined capacity might be roughly 425,000 t/yr, if the plans are neatly combined, but the firms have not specified capacities yet.

Fortescue had said it might start building in 2026 and start making renewable ammonia by 2028, but the company has narrowed its focus to just a handful of projects.

Its separate 300MW power input and 280MW electrolyser Holmanesnet project in Norway, due to make 225,000 t/yr, has won EUR204mn (USD234mn) from the EU's Innovation fund. It is among Fortescue's remaining handful of favoured hydrogen. ■

MARKET ANALYSIS ›

Commodity updates • Shipping news • Price watch

Soft commodities: Fundamentals to continue weighing on wheat market

Information from ***Argus Agritel Outlook***

Wheat summary

A bearish outlook for grain market fundamentals continues to put pressure on wheat prices for current and future marketing years. Slow spot and forward demand is leading to rising stocks among major exporting regions, and the absence of significant weather risk is preventing any rally in prices.

The US Department of Agriculture (USDA) acknowledged the weakness of demand in its May World Agricultural Supply and Demand Estimates (Wasde) report, and the agency may further cut its export estimates, particularly for Russia and Australia. Argus has reduced its export estimates for Argentina, which could push carryover stocks for 2024–25 to nearly 66mn t for the top eight exporting regions combined. Excess stocks in the southern hemisphere are set to weigh on prices and limit any weather-driven price rallies, especially as the northern hemisphere harvest approaches. The weather has been favourable, and crop conditions are generally positive globally.

In terms of fundamentals, Argus forecasts renewed market pressure in future years. Production is set to increase in the main exporting regions by 17.6mn t compared with last year, which will outpace a 10mn t rise in global import demand. Argus maintains its production estimates for the northern hemisphere with little change from the previous month. But following this month's Argus crop tour in Romania, we see the country's wheat production potential at 12.2mn t, up from our previous forecast of 11.5mn t. EU+UK soft wheat production is expected to approach 140mn t, compared with 123mn t in 2024. These production increases are weighing on the European market, adding to pressure from other weaker fundamentals as well as the euro/dollar exchange rate.

On the demand side, French wheat faces challenges in securing export markets. The absence of Algeria as a destination for the origin owing to tensions between the countries and a lack of Chinese wheat demand will keep prices under pressure as French wheat producers strive to stay competitive. France will need to export 8mn t to non-EU countries in 2025–26, based on Argus forecasts. Morocco could remain a key destination and help absorb 2.5mn t of French wheat. But record availability in Argentina, forecast at 25mn t for 2025–26, could lead to heightened competition in 6–8 months. Argus expects carryover stocks in France and the EU+UK as a whole to rebound significantly, reaching 3.7mn t and 18.9mn t, respectively. Across the eight major exporting regions, end-of-year wheat stocks could hit their highest since 2017–18 at 71mn t for 2025–26, up from 66mn t forecast last month.

In the absence of unfavourable weather or a sudden surge in demand, the wheat market is expected to remain under pressure at current prices. But uncertainty over production in Iran, the broader Middle East and China will need to be monitored in the coming weeks, as it could trigger an unexpected rebound in import demand.

Feed grains summary

The global corn market is still well supplied in the short term while demand remains lacklustre, as China is expected to import only 4mn t in 2024–25. US corn prices often compete with South American origins into key delivery markets. US weekly export sales exceeded 1mn t recently, in contrast to a typically slower fourth quarter of the marketing year. We have revised our 2024–25 US export forecast to 67.3mn t, compared with the USDA's projection in April of 64.77mn t, tightening US corn ending stocks and driving the stocks/use ratio to its lowest since 2020–21.

In Brazil, we have revised up our 2024–25 production forecast by 2mn t to 134mn t, compared with the USDA's 131mn t. The production outlook has been boosted by ideal Safrinha

Figure 1. Wheat price (USD/t)

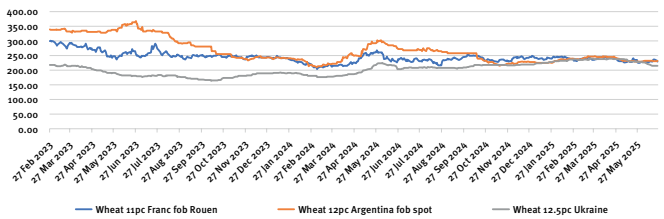


Figure 2. Corn price (USD/t)

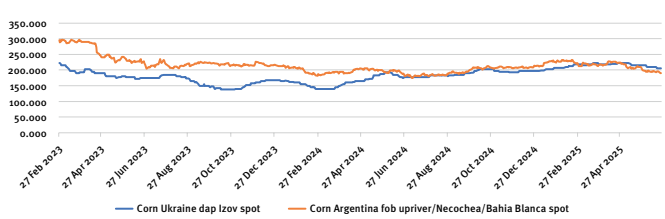
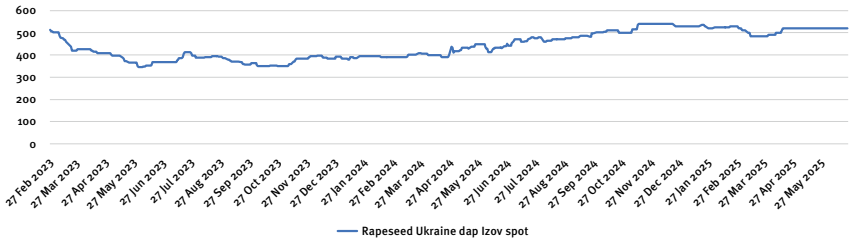


Figure 3. Rapeseed price (USD/t)



— or second corn crop — growing conditions across key producing states, particularly Mato Grosso, despite irregular rainfall and above-average temperatures in March. Brazil's ability to export 42mn t should help offset tight Ukrainian corn availability and supply the EU in the coming months.

Looking out to 2025–26, Mexican import requirements are forecast to rise by 4mn t to 29mn t because of a below-average domestic crop, contributing to global import demand rising by 8mn t for the new crop season. This demand recovery occurs alongside expanding global exports, with Brazil, Argentina and Ukraine collectively forecast to increase export availability by 5mn t.

Corn areas in south-eastern EU countries are expected to fall to a multi-year low for 2025, with 3.3mn hectares (33,000km^2) to be planted and harvested in Bulgaria, Romania and Hungary combined. Unfavourable weather, quality issues and weak margins on the crop in recent years have pushed farmers away from corn. In Romania, the area reduction is estimated at 300,000ha from last year. Even then, we still expect the EU's production to recover slightly to just below 60mn t, thanks to optimal crop conditions in most of the bloc. EU imports are expected to be stable in 2025–26 at just below 20mn t, with much of this to be supplied by Ukraine, where production is set to recover from a multi-year low.

China's customs authorities approved imports of Brazilian dried distillers grains with solubles (DDGS) at the end of last month. DDGS could serve as a soybean meal replacement in animal feed formulations, potentially helping reduce China's soybean import demand. Should these exports materialise, Brazilian ethanol producers could see higher co-product margins, in the context of rising corn-ethanol output.

In other feed markets, persistent dry weather conditions affecting France, the UK, Denmark and parts of Germany are raising risks for the barley crop. Poland recorded some rainfall that will help the crop, but this may still be insufficient for malting barley. Overall European barley areas are expected to fall in 2025–26, but spring barley supply remains sufficient in the first half of 2025. Near-term weather conditions should be monitored to assess the extent of risk for the spring crop.

Oilseeds summary

On the soybeans market, the outlook for the rest of the 2024–25 marketing year is still evolving while the southern hemisphere harvests are under way. The harvest has drawn to a close in Brazil, but rainfall in Argentina has impeded progress in recent weeks, posing a quality rather than quantity risk for the crop.

Looking ahead to 2025–26, the return of dry weather in key US producing areas has enabled farmers to ramp up planting progress. But production is still set to be lower on the year owing to unfavourable farmer margins. Much of the soybeans demand outlook will depend on upcoming mandates, after uncertainty fuelled recent drops in soybean oil prices. Greater clarity on the implementation of the "45z" credit will also be key for crop-based feedstocks. On the export side, much will hinge on China's purchasing decisions in the context of the trade war with the US. Alternative feed compounds, such as DDGS from Brazil, may help feed makers diversify feedstocks going forward to some extent, but soybean meal is set to remain the dominant feed product in China. Ample meal availability in Europe, and globally, is helping keep a lid on oilseed prices in the EU.

Meanwhile, the soybean crop is becoming increasingly attractive for Ukrainian farmers, as planting is progressing faster than last year. We forecast that 2.7mn ha will be planted in 2025, slightly higher than last year's record planted area, and this figure has the potential to be revised up further to 2.8mn–3mn ha going forward.

And in South America, we still expect record production from Brazil of 173mn t, while Argentina's output is forecast to reach 49.5mn t.

On the rapeseed/canola complex, we have again reduced our 2024–25 crush estimate for the EU, to 24.2mn t, compared with the USDA's 25.05mn t forecast in May. Looking out to 2025–26, combined supply from the top exporting countries is set to be tighter. Production in Canada will drop in 2025–26, leaving an export availability of 7.5mn t. Meanwhile, we maintain our Australia rapeseed production forecast at 6.1mn t for 2025–26, despite Australia's Abares lowering its expectations to 5.7mn t. On our figures, some 4.9mn t would be available for export from Australia. This is while frost events earlier this spring in Ukraine constrained its production outlook, and the country may only be able to ship 2.8mn t.

But prospects for increased supply of sunflower seed in the Black Sea and Europe will help offset the tighter rapeseed outlook. Ukraine is forecast to produce 14.4mn t of sunflower seed, with most of it expected to be crushed domestically and exported as oil. Russia is also on track for higher output, of 17.7mn t. And the EU's production is set to recover from last year's multi-year low to reach 10.6mn t. With the three regions combined, the total sunflower crush could exceed 40mn t. Sunflower oil in northwest Europe has opened a discount to rapeseed oil prices, and the trend may well continue given the contrasting fundamentals for the two oilseeds. ■

Hard commodities: Dialling back on the hit from tariffs

Written by

David Fyfe, *Chief Economist,* ***Argus Media, UK***

Commodity market prospects remain weaker than envisaged in the first quarter before President Trump's widespread levying of trade tariffs. Questions remain over the duration of an ongoing divestment of US financial assets, but expectations for late-2025 industrial metals, olefins and natural gas prices all look weaker than they did earlier in 2025.

In contrast, the crude price outlook has remained remarkably steady at between USD64-65/barrel (WTI) for 4Q25, albeit assuming OPEC+ producers continue to moderate supplies to prevent surpluses from emerging. Israeli attacks on Iranian nuclear infrastructure at mid-June have propelled prices significantly higher, but in the absence of sustained damage to regional hydrocarbon infrastructure or blockage of the Straits of Hormuz, crude may revert to a lower profile in due course.

Turmoil across commodity and financial asset markets in April followed the announcement of aggressive US import tariffs. Risky and safe assets in early-April sold off simultaneously as traders monetized the latter in an attempt to service increased margin calls due to earlier losses in the former. However, at the time of writing in mid-June a degree of market stability has been regained, even if major policy uncertainty remains.

Gold has regained its lustre since the Trump Administration backed off from punitive reciprocal tariffs suggested for all its trading partners, but is also reflecting its safe-haven status amid persistent geopolitical and economic uncertainties. The ECB reported in early-June that gold has overtaken the Euro as the second most important reserve asset for central banks worldwide. Equities have meanwhile recovered most of the ground lost between February-April (when the global equity index fell by some 17%).

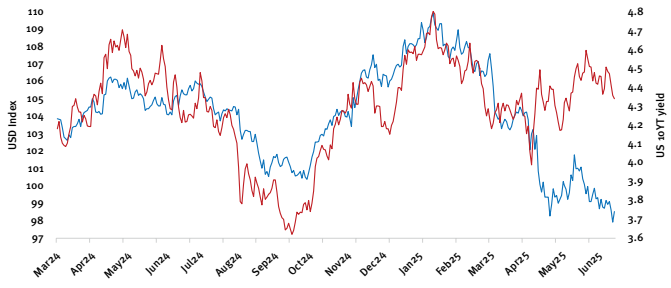
Weak domestic demand

A tentative truce between Washington and Beijing now looks like leaving tariffs of 55% on US imports from China and 10% on merchandise goods flows in the opposite direction with compromises also reached on rare earths supplies out of China and computer chip exports from the US. Moreover, the US has also doubled its across-the-board import tariffs on steel and aluminium to 50%, something that will hit exporters in Canada, Mexico, Brazil and South Korea very hard. The effective tariff rate now deployed by the US spread across all imports is now estimated at 17% - well down from the threatened 27% rate in early-April, but nonetheless significantly higher than the 2% level at the start of 2025. US core inflation ticked higher to 2.8% in May and there are expectations of further rises in US inflation in the months ahead.

The now-lower US tariffs on China have seen analysts nudge their anticipated Chinese GDP growth estimates higher into a 4.0-4.5% range for 2025 and 2026, although deflationary pressures persist. With domestic consumer demand remaining weak amid an ongoing real estate slump and manufacturing activity still anaemic, commodity import demand into China is suffering. Major commodity imports into China are down by -5% year-on-year for January-May, with natural gas and coal imports looking especially weak. Copper and crude oil imports however are showing year-on-year growth so far in 2025.

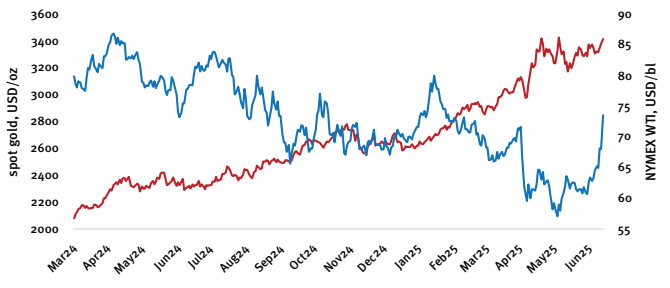
More broadly, May and June saw the progress of the Trump Administration's budget bill through Congress, which the Congressional Budget Office estimates could add a net USD2.4 trillion to an existing USD36.2 trillion

Figure 1. USD index and yields diverge



Source: Refinitiv; Argus Media

Figure 2. Crude and gold both strengthen



Source: Refinitiv; Argus Media

US budget deficit over the next decade. Ratings agency Moody's responded with a downgrade of US debt. A loss of confidence in US markets by investors has seen a highly unusual concurrent sell-off in both the US dollar and US Treasuries. The combination of rising Treasury Yields and a weakening dollar goes against the traditional relationship and implies that investors may have begun to doubt the dollar's status as the global reserve currency and are seeking a higher risk premium to hold on to US assets.

However, consultants Oxford Economics for now dismiss the likelihood of a sustained threat to the dollar's reserve currency status, suggesting instead that a concurrent sell-off of the dollar and fixed-income assets is driven by three cyclical factors specifically related to the US tariff shock:

- A demand hit in the US due to inflationary pressures, contrasting with deflationary pressures elsewhere
- An over-exposure of international investors to US assets prior to President Trump's "Liberation Day" tariffs, with the recent sell-off representing a rebalancing
- Ongoing and acute policy uncertainty which is contributing to the selling of the US dollar

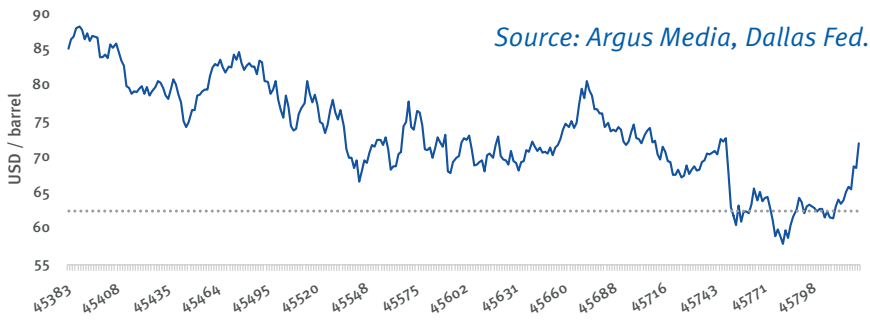
US inflationary pressures

Further selling of US assets may persist as long as a high degree of policy uncertainty remains, which implies further pressure on the US dollar to enable the market to clear. However, offsetting that may be a widening of interest rate differentials between the US (where the Federal Reserve is likely to remain cautious about further monetary loosening) and other markets which, all else equal, would tend to be supportive of the dollar. On a net basis therefore the dollar could stabilise near current levels.

Macro-economic outlook downgrades and elevated levels of policy and geopolitical risk are a combination that would normally sustain divergence between gold prices on the one hand and commodity prices on the other. Comparing both Argus Consulting and other analysts' projections for olefins and industrial metals price forecasts from the first quarter with those generated in May/June it is indeed true that expectations are now lower. GDP downgrades, US inflationary pressures and a likelihood of reduced activity levels in China all point to weaker demand than was envisaged in the first quarter of this year for 2025 and 2026. Weaker Asian demand prospects and reduced EU gas storage requirements have also weighed on European gas price expectations. Argus Consulting's 4Q 2025 projection for TTF gas now stands near EUR35/MWh, compared to EUR40/MWh back in March, notwithstanding a spike in prices at mid-June caused by Iranian airstrikes on Iranian nuclear facilities.

Until recently, crude futures were also diverging from steadily appreciating gold prices, but WTI prices have rallied from a low point near USD57/barrel in early-May to near USD74/barrel on 13 June. Crude prices jumped following Israeli airstrikes on Iran and fears that Iranian retaliation could involve regional hydrocarbon producing assets or a blockage of the Straits of Hormuz. Despite a sustained closure of the Straits remaining unlikely, the fact that 15% to 20% of global oil and LNG supplies move to market via this seaway is likely to keep prices high and volatile until the situation is resolved. Before this geopolitically-inspired price spike, against a backdrop of the Trump Administration's tariff announcements, OPEC+ Ministers announced accelerated production increases scheduled for May, June and July, albeit these were to be diluted by separate compensatory output cuts from those guilty of exceeding historic production targets such as Iraq, Kazakhstan and Russia.

Figure 3. WTI Midand back above new well breakeven



Sustained WTI pricing

The market originally interpreted OPEC+ supply increases bearishly, propelling physical prices below break-even levels for the drilling of new wells in the US Permian and other shale provinces. This led a number of US shale producers to suggest that sustained WTI prices at or below USD60/barrel would see lower drilling and ultimately declining US supply. Indeed the US EIA's latest Short-Term Energy Outlook predicts US oil production falling from today's 13.5 mb/d to 13.3 mb/d by end-2026.

Perceptions of weaker non-OPEC supply growth have been accompanied by tanker tracking data that has yet to show appreciable net gains in Middle East crude supply, suggesting that either production increases have been less than announced or that higher summer domestic crude burn has retained incremental barrels within the domestic market. Add in the risk of tighter US sanctions on Venezuelan exports, 13th June Israeli attacks on Iranian nuclear infrastructure and EU and US Congressional proposals aimed at reducing Russian oil exports, and it is clear that significant question marks hang over crude supply in 2025. Taken together with an assumption that OPEC+ policy continues to prioritise the avoidance of surplus rather than market share, this implies ongoing support for crude prices, with Argus Consulting's early-June projection for 4Q25 WTI Midland physical prices largely unchanged from early-year expectations at close to USD65/barrel. Middle East tensions may sustain prices higher than this in the interim, but crude could revert to a lower profile assuming the Straits of Hormuz transit route remains open. ■

Argus Insight:

China's emphasis on food security is driving potash demand growth

In an era of increasing instability in the global supply chain driven by geopolitical shifts, the critical importance of food self-sufficiency has become more evident than ever. For China, this necessity has solidified food security as a national strategy. China's vast population and rising living standards mean its food supply remains finely balanced, despite consistently high grain output. This has led the nation to set ambitious targets for grain production and yield per hectare, aiming to ensure stable supply for food. Achieving these goals requires more investment in agricultural production.

Besides optimising crop varieties, applying the latest farming techniques and adopting more mechanisation, efficient fertilizer application is one of the essential means. This paper explores the factors driving China's increasing potash demand, examines the challenges posed by its limited domestic potash resources, details China's import channels to secure supply, and analyses the recent market dynamics that shaped potash prices in the first half of 2025. The paper will conclude with a short-term outlook on Chinese potash market.

China's push for greater self-sufficiency in grains

Although China's grain output has remained stable at high levels for many years, reaching a new milestone of 706 mn t for the first time in 2024, its grain supply remains in a tight balance. This reflects its vast population and growing food demand driven by rising standards of living. To further strengthen grain production capacity, China's 2025 Government Work Report clearly sets a new goal to stabilise annual grain output at around 700 mn t. More importantly, while emphasising high overall grain output, China's national policy also aims to increase grain yield per hectare based on strict arable land protection, targeting a yield level of approximately 6,300 kg/hectare by 2030. According to the National Bureau of Statistics, China's grain yield per hectare was 5,920 kg in 2024. Applying fertilizers to enhance soil fertility will help achieve this goal.

The nation has set ambitious targets for grain production

But it is crucial to note that this does not mean indiscriminately increasing fertilizer application without considering its adverse effects on soil. China's 14th Five-Year Plan emphasises reducing fertilizer use while ensuring grain production, and shifting towards smarter, more sustainable application methods. The Chinese government's commitment to higher fertilizer efficiency had a more significant impact on phosphate fertilizers, and a relatively smaller effect on potash. This allows potash consumption to continue climbing.

Furthermore, the growing acreage of cash crops such as vegetables, fruits and cotton, which require more potash, also drives the growth in potash demand. In 2023, China's pure potassium chloride (KCl) application per hectare for soybeans and wheat was 6.45 kg and 0.6 kg, respectively. In contrast, apples and cotton each saw per-hectare applications of 20.85 kg and 46.35 kg, respectively.

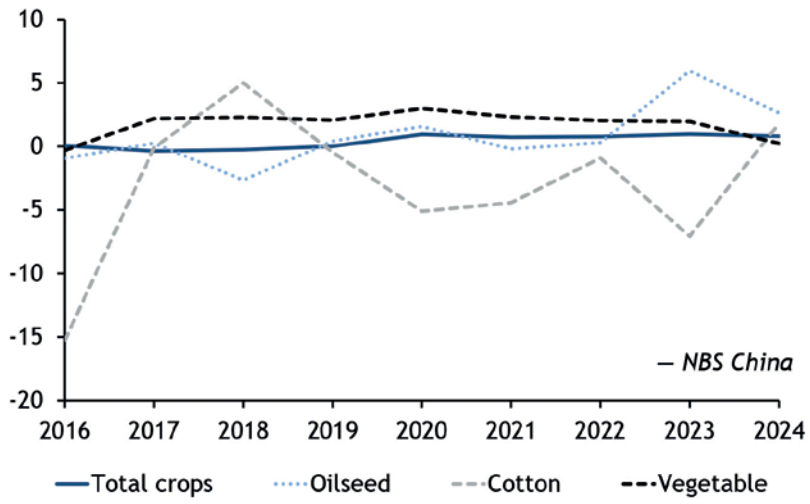
These shifts have demonstrably driven up China's MOP consumption demand in the past two years. China's MOP demand reached 16.7 mn t in 2023 and 17.3 mn t in 2024, according to Argus. Given China's focus on agricultural self-sufficiency, Argus projects MOP consumption will rise with agricultural production growth, with MOP consumption slated to reach 20.4 mn t by 2039.

Limited potash resources drive China's potash imports

In stark contrast to continuously growing demand, China faces a significant shortage of potash resources. China's proven potash reserves totalled only 322.01 mn t of KCl by the end of 2023, according to the 2024 China Mineral Resources Report released by China's natural

China is implementing various methods to encourage MOP imports

Figure 1. Growth in cultivated area for different crops *(±% yr/yr)*



resources ministry. Compared with other resource-rich countries in the world, this quantity can be described as scarce. This sharply contrasts with China's enormous potash demand, which accounts for over 20% of the global total.

Furthermore, China's limited potash resources are unevenly distributed and highly concentrated in a few areas. Qinghai and Xinjiang provinces encompass almost all of China's potash reserves, particularly the Qarhan Salt Lake in the Qaidam Basin (Qinghai) and the Luobei Depression in Lop Nur (Xinjiang). Data from the natural resources ministry in 2024 shows that the Qaidam Basin in Qinghai Province holds 75.3% of the nation's total potash resources.

The high-altitude environment, complex climate conditions, and scarce freshwater resources in the Qinghai region increase the difficulty and cost of equipment maintenance. The Qaidam Basin's ecosystem is extremely fragile, and its salt lake ecosystem balance is sensitive. Large-scale exploitation and production activity could impact groundwater hydrology and the salt lake's ecological balance, thereby exacerbating the ecological environment's burden.

In recent years, central ecological and environmental protection inspection teams have repeatedly pointed out issues such as disorderly expansion, illegal water extraction and encroachment on grasslands in the Qaidam Basin's salt lake resource development. This requires potash mining to operate under strict environmental constraints, limiting extensive capacity expansion.

Moreover, unlike major overseas solid potash mines, over 95% of China's potash resources are derived from salt lake brine. As extraction scales continuously expand and volumes gradually increase, the potassium content in the brine is steadily decreasing, while impurity salt content is rising. This significantly disrupts the original production processes. Some mining areas are already showing signs of declining potash quality and increasing difficulty in extracting potassium chloride.

Additionally, brines from Qinghai's salt lakes often contain multiple associated salts including lithium and magnesium, which add to the complexity and cost of the potassium chloride extraction process.

These factors collectively mean that China's domestic potash production has limited room for growth, making it challenging to significantly increase output to meet national demand. Consequently, even with major MOP producers such as Qinghai Salt Lake (QHSL) and Zangge Mining, and SOP producers such as SDIC Luobupo Potash, their capacities are far from sufficient to fill the massive gap in domestic demand.

As a result, China relies heavily on imports for approximately 50% of its MOP demand. China's MOP imports reached a record high of 12.78 mn t in 2024. This surge was partly driven by firm demand for MOP in China. Shipments of MOP to China increased by 9% on the year, with imports from Russia, Canada and Laos offsetting decreases from Belarus, Israel and Jordan, the latest GTT data shows.

China's MOP import channels

China's immense demand for MOP, coupled with its scarce domestic resources, creates a supply-demand gap that the country must bridge through imports. Consequently, China is actively implementing various methods to encourage MOP imports and diligently working to expand and diversify its import channels.

The most direct and powerful support measure involves significantly reducing or even eliminating import tariffs. China reduced the tariff on various potash products to zero from 1%, including MOP and SOP, effective from 1 January 2023. This substantially lowered import costs and greatly stimulated the enthusiasm of importers to import MOP.

Simultaneously, to secure more favourable prices and stable supplies from the international market, the Chinese government actively supports joint negotiation teams composed of large state-owned companies including Sinochem's fertilizer arm Sinofert, China National Agricultural Means of Production Group (CNAMPGC), and state-controlled China National Offshore Oil (CNOOC).

Annual contract for seaborne cargoes

The Chinese consortium of buyers signs an annual contract for standard MOP with major global potash suppliers, including Canada's Canpotex, Russia's Food Security Solutions/Uralkali, Belarus' BPC, Jordan's APC, and Israel's ICL. Cargoes from these suppliers are typically shipped to Chinese ports, which are then further distributed nationwide via rail or road. Since 2005, this mechanism has significantly enhanced China's bargaining power in the international potash market through centralised purchasing, ensuring China maintains its lowest price level in the global market.

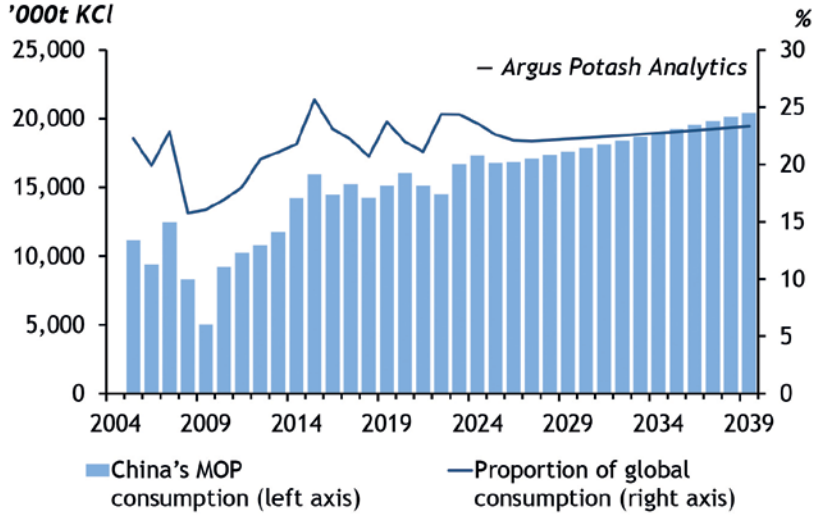
Cross-border monthly contracts with FSU suppliers

Besides seaborne cargoes, China also imports MOP cargoes from Russia and Belarus through cross-border trade. Chinese importers negotiate a monthly contract with Russian supplier Uralkali, and they sign the contract on a DAP Manzhouli basis.

Investment in overseas potash projects

Beyond these measures, more Chinese producers have started to invest in overseas potash mining resources, especially in Laos. MOP from Chinese-backed projects in Laos is directly shipped back to China via vessels or the China-Laos railway on an ex-warehouse basis.

Figure 2. China's MOP consumption and its global proportion



These Chinese-backed Lao potash producers mainly move product to Southeast Asia, in addition to China. Producers will adjust the volume of cargoes they sell to each region based on prices in the Chinese and Southeast Asian markets.

In the first quarter of 2025, the two major Chinese-backed Laotian producers — Asia Potash and Lao Kaiyuan — shipped around 70–80% of their production back to China, because Chinese domestic prices are much higher than Southeast Asian prices. Currently, the uptrend of MOP prices in Southeast Asia and weak demand in domestic China are pushing these producers to send less than 50% of their production back to China.

Factors affecting China's imports and prices in 1H25

China's MOP port stocks had reached a historical high of 4 mn t in March–April 2024, which put them in a good position in negotiating the 2024 contract price with MOP suppliers, concluding 2024's contract at USD273/t cfr, down from USD307/t cfr in 2023. But since April last year, China's port stocks have been drawing down steadily to almost 2 mn t by September, before climbing to nearly 3.5 mn t by end of 2024. Stocks have again been drawn down steadily since the start of this year, thanks to strong domestic offtake against declining seaborne arrivals.

At the start of the year, news of Canadian potash distributor Canpotex selling out for the first quarter sent a signal of tight supply and bullish sentiment to the global market. In the Chinese market, NPK producers reacted by ramping up MOP purchases over fears of supply tightness, which boosted domestic prices. At the same time, local MOP producer Zangge carried out turnarounds from late January through February, further tightening MOP supply in the domestic market. NPK producers gradually ramped up production and purchases of MOP after the Lunar New Year in mid-February, contributing to the firming domestic prices and further drawing down inventories.

By late February, the sharp rise in domestic MOP prices had attracted the attention of the industry association, which urged potash producers and suppliers to prioritise supply and keep prices stable in an initiative published on 24 February. Major importers responded by releasing MOP reserves at the start of March to stabilise domestic prices and to ensure enough

supply in the domestic market. Local producers QHSL and Zangge also responded by steadily restoring and raising operating rates to secure supply into the market.

By the end of March, domestic prices stabilised at around CNY3,100–3,200/t ex-works for port-side 62% white powdered MOP, while port stocks were being drawn down steadily. At the start of April, domestic demand for MOP from NPK producers had gradually tapered off as the period for NPK production in preparation for the spring application season had come to an end. Domestic prices held broadly stable at around CNY3,200/t ex-works throughout April and May.

China's MOP imports in January–April were broadly stable on the year at around 4.7 mn t, but out of which, seaborne arrivals from Canada for January–April this year were down by 33% on the year to 778,400 t, according to trade data. This was outweighed by an increase in deliveries from Russia and Belarus, which accounted for 1.6 mn t and 1.1 mn t during this period, up by 2% and 21% on the year, respectively.

By the end of May, demand for MOP had tapered off. Chinese NPK producers have already finished producing high-nitrogen fertilizers to meet the demand for summer corn planting. Liquidity in the domestic MOP market is low as the market awaited the settlement of the new MOP contracts by China and India to provide a benchmark for the market. China's port stocks by the end of May also hit their lowest since January 2024 at around 2 mn t. This placed them in a less advantageous position in their annual contract negotiations with key MOP suppliers this year.

The consortium of Chinese buyers finally concluded the annual contract price for 2025 with potash supplier Food Security Solutions on 12 June at a headline price of USD346/t cfr, up from USD273/t cfr in 2024 and USD307/t cfr in 2023. The volumes to be shipped by the end of the year are still in discussion.

Figure 3. Global potash reserves and major country holdings *('ooot)*

Country	Recoverable ore	K2O equivalent	Proportion (%)
Canada	4,500,000	1,100,000	31
Belarus	3,300,000	750,000	21
Russia	na	650,000	18
Israel	na	Large	-
Jordan	na	Large	-
US	970,000	220,000	6
China	na	180,000	5
Germany	na	150,000	4
Chile	na	100,000	3
Laos	1,000,000	75,000	2
Spain	na	68,000	2
Brazil	10,000	2,300	0
Other countries	1,500,000	300,000	8
World total (rounded)	**11,000,000**	**3,600,000**	**100**

note: Israel and Jordan recover potash from the Dead Sea, which contains nearly 2bn t of potassium chloride

— Mineral Commodity Summaries 2024 from US Geological Survey

Short-term outlook: Stable to firm

With the conclusion of the annual contract in mid-June, the general view is that MOP suppliers are likely to resume regular shipments into China, which will thereby help build domestic inventories and stabilise prices. But tight supply among most MOP producers and firm demand in other regional markets including Southeast Asia could push MOP suppliers to ship less into China and more into other more attractive markets in the second half of this year, making it challenging for China to lift its MOP port stocks significantly.

Within the domestic market, NPK producers remain reluctant to start building inventories thanks to the seasonal lull, as they hold the bearish view that domestic prices could fall in the short term following the conclusion of the annual contract.

NPK producers are expected to start production in end-July/early August for the autumn application season starting in end-August/early September. But if NPK producers continue to wait on the sidelines in July and only rush in to procure raw materials at the last minute, it could cause a sudden spike in domestic prices.

On a broader note, the current geopolitical conflict in the Middle East has already led to volatility in the nitrogen market and steeper freight rates for vessels coming from that region into the east of Suez. Lingering uncertainty over geopolitical tensions and US trade tariffs on various countries, on top of tight potash supply and robust demand from the other key demand regions, could support global MOP prices in the second half of this year, resulting in limited downside for the Chinese market. ■

Shipping and trade news

Partners to build NH3 bunkering in Australia's Pilbara

Australia-based blue ammonia firm NH3 Clean Energy and marine fuels company Oceania Marine Energy have signed an initial agreement with Australian port authority Pilbara Ports to develop low-emissions ammonia bunkering at the port of Dampier in Western Australia (WA). The partners aim to establish ammonia bunkering to service iron ore carriers at Dampier by 2030, NH3 Clean Energy said.

PPA is the world's largest bulk handling authority, shipping 750mn t/yr of commodities. NH3 Clean Energy is developing the WAH-2 blue ammonia plant near the WA city of Karratha, for which it hopes to take a final investment decision for a 650,000 t/yr phase 1 in late 2026. Privately owned Oceania is establishing a bunkering business that will use LNG and ammonia at Pilbara Ports sites, with operations set to begin in 2027 and 2028, respectively. Oceania plans to use ship-to-ship transfer to supply low-emissions fuels, and is working with Singapore maritime firm Seatech Solutions on a vessel with capacity for 10,000m³ NH3 parcels.

About 300 bulk carriers service Pilbara Ports's iron ore trade. If just 16 of these operated on ammonia and bunkered in Australia, 600,000 t/yr of ammonia would be required — more than 90% of WAH-2 's phase 1 output, NH3 Clean Energy said.

WA could become a world leader in lower-emissions shipping, the firm said, referencing recently adopted International Maritime Organisation (IMO) emissions limits and carbon pricing.

The IMO's plan has disappointed some hydrogen industry associations and environmental groups, which claim hydrogen-based bunkering fuels will remain at a disadvantage to biofuels and LNG under the agreement.

Marine net-zero target in doubt

The International Maritime Organization's (IMO) 2050 net-zero greenhouse gas (GHG) target for shipping is unlikely to be met, experts warned, citing high costs and scalability challenges for alternative marine fuels.

Conventional oil-based bunkers will continue to dominate the fuel mix, accounting for 77%, 66.5%, and 55% of global demand of in 2030, in 2040, and 2050, respectively, said Adrian Tolson, principal at consultancy 2050 Marine Energy, speaking at Petrospot's Maritime Week Americas conference in Tampa, Florida.

LNG is projected to make up 8%, 10%, and 13%, while methanol will reach 5.5%, 9%, and 12.5% in those timeframes. B100 biofuel will hit 5.5%, 7.5%, and 9%, with ammonia at 2.5%, 5%, and 7.5%. Other energy sources - including shore power, solar, and wind - will contribute 1.5%, 2%, and 3%, he said.

Tolson estimates that LNG accounted for 3-4% of total US marine fuel use in 2024, or around 1.2mn m³.

Ankur Arora, market leader at vessel classification society Bureau Veritas, said global demand for biofuels could hit 150mn t by 2030, but supply may only reach 60mn t. Green ammonia demand is projected at 80mn t, with just 25mn t in supply. Green methanol and hydrogen will face similar shortfalls, with expected demand of 60mn t and 40mn t, respectively, but available supply of just 15mn t and 10mn t. Only LNG is expected to come close to matching demand in 2030, said Ankur, with 120mn t of supply forecast against 130mn t of demand.

Malaysia's Sarawak eyes 250,000 t/yr green H2 by 2035

Malaysia's Sarawak state estimates it could produce up to 250,000 t/yr of renewable hydrogen by 2035 and 500,000 t/yr by 2050.

FREIGHT RATES

POTASH	Price type	Units	Timing	Low	High	Date
Dry potash Vancouver - China 60-65kt	outright	USD/t	prompt	23	25	26-Jun-25
Dry potash Red Sea - WC India 25-30kt	outright	USD/t	prompt	23	35	26-Jun-25
Dry potash Baltic Sea - Brazil 30-40kt	outright	USD/t	prompt	39	41	26-Jun-25
Dry potash Baltic Sea - SE Asia 25-30kt	outright	USD/t	prompt	55	95	26-Jun-25
Dry potash Vancouver - SE Asia 25-30kt	outright	USD/t	prompt	50	52	26-Jun-25
Dry potash Baltic Sea - China 60-65kt	outright	USD/t	prompt	45	72	26-Jun-25
Dry potash Baltic Sea - US Nola 50-55kt	outright	USD/t	prompt	40	55	26-Jun-25
Dry potash Vancouver - Brazil 30-35kt	outright	USD/t	prompt	37	39	26-Jun-25
Dry potash Hamburg - Brazil 30-35kt	outright	USD/t	prompt	20	22	26-Jun-25

SULPHUR	Units	Low	High	Date
50-60kt – Vancouver-China	USD/t	22	26	26-Jun-25
Below all 30-35kt				
Mid East – EC India	USD/t	19	21	26-Jun-25
Mid east – North/River China	USD/t	26	29	26-Jun-25
Mid East – South China	USD/t	22	25	26-Jun-25
Mid East – Brazil	USD/t	28	31	26-Jun-25
Mid East – North Africa	USD/t	40	44	26-Jun-25
Mid East – South Africa	USD/t	21	23	26-Jun-25
Black Sea – North Africa	USD/t	36	40	26-Jun-25
Black Sea – Brazil	USD/t	41	45	26-Jun-25
Baltic – Brazil	USD/t	43	46	26-Jun-25
Baltic – North Africa	USD/t	35	40	26-Jun-25
35-40kt – US Gulf - Brazil	USD/t	22	24	26-Jun-25

The estimates are included in the state's recent hydrogen roadmap.

Sarawak is also looking to produce hydrogen from natural gas with carbon capture and storage (CCS). The state on Borneo estimates it could host 800,000–1mn t/yr of CCS-based hydrogen production by 2035 and 1.5mn–2mn t/yr by 2050.

Combined production could far outpace domestic demand, allowing for potential exports of up to 1mn t/yr by 2035 (see table). The state is eyeing Japan, South Korea and Singapore as potential offtake markets.

The roadmap outlines investment opportunities worth MYR20–25bn (USD4.7–5.8bn) by 2035, rising to MYR50–60bn by 2050.

Between 2025 and 2030, Sarawak plans to establish hydrogen hubs in Bintulu and Kuching, roll out a certification platform to verify "clean" hydrogen production, and introduce incentives to encourage local hydrogen use from 2027-28. The state will also develop shared infrastructure including pipelines and storage facilities.

Key domestic industries expected to use hydrogen include production of iron and steel, cement, alumina and petrochemicals. Sarawak also foresees demand from the transport sector, particularly in heavy vehicles and shipping.

Several companies have announced production plans in Sarawak, especially in Bintulu, but they are all in early stages of development.

Malaysian state-owned Sarawak Economic Development (SEDC) last year signed a deal with Gentari Hydrogen, a subsidiary of state-owned Petronas, to jointly develop a centralised hydrogen production hub in Bintulu.

Two consortia had already announced flagship projects in Bintulu previously, but their plans have faced delays.

Project H2biscus, led by South Korea's Samsung E&A, Korea National Oil Corporation and Lotte Chemical in partnership with Sarawak's SEDC Energy, aims to produce renewable hydrogen for export as ammonia.

Project H2ornbill, a collaboration between Japan's Sumitomo, Eneos and SEDC Energy, envisages exports of hydrogen as methylcyclohexane (MCH), a liquid hydrogen carrier.

Sarawak's ongoing hydrogen initiatives also include the Kuching Urban Transportation System, which will use 5 t/d of hydrogen produced at SEDC Energy's Rembus plant to fuel autonomous rapid transit vehicles and hydrogen-powered feeder buses. Sarawak currently operates one hydrogen refuelling station and plans to build six more by 2030. The state recently added hydrogen-related activities to its natural gas distribution act, thereby providing a formal regulatory framework, including on safety matters.

North American railroads shrug off tariff impacts

Three of the biggest North American railroads said their businesses are no worse for wear from impending tariffs, with strong volumes despite tariff threats that one railroad described as "headline noise".

The five publicly traded North American Class I railroads have reported few tariff drawbacks in reporting their first quarter earnings. But analysts had been concerned about the potential for customers to ship fewer railcars of commodities, grain, fertilizers and other goods as the tariffs being pursued by US president Donald Trump took hold in the spring months.

Railroads say their shipments have been up so far in the second quarter, and their customers got a reprieve this week when the US and China announced an agreement to reduce some of the tariffs both countries have imposed since Trump took office and to pause others for a period of 90 days.

"We haven't seen a big impact so far from the tariffs," Canadian National (CN) chief executive Tracy Robinson told a conference hosted by BofA Securities on 13 May. "Right now. we're running at velocity levels that we haven't seen in May in a number of years."

Railroads' readings of North American economic patterns have turned increasingly positive since Trump reached preliminary tariff deals with the UK and China.

"The tariff news is upside," said Canadian Pacific Kansas City's (CPKC) chief financial officer Nadeem Velani, speaking to analysts at RBC Capital Markets, describing the tariffs as "headline noise".

"I think the headline risk of a recession has probably lessened as we sit here today than where we were a few weeks back," Velani said.

Trump's tariffs against China are most likely to affect western carriers like Union Pacific and BNSF, since Chinese imports largely enter the US from west coast ports. CN and CPKC both haul Chinese goods from Canadian ports.

CN said about a third of its business crosses North American borders and a third connects to international markets through ports, with the remaining third wholly contained within the US or Canada. Two thirds of CN's volumes run southbound from Canada to the US and mostly comprised of petroleum products, agricultural

Despite the concerns about tariffs, "we've seen strength in a lot of our key markets," CPKC's Velani said. April was a strong month for volumes, and shipments have accelerated in May, with double-digit growth in Canadian grain and coal, Velani said. CPKC has seen some tariff impacts on steel and aluminum shipments, but those are a small portion of its freight, he said.

Railroad analysts have been on the lookout for an "air pocket" in railed shipments that could come from a tariff-driven slowdown in shipments from China to west coast ports in the US and Canada.

"We still don't see an air pocket. I'm not sure I know what an air pocket is," CPKC chief marketing officer John Brooks told the BofA Securities conference.

Velani said CPKC's overseas sales team is "quite bullish near term" after the US-China tariff reduction deal was announced over the weekend. Looking forward, CPKC said it expects its railed volumes to increase in coming months, as "Christmas shelves need to get filled."

Eastern US railroad CSX has seen signs that customers were pre-shipping goods to prepare for potential tariff impacts after Trump's 2 April "Liberation Day" tariff barrage but stopped short of calling it a surge in shipments. The railroad hauled about 125,000 carloads in the latest week of data, just 1,000 carloads short of its 2025 peak level.

Any potential "air pocket" would likely impact western railroads more than eastern ones, CSX chief financial officer Sean Pelkey told the BofA Securities conference. ■

NITROGEN/UREA		Units	Low	High	Date
Middle East - US Gulf	45kt	USD/t	34	36	26-Jun-25
Middle East - Thailand	30kt	USD/t	22	24	26-Jun-25
Middle East - Brazil	40kt	USD/t	24	26	26-Jun-25
Baltic - Brazil	30kt	USD/t	31	34	26-Jun-25
China - India	60kt	USD/t	20	22	26-Jun-25
Algeria - Brazil	30kt	USD/t	22	24	26-Jun-25
Algeria - French bay	12kt	USD/t	21	23	26-Jun-25
Baltic - EC Mexico	30kt	USD/t	35	38	26-Jun-25
Baltic - WC Mexico	25kt	USD/t	50	55	26-Jun-25

PHOSPHATES		Units	Low	High	Date
Morocco – Brazil	30kt	USD/t	18	20	26-Jun-25
Tampa – Brazil	30kt	USD/t	29	31	26-Jun-25
Saudi Arabia – EC India	30kt	USD/t	22	24	26-Jun-25

AMMONIA	Units	Latest	Date
Ras al Khair - Ulsan, 23kt	USD/t	29	26-Jun-25
Ras al Khair - Kakinada, 23kt	USD/t	36	26-Jun-25
Ras al Khair - Kandla, 23kt	USD/t	19	26-Jun-25
Point Lisas - Ulsan, 23kt	USD/t	109	26-Jun-25
Point Lisas - Houston, 23kt	USD/t	29	26-Jun-25
Point Lisas - NW Europe, 23kt	USD/t	47	26-Jun-25
Bontang - Ulsan, 23kt	USD/t	29	26-Jun-25

Price watch

*These market insights are provided by **Argus Fertilizer Analytics team***

AMMONIA

Tighter global supply

Outages are occurring across the world and are therefore affecting prices at all of our major benchmarks. East of Suez, Saudi Arabia's Ma'aden started a seven-week outage in May at a 1.1mn t/yr unit, expected to result in more than 120,000 t of lost production, and Parna Raya in Indonesia is expected to conduct a 30- to 45-day maintenance at its 500,000 t/yr KPI unit in late July.

Probably of more concern was the news in that gas supply issues again were on the horizon in Trinidad, with the ammonia export forecast in June and July under threat as a result. Since the loss of 4mn t/yr of Russian exports in 2022, the ammonia market has been more vulnerable to pricing shocks, and historically these have been most prevalent when the Middle East and Trinidad suffer outages simultaneously. But given the timing of these outages, when demand for fertilizers at most major demand centres is low, we are not expecting the news to cause a sharp price increase.

There is another factor to consider for pricing in the summer — whether Gulf Coast Ammonia's 1.3mn t/yr merchant unit in the US can finally start up commercial production after delays spanning more than three years. If the plant comes on line early in the third quarter as we expect, its supply will mitigate some of the lost volumes from other production sites in the middle of this year.

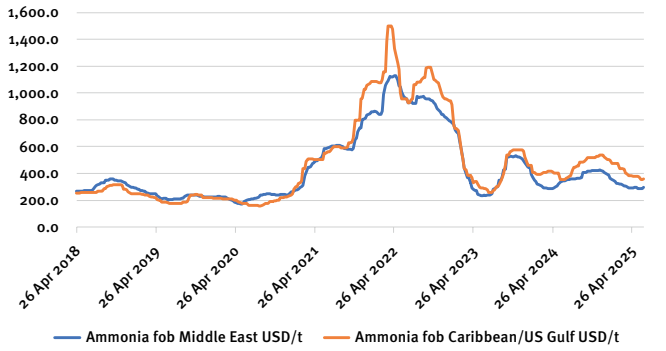
On the demand front, there have been fewer developments. India's buying ahead of the Kharif crop season is still the main source of spot demand, with applications in the US having slowed recently. OCP in Morocco has reduced its buying recently on high stocks and plenty of supply options, although import levels are expected to remain high in the short term. And industrial demand from Europe and East Asia is showing no signs of improvement.

Moving towards the end of this year, another supply addition will affect price sentiment — Woodside's 1.1mn t/yr project in Beaumont, Texas. The plant, acquired from OCI in mid-2024, is expected to begin producing by the end of this year. We are including an export cargo in our balance for December. Although touted as a 'blue' ammonia plant, it will begin by producing conventional grey ammonia, before a CCS unit is added later, with the current timeline set at late 2026.

The additional production, coupled with steadily building output from Eurochem's Port Favor terminal on Russia's Baltic Sea coast, will limit the extent to which prices can rise in the latter part of this year and lead to a reduced price peak in late 2025 compared with a year earlier. The impact will be felt mostly at west-of-Suez benchmarks, given the logistical and safety challenges preventing passage through the Red Sea, with prices expected to peak at about USD100/t lower than they reached in late 2024. East-of-Suez benchmarks also will not rise as high, but to a lesser extent, with high points at USD40–50/t below last year's levels.

A bullish forecast for urea prices in 2026, given the market's structural tightness next year, is having an impact on our ammonia forecast, mitigating some of the bearish ammonia sentiment from a well-supplied market in the middle of 2026.

Ammonia historical pricing



PHOSPHATES

Latin America faces affordability hurdles

Phosphate prices have continued to climb higher east and west of Suez. But we expect there will be a slight divergence in the coming months, as DAP moves higher, while MAP undergoes temporary softening. Looking east of Suez, built-up DAP demand is offsetting emerging Chinese exports, and supply will remain in conditions of sustained tightness in the near future, resulting in DAP prices firming further.

This view is largely driven by persistent demand from India in the absence of inflows of Chinese DAP supply, and shifting trade dynamics across Southeast Asia, the Middle East, and Africa. With domestic inventories low and the rabi season approaching, Indian buyers are compelled to remain active. Their inability to delay purchases, combined with strong competition from east of Suez markets, is keeping prices buoyant.

In the near term, DAP prices will be supported by fresh demand from Southeast Asia, Bangladesh, and Ethiopia. And Indian importers are under pressure to secure volumes consistently, while producers are increasingly drawn to alternative destinations. China's role in the market remains pivotal, despite reintroducing substantial DAP supply. Many buyers had delayed purchases in anticipation of China's return, and this pent-up demand is now absorbing the additional supply. And the extension of CIQ inspection periods for other phosphate products like TSP and SSP means buyers are shifting more rapidly to DAP and MAP, further tightening the market.

But the outlook also has moderating factors. Affordability and a gradual decline in non-Indian import demand are expected to temper price gains later in the year. While Bangladesh may offer some additional demand, concerns over financing may deter some producers. Meanwhile, the structure of China's export quotas, applying fixed levels to DAP and MAP and preventing interchangeability, could lead to sales pressure in the third quarter, eroding the upward momentum for DAP.

The DAP market east of Suez is poised for a period of firm pricing, underpinned by strong Indian demand, lower-than-typical Chinese supply, and shifting regional trade flows. Periods of stability are expected, but the broader trend points to more elevated prices by the end of the year and into 2026.

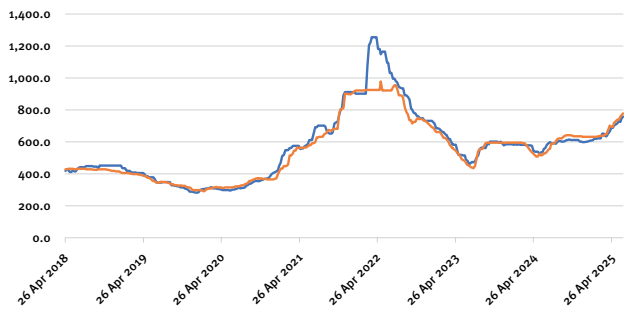
Looking west of Suez, in the US, DAP barge prices are strengthening despite weaker near-term demand, driven by tight domestic supply and ongoing uncertainty around import tariffs. The market remains heavily reliant on domestic producers, particularly as international suppliers remain cautious. Some buyers are moving early to secure product, which will help maintain price strength in the interim.

In Brazil, MAP demand is under pressure from weak crop economics and high fertilizer costs, leading to reduced offtake despite ample supply. While increased Chinese availability is expected to weigh on prices in the near term, a temporary rebound is forecast later in the year as logistical constraints limit arrivals in time for application. Seasonal softening is likely to resume from November through early 2026, though prices are expected to remain above early-year levels.

In Europe, the market is largely in the offseason, with limited activity outside of opportunistic sales. Tight supply in South Asia has led to India surpassing Europe as the premium market, but Europe is forecast to recapture itself as a premium market by early 2026 as spring demand builds. European phosphate consumption may decline slightly because of cost pressures, but not significantly more so than in recent years.

Russian phosphate exports are currently focused on domestic needs, but a shift away from Europe is expected later in the year, especially as new tariffs further dampen European demand. While other suppliers are expected to cover the redirected volumes, this shift will likely contribute to firmer prices in Europe heading into the spring season.

Phosphates historical pricing



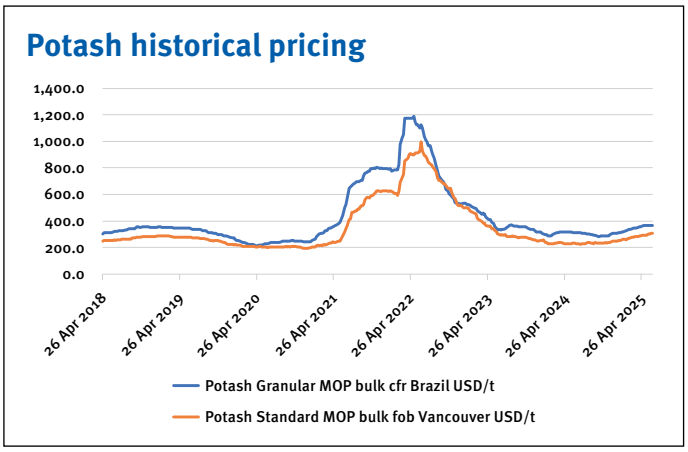
POTASH

Sentiment firms on Middle East tensions

Market sentiment is marginally firmer following the escalation of the conflict between Israel and Iran. So far, ICL's operations and shipments are unaffected. But freight rates may rise, which has also contributed to the firmer sentiment.

APC and IPL have signed a new Indian standard MOP contract at USD349/t cfr with 180 days' credit for deliveries through to the end of the year. Volumes will be in line with their long-term potash agreement at 275,000–325,000 t/yr. Talks between China and major suppliers for a new contract are ongoing, with discussions focused mainly on volumes.

Market drivers: The lowest offer in an Indonesian buy tender seeking 30,000 t of standard MOP and 5,000 t of fine MOP was submitted at USD390/t cfr under an e-auction which closed on 13 June. The offer is USD10/t below the lowest offer submitted in the first round. Meanwhile, Nutrien is continuing to offer granular MOP at USD390/st fob Midwest as part of its summer fill pricing programme. The price is thought to be equivalent to USD332/t fob Nola and is the same level as Nutrien's previously announced Midwest price increase. Uptake in the programme is expected to be significant.



Over the next two months, the potential supply disruption created by the Israel–Iran conflict as well as firmer freight rates – which will likely translate to higher delivered prices – is providing the market with more upside, and suppliers are likely to continue to push for higher prices until there is more certainty in the region.

SULPHUR

Muted sulphur demand from Morocco

After reaching a peak at the end of May, global sulphur pricing began to drop as expected in response to the rapid price rise in early 2025. Largely bearish fundamentals are expected to weigh on pricing, but sentiment has been propped up by the uncertainty surrounding the conflict in the Middle East and US president Donald Trump's threat of involvement. If the US joins Israel's attacks on Iran, sulphur pricing would likely rise further, potentially to over USD300/t Middle East fob with sustained increases in freight rates, buyers wanting to ensure security of supply, the potential for attacks on refineries and gas plants that produce sulphur, and uncertainty driving up market sentiment.

If the US does not directly get involved in the conflict, pricing could be tempered and follow the softening trend in alignment with more bearish general market fundamentals. At the time of writing, Trump's expected action is unclear given his wide-ranging remarks hinting at a potential US role in Israel's bombing campaign against Iran, and we have taken this uncertainty into account across our forecast period, offsetting the overall bearish fundamentals within the market while the conflict is under way.

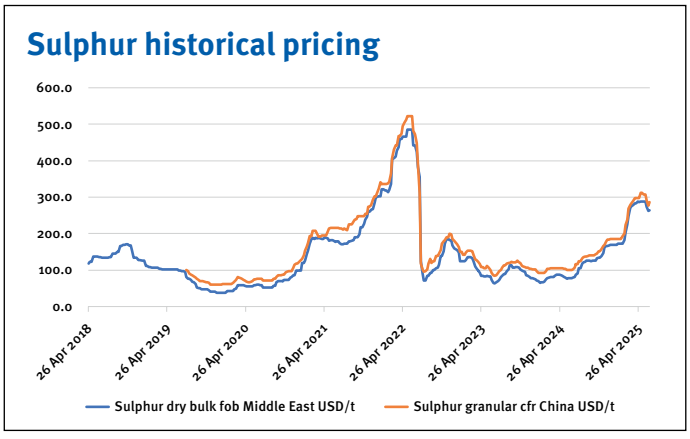
Iran and Israel are launching more attacks as Trump weighs up US involvement in the conflict, which is already driving up freight. Offers for import cargoes into China were up by USD10/t for granular product in the third week of June, a significant rise from the USD32/t drop from the end of May to mid-June. As the market gauges impacts from Middle East conflicts, buyers are in a wait-and-see mode, which is reflected in the gradual softening of our forecast, before settling into seasonal fertilizer demand trends in the first quarter of next year.

Throughout our forecast period, pricing is still being supported at above USD200/t Middle East fob as the conflict uncertainty and firm phosphate market are providing a floor, preventing any significant price collapse. The market is expected to gradually soften throughout 2025, and in December a floor is expected to be reached, with a seasonal uptick coming into 2026, paired with a tight trade balance.

In June, large consumers are taking fewer tonnes as their demand is covered and there is a move to the sidelines as prices soften. Moroccan demand is muted by more sulphuric acid being imported owing to technical issues at processing plants. Brazil is covered for tonnes in preparation for extended maintenance at the Tiplam terminal that will limit delivery of tonnes in June–July. Chinese demand from the fertilizer sector is low, with imports being stockpiled at ports, leaving Chinese consumers with ample supply to meet demand for phosphate production during the fertilizer export window.

Also, domestic sulphur production has been strong in China so far this year, with output having reached 1mn t in both January and March for the first time, further improving availability in the local market. Egypt and Turkey also are covered for tonnes, and although they can take discounted Russian product, buyers are waiting for lower-priced offers. This softening demand from key sources has seen more offers from suppliers be rejected, and the market is subdued as buyers await more favourable pricing.

An increase in non-mainstream and discounted tonnes from the FSU also has been more prevalent, with increased availability from Russian port stocks and the resumption of product movement following sanctions uncertainty earlier this year. Demand from the Indonesian nickel sector also is subdued after some nickel producers limited operating rates by staggering maintenance given concerns over softening nickel prices, the potential for



low nickel ore quality and their ability to buy mainstream Middle East sulphur following the price increase. The announcement of increased royalties on Indonesian nickel companies has reduced demand in June–July and they are rejecting bids at the higher end.

Overall, we expect an uptick in pricing in late June and July before a softening market through the third quarter, primarily as a correctional response to the run-up from February–May, and support from muted demand and a lack of market competition. The Middle East conflict is expected to firm the price outlook across the coming months, but from July we expect a downturn in pricing because of the early-2025 ramp-up and multiple bearish fundamentals. We continue to monitor the situation to determine the extent of impacts from the conflict.

NITROGEN/UREA

Deficit of export supply

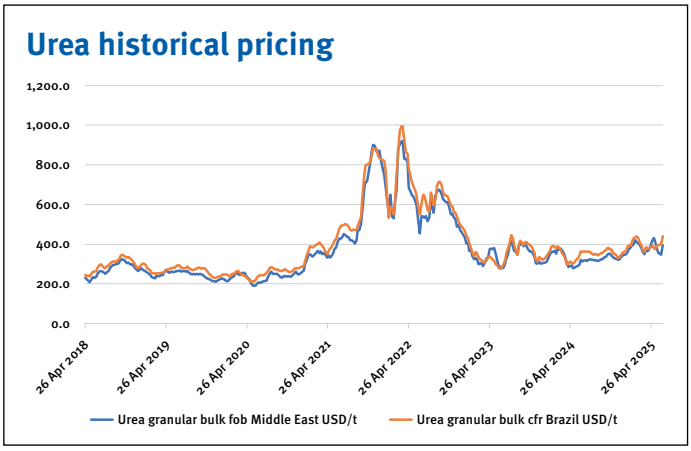
Urea prices have moved largely as forecast recently, remaining much firmer than usual. Prices in most regions are USD60–70/t higher than 12 months ago and are at their highest level in the second quarter since 2012, apart from the war-affected year of 2022.

Our forecast shows a deficit of export supply in June, and prices remain firm for now. Middle East urea is trading at USD380–385/t fob for spot sales. The market turns to surplus in July–August, which is likely to lead to some price weakness as June progresses.

The issue of affordability also is starting to raise questions about future demand in some countries. Wheat prices are about EUR50/t lower in Europe than at the same time last year, and corn prices in the US are level with 2024, meaning there is little scope with which to absorb the higher cost of fertilizer. Farmers in countries with weak currencies, such as Turkey and Mexico, face additional cost pressures on imported urea.

Beyond normal supply and demand factors, other developments continue to complicate and confuse urea pricing:

- China is trying to micromanage its return to the export market, specifying minimum prices for exports and barring exports to India, its largest potential market.
- The EU will impose a EUR40/t tariff on imports of Russian urea and nitrates from 1 July, which is likely to increase prices in Europe and trigger some reorientation of trade.
- The US has flip-flopped on import tariffs to the extent that it is not clear what will happen at the end of the 90-day stay on tariff increases for some countries.
- Gas supply issues cropped up again in Egypt, earlier than last year. These are likely to affect production and exports in the summer months.



Estimates put Egypt's loss of production in May at 100,000–150,000 t because of limited gas supplies. This is equivalent to a cut of about 30% on normal monthly exports and reversed Egyptian prices' declining trend, enabling sales of more than USD400/t fob for small lots. Falling production at Egypt's main gas field and no evident increase in LNG imports suggest urea producers again will see gas supply restricted in the hottest months of July and August.

China is resuming urea exports, with customs inspections having started again at factory level. But there are more restrictions than in the past. Producers are allowed to export under strict "self-discipline," which, in practice, means they will keep prices in the domestic market low (1,830 yuan/t, equivalent to about USD254/t ex-works) and observe minimum export prices, currently at USD360–370/t fob.

An export quota of 2mn t has been reported for 2025, partitioned between various agencies and producers. This quantity is slightly less than we had forecast for exports in the second half of 2025, so it tightens the trade balance rather than eases it. Whether this quota is fulfilled or exceeded remains to be seen. Barring exports to India is economically illogical since it is by far the largest market for Chinese prilled urea. Suppliers are offering at minimum price levels for now, but this raises an umbrella for competitors to sell under and adjustments — downwards — may have to be made.

The greatest reaction to the EU's decision to impose additional EUR40/t tariffs on Russian fertilizers has been seen in the market for nitrates rather than urea. There are few alternatives to Russian UAN imports, and distributors are active at this time of year, selling forward for 2026 application. The urea market is entering its low season in Europe, and there has been little discernible effect to date. Russian exporters are likely to raise prices and ship larger tonnages to markets such as the US, India, and Latin America, where they do not face import tariffs. European farmers will be the main losers and North African exporters the key beneficiaries. ■

Special focus

CLEAN AMMONIA ›

A pragmatic approach to hydrogen transport and infrastructure

Written by

Morten Stahl, *Partner and Specialized Investor,* ***Natural Hydrogen Ventures***

Hydrogen is often touted as a cornerstone of the clean energy future, but all hydrogen – whether 'green' from renewables, 'blue' from gas with carbon capture, or natural/geological hydrogen sourced from the ground – faces the same thorny issue: how to move it from where it is produced to where it is needed.

The fundamental properties of hydrogen make it a logistical headache. It is the lightest molecule, with very low energy density as a gas, meaning it must be either highly compressed or cryogenically cooled to carry any meaningful energy. These processes are expensive and energy intensive.

According to BloombergNEF, liquefying hydrogen and shipping it could add USD3.0-8.0/kg to the delivery cost even by 2040 – a staggering penalty that wipes out any 'cheap at source' benefit. As one energy expert quipped: "Hydrogen on a ship is, frankly, less plausible than snakes on a plane."

For firms like ours, investing in natural (geologic) hydrogen – often found in remote, out-of-the-way locations – the transport hurdle is especially pronounced. A well of natural hydrogen in the middle of nowhere is of little commercial or climate value if we cannot get the hydrogen to market economically. And building brand-new hydrogen pipelines or liquefaction export terminals for every discovery is impractical in the near term – and may remain so indefinitely unless massive discoveries are made.

Simply put, whether hydrogen is generated at a solar farm in the desert or bubbling up from a geologic dome, the challenge is the same: distance and infrastructure stand between cheap production and useful consumption.

Our view is clear: in the short to medium term (and perhaps indefinitely), hydrogen will not be a globe-trotting molecule in its elemental form. The costs and complexities are too high, and existing infrastructure too limited, for H_2 itself to be the workhorse of a global clean energy economy. Instead, we suggest turning hydrogen into something transportable and sellable – for example, derivatives such as ammonia and methanol, which are easy to ship, already supported by infrastructure, and have massive existing markets.

(left) The shipping industry offers both potential off-take and infrastructure. Maersk and other carriers have ordered dual-fuel vessels, and many LNG or LPG terminals and ships can be upgraded to handle ammonia with relatively modest investment

Hydrogen carriers: Ammonia and methanol to the rescue

Ammonia (NH_3) and methanol (CH_3OH) – two hydrogen-rich molecules – stand out as practical options to carry hydrogen's energy in a dense, shippable form. They are liquids under relatively mild conditions (ammonia at ~10 bar or -33°C; methanol at ambient conditions), with far higher energy densities than gaseous hydrogen.

More importantly, we already have global infrastructure for ammonia and methanol. Furthermore, the markets for ammonia and methanol are today an order of magnitude larger than the market for hydrogen. While hydrogen can theoretically be used in many ways, widespread adoption will only occur when clean, competitively priced hydrogen is available at scale.

Using these carriers, hydrogen can hitch a ride on established supply chains. For example, a remote natural hydrogen source could be paired with a small-scale ammonia plant to produce ammonia on-site, which is then shipped using standard chemical tankers to where it is needed. Similarly, hydrogen can be reacted with CO_2 (from the air or industrial sources) to produce methanol fuel, creating a liquid that is much easier to transport.

By converting hydrogen into ammonia or methanol, we turn a difficult transport problem into a much more manageable one.

Equally important, ammonia and methanol leverage existing safety protocols. Yes, ammonia is toxic and methanol is flammable – but the industry has 50+ years of experience handling them safely. Each challenge – ammonia's toxicity and corrosiveness, methanol's toxicity and lower energy density – is being addressed with incremental improvements in ship design, port handling, and safety systems.

Contrast that with liquid hydrogen, which introduces new cryogenic technologies and embrittlement issues that very few operators are equipped to handle.

Use the carrier, skip the 'crack-back' step

Using ammonia or methanol as a carrier and then cracking it back into hydrogen at the destination is often touted as a solution. Given how much easier they are to transport, it might sound like a good idea. But 'crack-back' adds cost. And the question that is not asked often enough is: "Why spend money turning a product that already has a market (ammonia and methanol) into one that doesn't (hydrogen)?"

So, what does "using the carrier directly" mean in practice? It means leveraging ammonia and methanol as fuels or feedstocks as-is.

Beyond its primary use in fertilizer production, ammonia can be burned in thermal power plants or ship engines, or used in fuel cells, without splitting it back into hydrogen. Development is underway for ammonia-fired gas turbines and marine engines, enabling electricity generation or ship propulsion using ammonia directly.

Methanol is even more immediately usable. It is a liquid fuel that can power cars, trucks (in blends or dedicated engines), and especially ships. The global shipping industry is increasingly eyeing green methanol as a drop-in replacement for fuel oil. It is easier to handle than cryogenic fuels and can leverage existing bunkering infrastructure with some modifications. Several major shipping companies have already ordered methanol-fuelled vessels.

In industry, methanol can be used as a feedstock for chemicals or burned for heat and power with relatively clean combustion – in addition to existing uses such as producing plastics, textiles, solvents, and antifreeze.

Leveraging existing infrastructure

One of hydrogen's few logistical advantages is that we do not have to start entirely from scratch. We can modify and build on existing infrastructure:

Ports, tanks and ships: Ammonia (and methanol, to a lesser extent) already has handling facilities. Many LNG or LPG terminals can be upgraded to handle ammonia with relatively modest investment. According to ammoniaenergy.org, studies show converting LNG import terminals to ammonia service is quite feasible and costs would be very manageable. Many new LPG carriers are being built 'ammonia-ready', meaning they can switch to carrying ammonia in the future. Repurposing existing ammonia tanks or LPG ships could shave years off the hydrogen transition timeline.

Pipelines and distribution: While dedicated hydrogen pipelines are rare, ammonia pipelines do exist (e.g. connecting fertilizer plants to ports), and could be expanded or duplicated. Ammonia can be moved by rail or truck using existing industrial gas protocols. Methanol, being a stable liquid, is even simpler – it can be shipped using standard chemical tankers or railcars.

For local delivery, this makes distributing a hydrogen derivative easier than distributing hydrogen gas, which requires ultra-high-pressure tanks or specialty cylinders. In the future, centralized cracking facilities could feed local hydrogen pipelines in industrial hubs, forming a 'hub-and-spoke' model where ammonia is shipped to ports, cracked into hydrogen, and piped to end users.

Don't let the dream of a "perfect" hydrogen economy blind us to the solutions that can work today

Ammonia fertilizer production already contributes significantly to CO_2 emissions, and demand is expected to continue growing. Converting hydrogen into ammonia and using it directly may be the most effective option

Let certificates cover the longest distances

Another powerful tool is virtualizing hydrogen trade through certificates – similar to how renewable electricity is sold. You might not physically send electrons from a wind farm to a specific factory, but you transfer certificates that verify an equivalent amount of clean energy was produced.

For instance, a fertilizer producer in Europe could buy green ammonia certificates from a supplier in Chile. The Chilean producer sells their ammonia locally, but the certificate ensures that the European product can be claimed as 'green' – since a matching clean molecule was made elsewhere.

This avoids shipping molecules halfway around the world when it is uneconomic, while still connecting cheap supply with high-value demand.

To be clear: certificates are a complement, not a replacement, for physical delivery. But in the short and medium term, they can help align markets and jump-start carbon accounting while infrastructure catches up.

A call to action for pragmatism and scale

Hydrogen can play a transformative role in the clean energy transition – but only if we tackle its transport and infrastructure challenges with pragmatism and urgency.

Our firm's focus on natural hydrogen has shown us that incredible opportunities – such as geological H_2 reserves – can be squandered without practical delivery solutions.

Our message is simple: Don't let the dream of a "perfect" hydrogen economy blind us to the solutions that can work today.

Above all, we must stay grounded in reality: hydrogen (in any form) is a means to an end – and that end is decarbonization. We should pursue the fastest, most cost-effective path to that goal, not the most idealized or technologically pure version of it.

If we pin our hopes on a utopian hydrogen future that is always "5-10 years away" – while delaying action – we risk missing our climate targets altogether.

The hydrogen industry now stands at a crossroads. Down one path lies a vision that is always just out of reach. Down the other lies a practical, realistic approach that uses the experience and methods we already have and gets to work immediately.

We advocate the latter. By embracing hydrogen's usable forms and building pragmatic partnerships across the energy, logistics, and industrial sectors, we can start cutting emissions today – not tomorrow. ■

The clean ammonia equation

Balancing supply, demand and decarbonization

Written by

Joyce Grigorey, *Principle,* and **Batool Mohsin,** *Analyst,* ***Argus Media Consulting Services – Hydrogen***

While traditionally mainly used as a feedstock for fertilizer production, ammonia's role is gradually evolving to include the decarbonization of hard-to-abate sectors, such as shipping and power. The carbon emissions of grey ammonia can be reduced by using blue hydrogen (produced from natural gas with carbon capture) or green hydrogen (from renewable electricity via electrolysis).

Demand for low-carbon hydrogen is on the rise, driven by decarbonisation policies globally and clean ammonia is emerging as a scalable, zero-carbon fuel since it is capable of being used directly, or as a hydrogen carrier, to reduce emissions and achieve decarbonisation goals.

What is driving demand for clean ammonia/hydrogen?

Mandates in Europe and Asia are driving hydrogen demand globally. These regions are net short of production and are therefore reliant on lower-cost imports, which is prompting plans for large-scale exports from regions with abundant, low-cost feedstocks.

In Asia, both Japan and South Korea have set specific targets for hydrogen consumption, mainly for co-firing into power generation.

Japan's Energy Ministry outlined a roadmap for ammonia to be used as a fuel, mainly into power generation and marine, but it also cites use in other energy-intensive industries, such as steel. It has specific targets for ammonia in power, aiming to introduce 20% co-firing in its coal-based power assets from 2030, increasing to at least 50% by 2050. Overall, Japan aims to import 3 mn t/yr of ammonia by 2030 and 30 mn t/yr by 2050.

South Korea has also set specific targets for ammonia and hydrogen co-firing in power generation. The government aims to burn 20% ammonia in its coal-based power plants by 2030 and 30% hydrogen in its gas-fired power plants by 2035. Ultimately, the country aims for around 14-22% of its total power generation to come from hydrogen/ammonia by 2050. In total, the country aims to have 4 mn t/yr of hydrogen consumption by 2030 and 28 mn t/yr by 2050 – the majority of which will need to be imported.

Meanwhile, Europe is expected to become one of the largest demand centres for low-carbon hydrogen, driven by strong regulatory support. In addition, funding from programmes such as the European Hydrogen Bank and national subsidies are aimed at reducing production costs and stimulating hydrogen adoption.

The EU has mandates requiring the use of renewable fuels of non-biological origin (RFNBOs) in industry and transport under the third Renewable Energy Directive (REDIII). Within industry, 42% of the hydrogen used needs to come from RFNBOs by 2030, increasing to 60% by 2035. Within transport, the REDIII mandates that RFNBOs and advanced biofuels must make up at least a 5.5% share of the renewable energy supplied to transport fuels in the EU and, of that, a minimum of 1% must be RFNBO.

As a result, Japan, South Korea and Europe are positioned to be early adopters of low-carbon hydrogen, much of which will be supplied from global markets in the form of ammonia.

How do these mandates translate into demand in Europe and Asia?

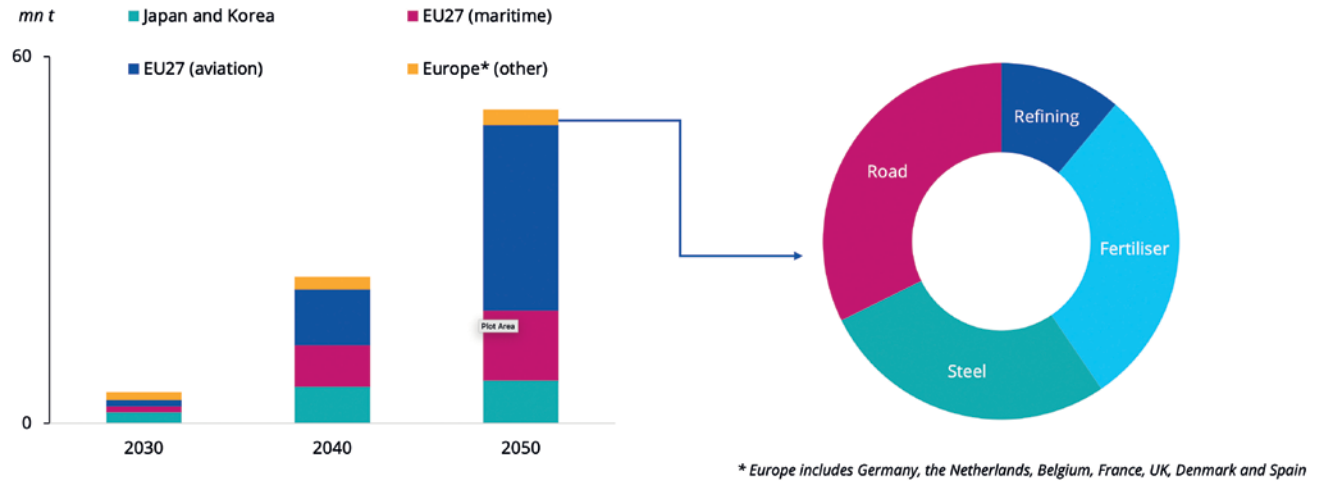
Argus Media published its Low-Carbon Hydrogen Strategy Report, where we have estimated the demand for low-carbon hydrogen generated from these mandates. Demand in power generation encourages early adoption of hydrogen, but marine and aviation dominate in the long-term as shown in figure 1.

Where will early supply of low-carbon hydrogen/ammonia emerge?

In Europe, a number of low-carbon hydrogen projects have taken a positive financial investment decision (FID). Many of these are refinery-linked, driven by their obligation to meet the REDIII mandates. Most are relatively small-scale and linked to local demand either via pipeline or 'over-the-fence' type of arrangements. But local production will be hampered by the high cost of production in Europe; therefore, imports of hydrogen derivatives, such as ammonia, from other lower-cost parts of the world will be necessary to meet the EU's increasingly stringent targets.

Meanwhile, Japan and South Korea have established funding programmes to support the procurement of large-

Figure 1. Mandate-led hydrogen demand in Europe, Japan and Korea



** Europe includes Germany, the Netherlands, Belgium, France, UK, Denmark and Spain*

Source: Argus Media

scale clean hydrogen/ammonia for use in power. These are prompting export-oriented clean ammonia projects globally to take FID.

Global ammonia (green)

Argus Media tracks the status of all announced low-carbon ammonia projects globally in its Ammonia Analytics service. Currently, much is still in the speculative stage, with only a handful having taken FID. Table 1 highlights some of the major projects that have taken FID - these collectively add up to 2.3 mn t/yr of green ammonia.

Table 1. Green ammonia: Major projects with FID

Producer(s)	Location	Ammonia capacity (000/yr)	Off-takers	Argus expected start-up
ACWA Power, NEOM, Air Products	NEOM, Saudi Arabia	1,200	Air Products	2H-2027
AM Green	Kakinada, India	1,000	Uniper*, RWE*, Yara*, Keppel*, BASF*	2H-2027
ACME	Duqm, Oman	100 (Phase 1)	Yara	2H-2026
	TOTAL	**2,300**		

**Preliminary offtake announced*

Global ammonia (blue) - Total pipeline

By comparison, we are tracking over 60 mn t/yr of announced blue ammonia capacity, with around half of that announced to come online in North America, as shown in figure 2.

It is worth noting that low-carbon hydrogen projects in the US are at critical crossroads. Generous tax credits for hydrogen production announced by the Biden administration under the 45V were expected to stimulate large swathes of hydrogen investment in the US. However, following a budget review under the current administration, the US House of Representatives approved a budget bill in May-2025 that, if passed, would see the end of the 45V production tax credit. Only projects that start construction before 31 December 2025 would be able to claim the credit, which would exclude most of the hydrogen projects announced. However, available tax credits under the pre-existing 45Q are expected to remain intact. Although the credit is less than the 45V, this could support the continued development of blue hydrogen projects in the US.

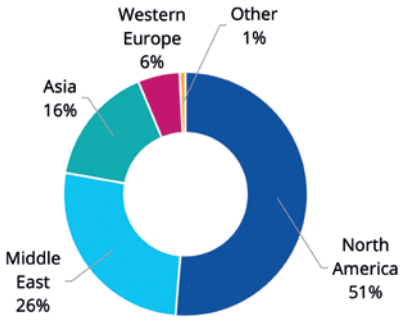
When considering the blue ammonia projects that are firm or probable, Argus estimates that less than 6 mn t/yr is likely to come onstream before 2030.

Asia ammonia procurement initiatives

In November 2024, Japan launched a JPY3 trillion (USD20.7 bn) contracts-for-difference (CfD) scheme to provide 15-year subsidy support for the procurement of low-carbon hydrogen/ammonia. METI received 27 bids, with winners to be announced on a rolling basis until April next year. Projects must be ready to start supplying from 2030 and meet its carbon intensity threshold set at 3.4kg CO2e/kg H2.

In 2024, South Korea launched its annual subsidy tender (the Clean Hydrogen Production Standard, CHPS), which aims to provide subsidy support to domestic power generators producing clean electricity generated

Figure 2. Blue ammonia project pipeline



Source: Argus Media

from low-carbon hydrogen/ammonia. The government targeted 6.5 TWh/yr in the first round, but only awarded one contract for 750 GWh/yr, to state-owned utility company, Kospo. A second tender aiming to subsidize 3 TWh/yr of power generation was launched in May-2025 and is open until Oct. The government introduced some changes to encourage more successful bids.

Securing these government subsidies will provide the clarity required to drive firm offtake agreements from suppliers of low-carbon ammonia.

EU REDIII transposition

The EU's REDIII mandates for RFNBO in industry and transport will translate into firm demand for renewable hydrogen from 2030. Individual EU member states had until 21 May 2025 to transpose the REDIII into their national laws; however, the deadline has passed and many countries still need to announce and/or finalise their plans. Each member state's decision on which companies or sectors will bear the obligation will shape company strategies and could likely have far-reaching implications on the competitiveness of European production.

Despite the slow start, demand for low-carbon hydrogen will begin emerging post-2030 as targets set by the EU and countries in Asia come into effect. Much of the supporting policy frameworks and funding initiatives have been laid down and projects are starting construction. But considering the time it takes for all the necessary pieces to align – from securing permits, applying and being awarded subsidies to agreeing offtake – if countries are to meet their targets, more large-scale export-oriented clean ammonia projects around the globe will need to start taking positive financial investment decisions today. ■

Unlocking ammonia's potential in the energy transition

A molecule at the crossroads of industry and energy

Written by

Nadja Håkansson, *CEO,* ***thyssenkrupp Uhde, Germany***

For more than a century, ammonia has been essential to modern industry, primarily as the nitrogen vector for global food production. Today, however, ammonia is being redefined. As the global economy pivots toward net-zero targets, this familiar molecule is emerging at the intersection of industrial decarbonization and clean energy logistics.

The potential of clean ammonia - produced from low-carbon hydrogen and air - extends far beyond fertilizer. It is now positioned as a viable fuel for maritime transport, a flexible hydrogen carrier, and a scalable medium for intercontinental energy trade. Each of these roles contributes to solving the persistent challenges of the energy transition: achieving deep decarbonization without sacrificing security of supply or economic competitiveness.

Yet unlocking ammonia's full value will require addressing specific technical and systemic bottlenecks - not least of which is ammonia cracking, the process by which ammonia is reconverted into hydrogen at the point of use. Commercially viable cracking technologies will be the key to making ammonia deliver on its promise as a global energy and hydrogen vector.

The energy trilemma and ammonia's promise

The pursuit of carbon neutrality has brought into focus the need to simultaneously address three intertwined energy priorities: environmental sustainability, security of supply, and affordability - the so-called energy trilemma.

Hydrogen is widely viewed as a linchpin of future decarbonization pathways, but its physical properties pose significant challenges for storage and long-distance transport. Ammonia, as an energy-dense, hydrogen-rich carrier, offers a practical route to circumvent some of these barriers. Its existing global handling infrastructure, ease of liquefaction under mild pressures (-33°C at 1 bar), and established safety protocols make ammonia uniquely suited to bridge the gap between renewable and clean hydrogen production sites and demand centres in Europe, Northeast Asia, and beyond.

In theory, ammonia can ease all three dimensions of the energy trilemma:

- ***Sustainability:*** When synthesized via low-carbon routes (blue or green ammonia), the molecule enables zero-carbon combustion or hydrogen delivery.
- ***Security:*** Ammonia's transportability allows energy importing regions to diversify supply away from fossil fuels.
- ***Affordability:*** The molecule leverages existing shipping, storage, and handling assets, potentially reducing infrastructure costs relative to liquefied hydrogen.

However, realizing these benefits at scale will require overcoming economic and technological bottlenecks.

Clean ammonia production: Green and blue pathways

Modern ammonia synthesis, principally via the Haber-Bosch process, accounts for about 1.8% of global CO_2 emissions. Reducing this footprint is essential not just for energy systems but also for

Ammonia Cracking facility by thyssenkrupp Uhde. *Copyright thyssenkrupp Uhde*

agriculture, which remains ammonia's primary consumer. The clean alternatives for a growing energy market - blue and green ammonia - differ sharply in carbon profile and economic maturity.

Green ammonia, synthesized using electrolytic hydrogen powered by renewable electricity, represents the zero-carbon ideal. However, its production costs remain significantly higher than those of conventional grey ammonia. Constraints on electrolyzer availability, high renewable PPA (power purchase agreements) prices in many regions, and the need for a 24/7 plant operation in face of fluctuating renewable input all complicate the bankability of green ammonia projects.

Blue ammonia, derived from hydrogen produced via SMR (steam methane reforming) or ATR (autothermal reforming) with CO_2 capture and sequestration (CCS), offers a faster and hence transitional solution with significantly lower CO_2 emissions. While it does not fully decouple production from fossil fuels, blue ammonia is currently more commercially viable in geographies with low-cost gas and established CCS infrastructure.

Several large-scale projects - both blue and green - are under development globally. Australia, the Middle East, and North Africa are positioning themselves as future exporters, while import demand is being driven by decarbonization mandates e.g. in Japan, South Korea, the EU, and other highly industrialized countries.

The role of ammonia cracking: Unlocking the hydrogen economy

Central to ammonia's role as a hydrogen carrier is the ability to efficiently crack it back into hydrogen and nitrogen near the point of use. Cracking allows ammonia to function as a long-range transport medium for hydrogen, overcoming the logistical limitations of pure hydrogen distribution. Current ammonia cracking technologies are well understood in principle, relying on high-temperature catalytic

decomposition. However, commercial-scale deployment is still in the making. Technical challenges include:

- ***Temperature requirements:*** Conventional thermal cracking requires operating temperatures in the 600–900°C range which is also challenging for the applied material.
- ***Catalyst optimization:*** Nickel-based and ruthenium-based catalysts offer trade-offs between cost, performance, and poisoning resistance.
- ***Hydrogen purity:*** Fuel cell applications demand ultra-high hydrogen purity, requiring additional purification steps such as pressure swing adsorption (PSA) or membrane separation.
- ***Emission control:*** using part of the imported clean ammonia as fuel gas to operate the crackers is important to minimize total emissions. One example is the EnviNOx climate protection technology by thyssenkrupp Uhde which removes even trace amounts of N_2O and NOx.

Efficiency losses in the cracking process are materially impacting the economics of ammonia as a hydrogen vector. Nevertheless, multiple pilot projects are advancing in Japan, Germany, and the Netherlands, some targeting integrated import terminals with on-site cracking for industrial or grid injection applications. One of the latest projects announced in this field is the uhde ammonia cracking technology, which is currently being built as a 28 mtpd demonstration unit as part of a scale-up to industrial ammonia crackers.

Achieving lower capital costs, improved conversion of ammonia to hydrogen, and modular scalability for cracking systems will be critical to making ammonia a credible hydrogen logistics platform. Without this capability, its role in a future hydrogen economy would be limited to direct combustion or industrial heating - applications that, while important, do not unlock the full scope of hydrogen use cases.

Ammonia is gaining traction in hard-to-abate sectors

Use cases in energy-intensive sectors

Even before cracking technology reaches maturity, ammonia is gaining traction in hard-to-abate sectors. Maritime shipping is at the forefront of this shift. With IMO regulations tightening on lifecycle emissions, ammonia is one of the leading candidates for future zero-carbon bunkering. Engine manufacturers are testing ammonia-compliant propulsion systems, and several port authorities in Asia and Europe are exploring ammonia refuelling infrastructure.

Industrial heat and feedstock substitution also offer near-term deployment opportunities. In sectors such as steel, cement, and chemicals, clean ammonia can displace coal or natural gas for thermal processes or hydrogen feed. Some ammonia-based hydrogen blending trials are already underway in gas turbine retrofits.

The fertilizer industry currently remains the largest demand source and a foundational user for any new supply. Decarbonizing existing ammonia-urea plants through green or blue hydrogen retrofits will play a dual role in reducing Scope 1 emissions and demonstrating early market viability for clean hydrogen.

Global trade, infrastructure and market formation

For ammonia to serve as a global hydrogen vector, new trade flows must be established and supported by infrastructure development at both ends of the value chain. On the supply side, regions with access to affordable renewable energy or gas with CCS potential are moving aggressively. The Middle East (notably Saudi Arabia, the UAE, and Oman), North Africa (particularly Egypt and Morocco), Australia, and the U.S. Gulf Coast are all developing production hubs, often with co-located solar, wind, or CCS assets.

On the demand side, Japan and South Korea have set national targets for ammonia co-firing in power generation. Europe is planning to rely on hydrogen imports to meet REPowerEU goals, with ammonia playing a key role in hydrogen import corridors. Terminal expansions are already underway in major ports such as Rotterdam, Hamburg, and Singapore to accommodate clean ammonia imports. These facilities will need to manage not only bulk storage and transfer, but also ammonia cracking, safety and environmental compliance and hydrogen distribution. Germany, for example, plans to build a 'hydrogen core network' of over 9000 km until 2032 to connect the most important domestic locations for hydrogen import, production, and consumption.

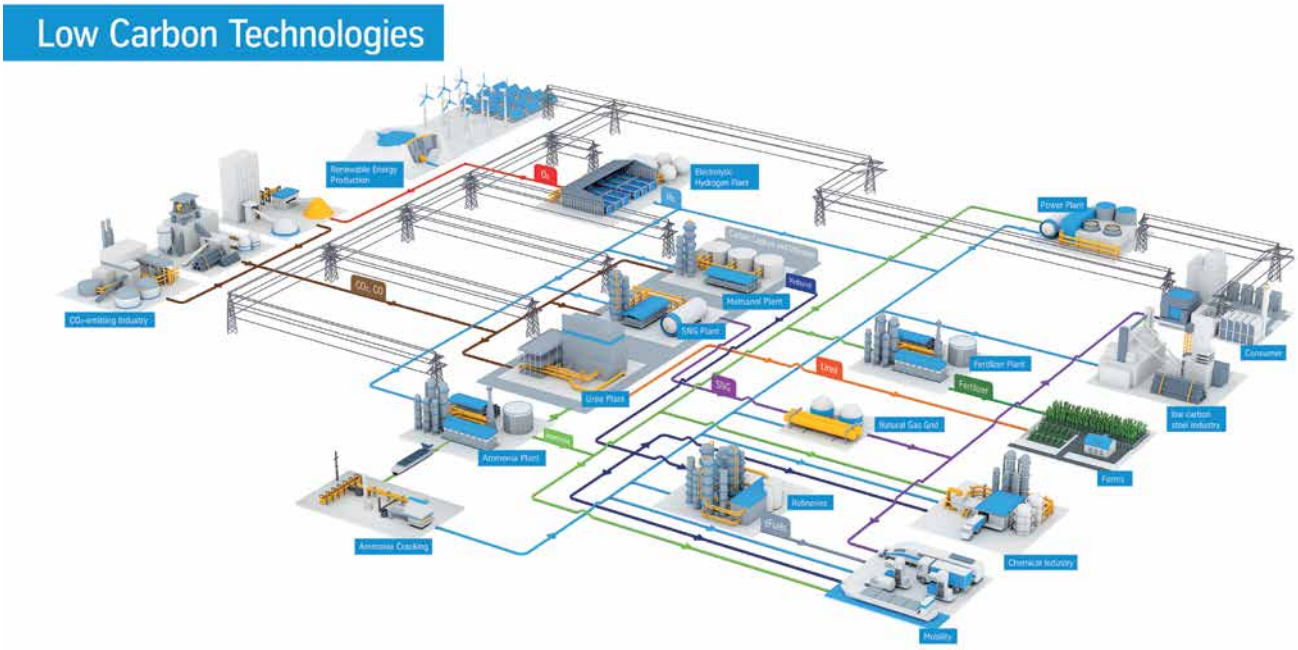
As various elements convert, standardization is emerging as a critical enabler. Without globally accepted carbon intensity certification frameworks, the tradability of clean ammonia will remain fragmented. Certification bodies such as CertifHy in Europe, and emerging alliances in Asia and the Americas, are working to create harmonized guarantees of origin and sustainability thresholds.

Fertilizer industry implications

For fertilizer producers, the rise of clean ammonia represents both challenge and opportunity. Decarbonizing fertilizer production is essential for climate goals, as scope 1 and 2 emissions from ammonia synthesis contribute meaningfully to national inventories.

Green and blue ammonia routes offer pathways to low-carbon fertilizer, but with differing cost, feedstock, and market dynamics. Producers

Hydrogen landscape and value chain. *Copyright thyssenkrupp Uhde*



must assess retrofitting versus greenfield options, renewable power sourcing, and potential revenue diversification into energy markets. In parallel, downstream fertilizer customers - particularly in Europe - will be demanding certified low-carbon nitrogen products, potentially reshaping market premiums and competitive positioning. Regulations like the CBAM (Carbon Border Adjustment Mechanism) in the EU will surely contribute to this development.

Policy, economics and outlook

The successful adoption of clean ammonia will depend heavily on policy support and economic viability. Currently, green ammonia costs up to 1.8 times more than fossil-based alternatives, though declining renewable electricity and electrolyzer costs may narrow this gap by 2030. Blue ammonia faces fewer cost barriers, but its long-term role is debated due to uncertainties around carbon storage.

Policy instruments such as hydrogen tax credits, emissions trading schemes, and international green hydrogen certification standards will be decisive. The European Union's Renewable Energy Directive, Japan's ammonia co-firing plans, and U.S. tax incentives under the Inflation Reduction Act are all shaping the early market.

Still, investors and governments alike must weigh ammonia's comparative advantage against other hydrogen carriers like methanol, LOHCs, or liquefied hydrogen. Each option has trade-offs in terms of energy density, safety, cost, and end-use compatibility. Ammonia's edge lies in its existing infrastructure, global trade footprint, and dual-use versatility in energy and chemistry, and ultimately agriculture.

A molecule for the next energy age

Ammonia is uniquely positioned to serve as both a transitional and transformational vector in the energy transition. Its chemical properties, industrial heritage, and existing infrastructure give it a distinct head start among clean fuels. But realizing its full potential will depend on strategic alignment across three axes:

1. Technological readiness; particularly in ammonia cracking, high-efficiency synthesis, and large-scale carbon capture.
2. Infrastructure deployment; including retrofitted terminals, integrated cracking and distribution hubs, and downstream applications.
3. Policy and certification; to enable market access, establish carbon accountability, and support first-mover economics.

Despite these uncertainties, the direction is clear. Ammonia – for long a fertilizer feedstock - will become a cornerstone of global energy trade, enabling the decarbonization of agriculture as well as heavy industry, shipping, and power. The next decade is pivotal. If ammonia cracking technologies can reach maturity and cost parity with competing hydrogen delivery routes, the molecule's role could expand far beyond current expectations.

Note: EnviNOx® and uhde® ammonia cracking technology are registered trademarks of thyssenkrupp ■

People and events

Genesis Fertilizers announces leadership change

Genesis Fertilizers announces that Jason Mann has stepped down as Chief Executive Officer, President and as Chair of the board of directors of Genesis Fertilizers GP Inc., the general partner of Genesis Fertilizers Limited Partnership. Mr. Mann is a founder of Genesis Fertilizers and its proposed nitrogen fertilizer production facility at Belle Plaine; SK and he will remain as a director of the company.

The other members of the Board are Ian Craven, Kathy Jordison and Garth Whyte, all of whom are independent directors. Mr. Whyte, who was previously the Lead Director, has assumed the role of Interim Chair of the Board.

Genesis Fertilizers is currently searching for a new Chief Executive Officer; this transition reflects Genesis Fertilizers' continued advancement from concept to execution. The Board had long envisioned a leadership evolution aligned with the company's progress into the design and engineering phase. With deep experience in agriculture, finance, governance, and infrastructure, the Board remains fully committed to executing the next phase with discipline and transparency.

"Jason's early leadership helped bring Genesis Fertilizers from vision to reality," said Garth Whyte, Interim Chair of the Board. "As we move into the design and development phase, our focus remains on delivering a world-class fertilizer facility that gives Canadian producers more control over their supply chain."

Sailesh Mehta appointed chairman of FAI

The Fertiliser Association of India (FAI)—the national body representing the fertilizer industry across the public, joint, and private sectors—has announced the election of Sailesh C. Mehta as its new Chairman. Mehta currently serves as Chairman and Managing Director of Deepak Fertilisers and Petrochemicals Corporation Ltd and Mahadhan AgriTech Ltd.

Sailesh Mehta brings over forty years of experience in the fertilizer and petrochemicals sector. He previously served as Chairman of the Fertiliser Association of India (Western Region) for more than five years, where he led regional initiatives and advocated for industry best practices.

Over the past two decades, India's fertilizer industry has been instrumental in boosting the nation's agricultural output. Agricultural output has increased by 60%, while horticulture production has grown by 40%. With operations benchmarked against global standards, the industry plays a key role in the efficient delivery of subsidized fertilisers to millions of farmers. It ensures food security and economic resilience.

Mehta highlighted the sector's contribution to India's transformation from a food-deficient nation to a global agricultural exporter. "India's journey from food scarcity to global agri-exporter has been remarkable. The fertilizer industry continues to play a vital role in this journey, now with a focus on more balanced and nutrient-efficient fertilisers that support sustainable growth," he said.

As FAI Chairman, Sailesh Mehta aims to strengthen collaboration across stakeholders. "I am truly privileged to serve as a bridge between the Government, Industry, and our farmers. I aim to act as a catalyst to elevate Indian farmer and farm productivity on the world map," he added.

Sinofert Holdings appoints Ms. Wang Ling to nomination committee

Sinofert Holdings Limited has announced the appointment of Ms. Wang Ling as a member of its Nomination Committee, effective 24 June 2025. Ms. Wang, who is also the company's executive director and CFO, is expected to enhance the committee's effectiveness in overseeing the nomination process and succession planning, reflecting the company's commitment to strong corporate governance.

Chambal Fertilisers appoints Narinder Goyal as Business Head of Manufacturing

Chambal Fertilisers & Chemicals Ltd. has appointed Mr. Narinder Goyal as the Business Head of Manufacturing Operations, effective 1 July 2025. With over 33 years of experience in the chemical industry, Mr. Goyal brings extensive expertise in project management and plant operations, particularly in the nitrogenous fertilizer sector. His previous roles include significant contributions to Chambal Fertilisers and a recent position at Avaada Group, where he was involved in green hydrogen and ammonia projects. This strategic appointment is expected to enhance Chambal Fertilisers' operational capabilities and strengthen its position in the industry. ■

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Advancing the field of microbial nitrogen-fixation

Written by

Christopher Grandlic, Deeya Burman, Eddie Marques, Fernanda Plucani do Amaral, Kyle Cox and **Varghese Thomas, *Ginkgo Agriculture, USA***

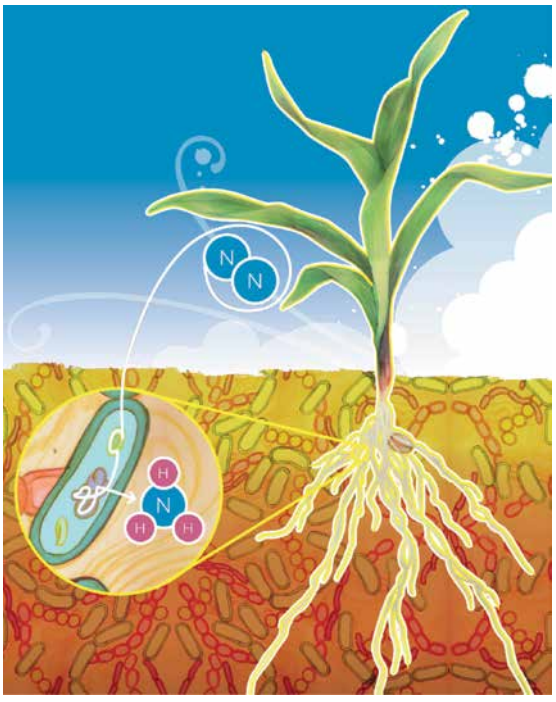
Over the past 50 years, the goal of developing nitrogen-fixing bacteria for non-leguminous crops has cycled in and out of favour – met alternately with hope, then scepticism. Such swings are understandable. If we are successful, the benefits to growers, the environment and the global food system are enormous. Yet, the field has struggled to prove it can be done.

Today, we are yet again in a moment of scepticism – recent articles including Giller et al's paper in 'Plant and soil' and a study led by North Dakota State University suggest it is time to close the door. But we are here to say – it is not time to give up yet. Rather, we detail three reasons why microbial nitrogen fixation remains a field of study with unrealized potential. First, industry and academic researchers are developing more rigorous approaches to making microbial N-fixation claims. Second, the existing body of work has only scratched the surface in terms of microbial diversity sampled for their carbon and nitrogen fixation abilities. Relatedly, engineering strategies to improve upon a microbe's native nitrogen fixation efficiency and plant colonization tendencies are vastly underexplored and offer significant upside.

Experimental design and statistical rigor

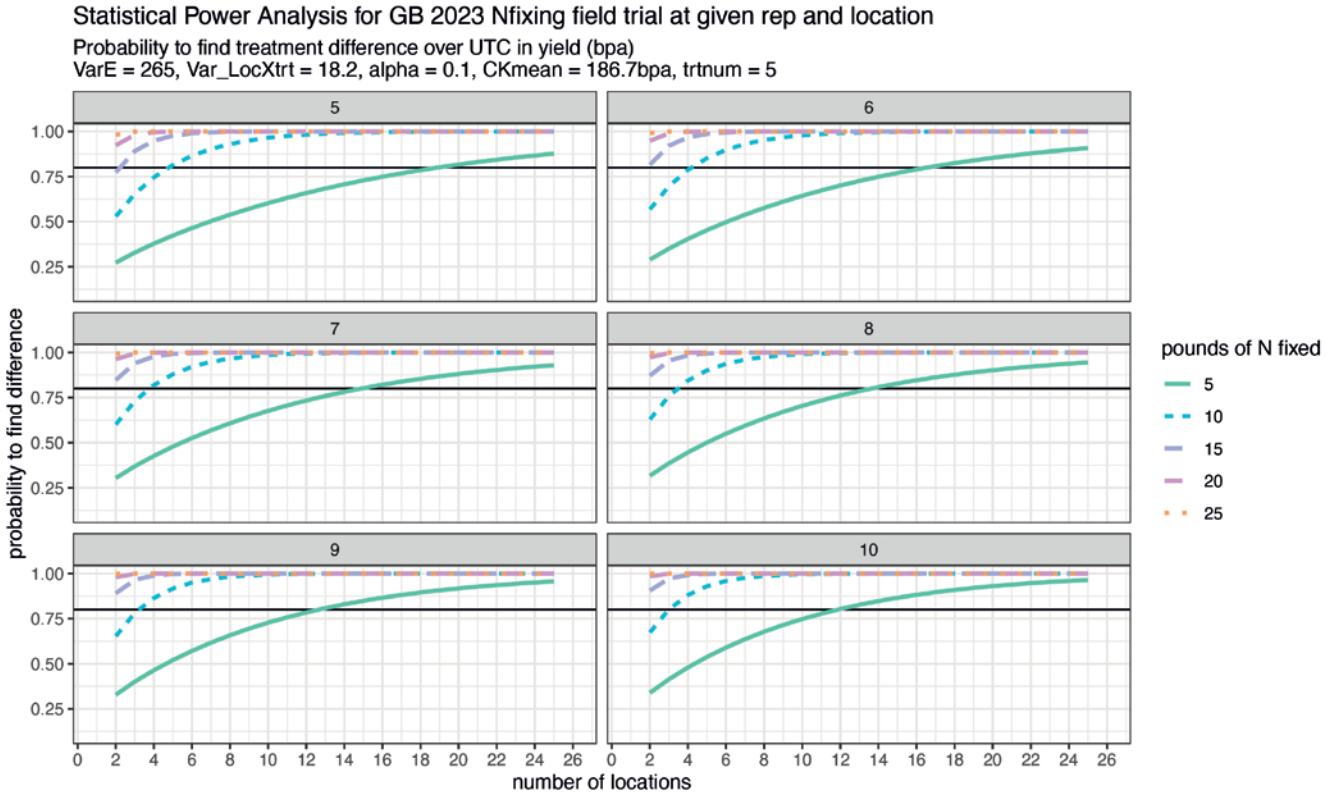
The basis for making nitrogen-fixation claims would benefit from statistically sound approaches that prioritize demonstrating the mechanism of action. By taking a more rigorous approach, researchers and innovators

Figure 1. Sample set of in vitro and in planta assays to comprehensively validate nitrogen fixation mechanism of action among treatment microbes



Assay	Purpose
Acetylene Reduction Assay (*in vitro* and *in planta*)	Measures activity of nitrogenase, the enzyme that converts atmospheric N_2 to bioavailable ammonia (NH_3)
Ammonia Excretion Assay (*in vitro*)	Quantifies microbe's ability to secrete bioavailable NH_3 to the rhizosphere
N15 Assay (*in planta* under N-stress conditions)	Enables quantification of nitrogen captured and transferred to rhizosphere, plant tissue
qPCR-based Molecular Detection	Enables quantification of treatment microbe relative to other microbes in the soil at various time points

Figure 2. This example power analysis shows the minimum field trial locations needed to detect treatment effects 80% of the time if trialling five experimental treatments. Each chart displays results for 5-10 replicates per treatment, with effect sizes from 5-25 lbs of replaced nitrogen per acre. To reliably detect a 10 lb/acre nitrogen replacement effect, this analysis suggests three to five locations (depending on whether you use 10 or 5 replicates per treatment, respectively). Smaller effects require more locations for reliable detection.



can distinguish claims of microbial nitrogen fixation from those of plant growth promotion. This shift requires experimental designs that measure traits directly correlative with increased nitrogen fixation under nitrogen stress conditions and sample sizes that satisfy a statistical power analysis.

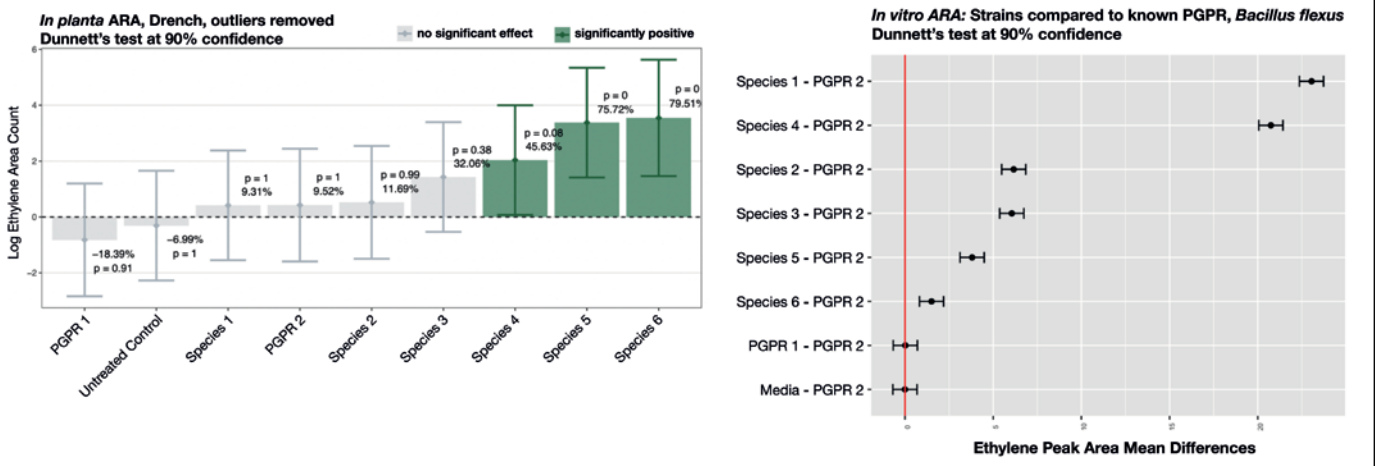
As this field of research was getting started, researchers relied on in vitro assays to compare microbes' ability to produce ammonia from atmospheric nitrogen: an energetically costly reaction uniquely performed by the nitrogenase enzyme in biological systems. The gold standard assay for nitrogenase activity measures the output of a surrogate reaction: the reduction of acetylene to ethylene.

Microbes may be producing ammonia but not secreting it for the plant to utilize

However, we have observed that these results translate poorly to in planta microbial N-fixation. There are a few hypothesized reasons for this. For one, microbes may be producing ammonia but not secreting it for the plant to utilize. Another reason may be that some microbes that perform well in vitro are unable to utilize plant carbon sources to drive ammonia production once they inhabit the rhizosphere.

To address these translational challenges, researchers and innovators can test microbes in vitro for ammonia excretion in parallel. The candidates that demonstrate both nitrogenase enzyme activity and ammonia excretion can then be progressed to in planta measurement of acetylene reduction. In addition to measuring acetylene reduction, researchers have developed, and companies have adopted the N15 assay, which uses a stable isotope of nitrogen to track translocation and cycling of nitrogen within plants and agricultural systems. Broadly considered the gold standard for

Figure 3. Strains belonging to different species within the diazotrophic Paenibacillus genus were compared with non-diazotrophic Bacillus sp. using a validated, in vitro acetylene reduction assay *(right)*. These strains were again tested for their in planta acetylene reduction performance *(left)*.



measuring nitrogen uptake from the soil, this assay provides robust evidence of microbial N-fixation when performed under nitrogen stress conditions on non-leguminous crops in controlled environments or in the field.

To bolster these claims, it is critical to measure root colonization by the microbes under evaluation during V6 and later stages. Using a qPCR-based method, researchers can quantify the presence of the treated microbe relative to other soil inhabitants to demonstrate its persistence in the rhizosphere.

Another critical component of experimental design is choosing a sample size that appropriately accounts for the effect size being measured. Through a pre-study power analysis, researchers can determine the minimum sample size to draw statistically significant results.

We recognize that growers measure their return on investment in new technology by measuring impact on yield. However, yield is affected by a number of co-variables in addition to nitrogen uptake. We encourage researchers in this field to measure variables that are more directly correlated with improved microbial nitrogen fixation. Traditionally, these plant physiological traits include plant vigour assessments, direct measurement of plant tissue nitrogen contents, chlorophyll meter readings and plant biomass. More recently, UAV technologies offer growers new and more comprehensive insights into crop nitrogen status through aerial imaging and multispectral analyses. Furthermore, field trial designs should incorporate testing under reduced nitrogen levels, especially in cases where there are high rates of residual nitrogen in the soil from synthetic or organic sources.

Yield is affected by a number of co-variables in addition to nitrogen uptake

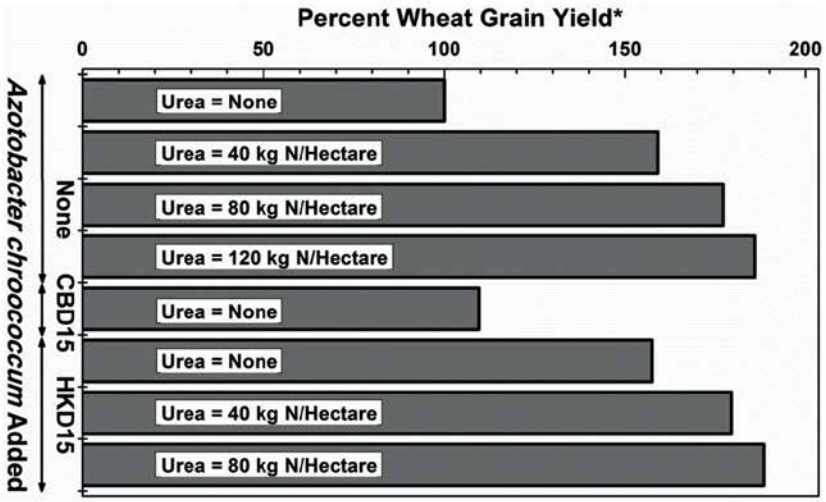
Underexplored diversity

Life on earth has benefited from a wide variety of mutualistic relationships centred around nitrogen and carbon fixation. We ask the reader to consider, "where does the pine tree get its nitrogen?" It behoves us to sample diverse diazotrophic genera and species for their nitrogen fixation abilities before declaring the opportunity intractable. We have evidence indicating that, within a genus, nitrogen-fixing abilities differ significantly species to species (see figure 3).

Furthermore, interdisciplinary research teams have just started to learn how certain landraces (indigenous varieties) of corn were able to fix atmospheric nitrogen. One such research team spanning the University of California at Davis, University of Wisconsin-Madison, and Mars Incorporated studied the landrace, Sierra Mixe, and found that it "obtains 28-82% of its nitrogen from the atmosphere". Through its aerial roots, it secretes "a gel-like substance, or mucilage. The mucilage provides the low-oxygen and sugar-rich environment required to attract

Field trial designs should incorporate testing under reduced nitrogen levels

Figure 4. Effect of inoculation of wheat HD 2967 with the engineered mutant, A. chroococcum HKD15, on yield of wheat grains in the field. The amounts of urea mentioned are in kilograms of N per hectare. Crop neither fertilized with urea nor inoculated with any bacteria was considered control (100%). The actual wheat crop yield (average of three plots) for this treatment was 291.0 g per m^2. The critical difference (equivalent to least significant difference) at 5% was 69.2, the standard error of the mean was 23.1, and the coefficient of variance was 8.4.



Source: Bageshwar et al.

bacteria that can transform nitrogen from the air into a form the corn can use."

For companies developing novel biologicals for nitrogen fixation (or any other agronomic benefit), we encourage approaches that favour diversity – both in the genera and species of microbial N-fixation candidates and in the sources from which novel candidates are isolated.

The potential of microbial engineering

The frontier of microbial nitrogen fixation for non-leguminous crops are engineered microorganisms. While pioneering researchers and companies are undertaking bioengineering to improve both nitrogen fixation and plant colonization abilities, the field is just beginning to develop strategies to meaningfully enhance these traits. However, preliminary data suggests that these approaches yield results.

In their 2017 paper, 'An Environmentally Friendly Engineered Azotobacter Strain That Replaces a Substantial Amount of Urea Fertilizer while Sustaining the Same Wheat Yield', Bageshwar et al. demonstrate 60% yield improvement in wheat that was inoculated by an engineered strain of Azotobacter chroococcum that they named HKD15. The group further demonstrated that "the same wheat yield could be sustained by using 85 kg less urea (40 kg less nitrogen) than the usual 257 kg urea (120 kg nitrogen) per hectare" when the seeds were inoculated with the same strain. In the wheat they cultivated in this study, they saw improvements in dry weight and nitrogen content, assimilated molecular 15N, total nitrogen content with no adverse effects to the soil's microbial composition.

Future directions

As consumers and regulatory bodies increasingly take on more environmentally conscious positions, the pressure is on for companies to provide growers critical agricultural inputs with lower environmental burdens. For microbial nitrogen fixation to provide a viable alternative, industry and academia must come together to advance the science and its translatability. While assay methodology and field trial protocols that are more rigorously validated can be adopted today, the diversity of diazotrophic microbes and biological engineering tools to enhance their beneficial activity remain underexplored and underdeveloped. Leveraging public-private partnerships could be one way to shrink this knowledge gap. For example, the Foundation for Food & Agriculture Research's (FFAR), established in 2014, has significantly advanced our collective understanding of the genetic and environmental drivers of enteric methane production by cattle. These advancements support the development of breeding or diet-based interventions to reduce the greenhouse-gas emissions associated with agriculture. Perhaps this model or other collaborations between public and private institutions to accelerate research into free-living microbe interactions with plants can unlock the potential we see in microbial nitrogen fixation technology. ■

What is circularity?

Realize that all flesh is grass

Written by

Henk Breman, *Agrobiologist,* ***AgroBioAfrica, The Netherlands***

The article "New EU Commission's Focus on Competitiveness and Food Security: A Boost for the Organic-Based Fertilizer Industry" emphasizes the need to apply inorganic fertilizers as part of Integrated Soil Fertility Management (ISFM). This approach provides crops with essential nutrients while maintaining soil health and fertility. It advocates for combining mineral fertilizers with soil amendments—particularly organic matter.

In the context of growing interest in a circular economy, the article offers a valuable perspective from the organic-based fertilizer industry. It counters the increasing focus on recovering minerals from livestock and human waste. As explained below, focusing solely on mineral nutrients may worsen climate change and increase groundwater and surface water pollution.

The following section is adapted from my Dutch article, published on Foodlog as part of a series on circular agriculture.

"Now the earth was desolate and empty." So begins the second sentence of the biblical creation story. "Let there be light" follows in the third. Air, land, and water appear next—then plants, animals, and finally humans. Geology confirms this order: around 350–300 million years ago, during the Carboniferous period, the planet became a haven for plant life. Large grazers arrived only 30 million years ago, posing a threat to this greenery. Humans appeared around 300,000 years ago and amplified the pressure—especially over the past 10,000 years through livestock domestication, the elimination of large predators, and the spread of arable farming.

Today's sustainability challenge lies in the growing nutrient deficit

Today's sustainability challenge lies in the growing nutrient deficit. To close this loop, agriculture must become more circular—returning nutrients to the food system as quickly as possible. A key point: even before the Carboniferous period, atmospheric CO_2 levels dropped as plant life expanded. Light and green plants enabled photosynthesis, which sequestered CO_2. However, only in the Carboniferous did intense greening and falling CO_2 coincide with a sharp decline in global temperatures. By the end of that period and into the Permian, both atmospheric CO_2 and global temperatures had reached levels similar to today. Much of the Earth's CO_2 had been stored in peat, coal, oil, and gas.

Elements for life

I learned in high school, via the Periodic Table, that the once desolate and empty Earth consists of 118 elements. Back then, we were taught that 16 of these are essential for life, though current understanding suggests we need at least 19 elements from our food. In this context, the saying "all flesh is grass" (Dubinsky & Seckbach) is fitting: plants extract these elements from soil and air, converting them into organic matter through photosynthesis. This organic matter—dead or alive—is the food source for humans and animals.

When we talk about circularity in food systems, we refer mainly to nitrogen (N), phosphorus (P), potassium (K), and other nutrients, all of which bind with carbon (C) and hydrogen (H) during photosynthesis, releasing oxygen (O_2). In the process, carbon dioxide (CO_2) and water (H_2O) are consumed. During digestion, decomposition, and combustion, O_2 is used while CO_2 and H_2O are released again. To link circularity to sustainability, it's essential to distinguish between gases like O_2, CO_2, and H_2O, and minerals like N, P, K, and others.

Human Disruption

Before humans, countless animal species participated in "eternal" natural cycles. Their populations were controlled by food availability and

(above) Goats leaving the village for grazing in the surroundings; *(right)* Using inorganic fertilizer in the context of ISFM. Left side is the control

competition. Humans drastically altered these systems through:

- Domestication of grazers, pigs, and poultry
- Arable farming
- Use of fossil fuels (stored CO_2) and mineral stocks like rock phosphate and guano
- Industrial nitrogen fertilizer production using fossil energy

One major sustainability issue is a growing nutrient deficit. This drives the need to recover nutrients from organic matter not directly usable as food—either by humans or livestock. Another issue is the decreasing duration of CO_2 sequestration in organic matter—living or dead organisms, litter, and soil organic matter. Ironically, current "solutions" such as manure fermentation or combustion worsen this second problem.

A related Foodlog article, “Electric Driving on Bread and Animal Feed – Is That Smart?”, highlights how the EU Renewable Energy Directive has intensified competition between the energy and food sectors for by-products, food waste, and feed. While bioenergy is seen as essential for the energy transition, it shortens CO_2 storage time and threatens the availability of organic inputs for fertilizer. This undermines soil health by reducing soil organic matter.

Without it, inorganic fertilizers can no longer be used effectively within Integrated Soil Fertility Management (ISFM), increasing risks of pollution in water and air. Nitrogen compounds, in particular, contribute to climate change alongside rising CO_2 levels.

An effective approach?

The use of inorganic fertilizers to ensure global food security also presents an opportunity to counteract humanity’s negative impact on carbon sequestration. While their production

emits significant CO_2, when used efficiently, inorganic fertilizers can boost crop yields to such an extent that multiple times more CO_2 is captured in organic matter than was released during fertilizer production.

This climate benefit is only realized if both crops and their byproducts are retained in the form of living or dead organic matter for as long as possible. A key strategy is the use of human and animal excreta as soil amendments to increase soil organic matter content.

In nature, soil organic matter generally increases with soil fertility, which is tied to the availability of minerals. The richer the nutrients, the greater the plant biomass produced annually, and thus the more litter and organic matter accumulate. Agriculture should follow this model: higher inorganic fertilizer application—when integrated into a sustainable system—should lead to higher soil organic matter. This also improves fertilizer use efficiency. Integrated Soil Fertility Management (ISFM) is a conditio sine qua non for sustainable, intensive agriculture.

Farm trial

A three-year on-farm ISFM trial in Karabédji, a Sahelian village in Niger (550 mm isohyet), illustrates this principle in practice. The sandy soil in the area loses both rainwater and fertilizer easily. Two sites were studied: a relatively fertile infield near the village and a nutrient-poor outfield farther away.

The difference in fertility is attributed to decades of centripetal nutrient transport—livestock grazing in the outfield by day but kept in or near the village at night. During the dry season, animals were stalled on the infields, enriching them with manure.

Pearl millet was grown at both sites over three years. Besides a control (no fertilizer), treatments included two nitrogen (30 & 60 kg/ha) and two phosphorus (15 & 30 kg/ha) doses, applied individually or in combination. Unlike traditional practice where straw is grazed post-harvest, here it was ploughed back into the soil—an ISFM practice.

Soil organic matter generally increases with soil fertility, which is tied to the availability of minerals

To demonstrate the impact, results from the control and the highest input treatment (N60P30) are summarized:

- ***Rainfall over three years:*** Year 1: 650 mm. Year 2: 470 mm. Year 3: 370 mm
- ***Control (Outfield):*** Grain yields: 185, 165, 150 kg/ha. Straw yields: 1,075, 480, 320 kg/ha
- ***N60P30 (Outfield):*** Average grain: 1,770 kg/ha. Average straw: 3,385 kg/ha
- ***N60P30 (Infield):*** Straw yield remained stable at ~4,050 kg/ha. Grain yield increased despite decreasing rainfall: 1,865 ⇢ 2,705 ⇢ 2,850 kg/ha
- ***Nutrient recovery (Outfield):*** Nitrogen: 53%, 40%, 39%. Phosphorus: 31%, 25%, 24%
- ***Nutrient recovery (Infield):*** Nitrogen: 56%, 60%, 63%. Phosphorus: ~37% (steady)

These results clearly demonstrate that ISFM not only improves fertilizer use efficiency but also mitigates the negative impact of variable rainfall. Improved soil fertility—partly due to organic matter management—was key to sustaining productivity and nutrient uptake under stress conditions.

Circular agriculture and international politics

If we want to prevent the Earth from becoming "desolate and empty" again—while ensuring global food security—we need more than just the use of inorganic fertilizers within an ISFM framework. In parallel with promoting highly productive circular agriculture, international policies must be enacted to maximize the preservation and restoration of forests and other natural vegetation, enabling long-term CO_2 storage.

Key principles of circular agriculture:

- Minimize transport of food and feed; prioritize local, plant-based diets.
- Use fertilizers optimally—not maximally—worldwide to reduce nutrient losses and free up land for reforestation.
- Reserve arable land for human food production, not animal feed. Ruminants should be fed crop by-products or grazed in areas unsuitable for crops. The number of pigs and poultry should match the availability of food waste and by-products from the food industry.
- Recycle human and animal excreta as soil amendments. Fermentation should be avoided to preserve organic matter and sequestered CO_2.

Essential political actions:

- Accelerate the energy transition by prioritizing solar, wind, and hydro power—not bioenergy, which competes with food systems and shortens carbon storage time.
- Minimize deforestation and restrict timber exploitation to maintain carbon sinks.

With this approach, minerals can be kept in a short, efficient cycle for food production, while CO_2 is stored in a long-term natural cycle through vegetation and soil organic matter. ■

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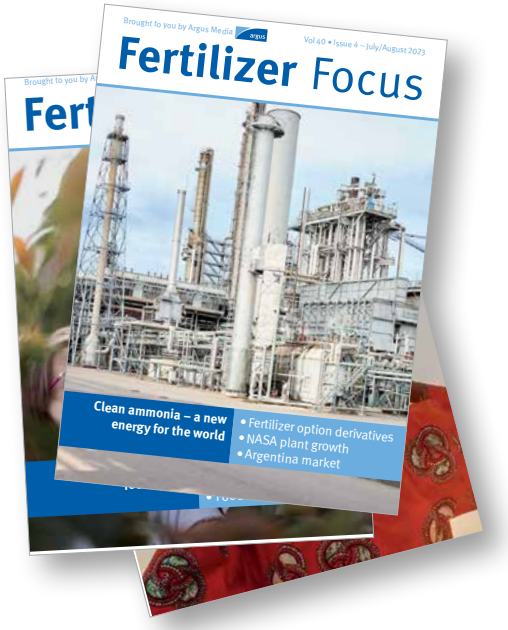
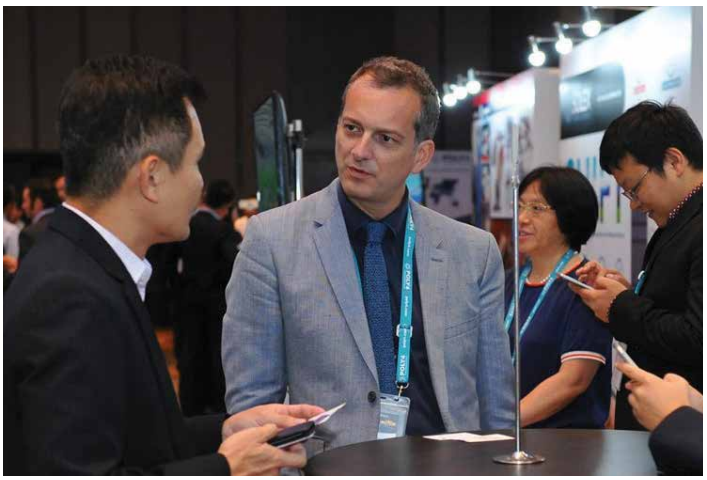
Argus produces the most comprehensive suite of pricing and market intelligence services available to the fertilizer industry

First published in February 1984 by FMB Consultants, Argus' Fertilizer Focus is the world's leading bi-monthly journal serving the international fertilizer industry. It covers the key developments influencing fertilizer and related markets, such as production economics, technology, plant and project news, and product logistics.



Drawing on Argus's unrivalled expertise and wealth of contacts from our market reporting, consulting and conferences, the editorial content in Fertilizer Focus covers the issues which are top-of-mind for senior executives in the industry. As an advertiser, your message reaches decision makers throughout the world and positions you as a thought-leader on the cutting edge topics which will define the future of the industry. The magazine features a unique blend of news, features, interviews and analysis of all aspects of the fertilizer industry, including:

- Spotlight on hot new trends and growth areas - including clean ammonia and low carbon/ sustainable fertilizers
- New product developments – fertilizer blends, enhanced efficiency ingredients, micronutrients, liquid fertilizers
- Fertilizer production technology across all products
- Port logistics and shipping
- Company strategy, industry developments and emerging markets
- Agronomic analysis and changes in agricultural practice impacting fertilizers



Editorial schedule

January/February issue

Advertising due date - **6 December 2024**

Special Focus - INFRASTRUCTURE AND LOGISTICS

- Overview of new facilities
- Risk accessing shipping markets
- Traceability and certification

SUPPLEMENT - AFRICA

- The African Fertilizer Financing Mechanism
- Regional Hub for Fertilizer and Soil Health in West Africa and the Sahel
- Integrating Africa through technology

March/April issue

Advertising due date - **14 February 2025**

Special Focus - LOW CARBON FERTILIZERS

- Adapting fertilizer production for decarbonisation
- Low carbon nitrogen processes
- Next generation enhanced efficiency fertilizers

SUPPLEMENT - ASIA

- The Asian sulphur markets
- Future growth in India
- Key transport routes

May/June issue

Advertising due date - **11 April 2025**

Special Focus - PRODUCTION TECHNOLOGY

- Innovations in water soluble fertilizers
- Case study: Updating production plants
- Modularisation of potash production

SUPPLEMENT - LATIN AMERICA

- Trends in Brazil's import markets
- Production facilities in Latin America
- Key crops and nutrient requirements

July/August issue

Advertising due date - **13 June 2025**

Special Focus - CLEAN AMMONIA

- Clean ammonia for agricultural uses
- Hydrogen transport and infrastructure
- Case study: Blue ammonia

SUPPLEMENT - MIDDLE-EAST

- Impact on fertilizers from Middle-East conflicts
- GCC investments
- Regional innovative technologies

September/October issue

Advertising due date - **11 August 2025**

Special Focus - FERTILIZER SUSTAINABILITY

- Soil health and balancing carbon emissions
- Balancing food security with sustainability
- Greener SOP production

SUPPLEMENT - EUROPE

- Sulphur demand and supply in Europe
- CBAM update
- Sustainable nutrients market in Europe

November/December issue

Advertising due date - **10 October 2025**

Special Focus - THE FERTILIZER ECONOMY

- The impact of geopolitics and trade legislation
- The changing landscape of US phosphate import duties on Morocco
- Fertilizer price volatility outlook

SUPPLEMENT - NORTH AMERICA

- One year on: US election and the impact on agriculture
- Mexican fertilizer transport routes
- Canadian import market trends

Distribution

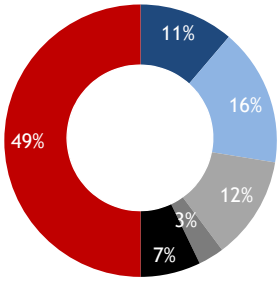
Sector leading digital and hard copy distribution

Published six times a year, the magazine is read by subscribers in over 90 countries. Fertilizer Focus has a unique, best in class distribution, benefiting from Argus' unrivaled presence in the fertilizer sector - **the digital circulation of the magazine in late 2024 was nearly 15,000 - and is growing substantially each month.** Around two thirds of our digital recipients are paying subscribers of Argus fertilizer price reporting and outlook services. This encompasses executives and decision makers in all of the major fertilizer producers, traders, importers and buyers, as well as sector focused financial institutions, shippers, engineering companies, plant contractors, government agencies and trade associations. Our key magazine features are promoted on leading social media platforms (LinkedIn, Twitter, Facebook)

Reader profile

Our unique and unrivaled circulation means your messages reach the industry's most important decision makers.

% of all Fertilizer Focus recipients with the following in their job title



- Executive, President, Director, Vice President
- Manager, Head, Consultant, Advisor
- Sales, Commercial, Marketing, Supply
- Procurement, Buyer, Purchaser, Sourcing, Business Development
- Analyst, Intelligence, Strategy, Accountant, Finance, Investor Relations, Economics
- Other

Unique event distribution

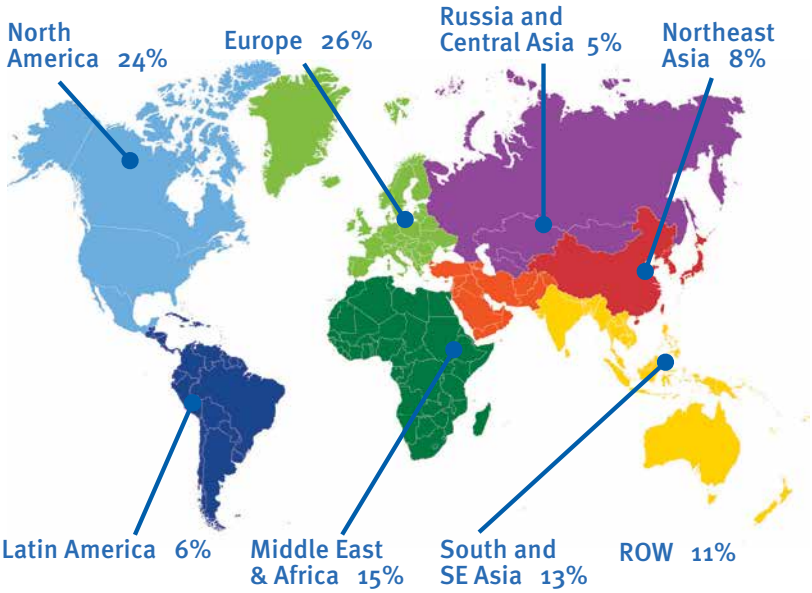
Fertilizer Focus is distributed to every one of the thousands of delegates attending Argus' fertilizer conferences around the world, and available at all of the major global and regional industry events.

Fertilizer Focus will continue to give you unrivaled events positioning. The pandemic temporarily restricted the ability of Argus and other events organizers to deliver physical events, but this is changing. Argus' industry leading conferences are returning in their traditional physical format and our magazine will be delivered to registrants at both physical and digital conferences.

Global distribution breakdown

Our geographic distribution is aligned with the broader Argus fertilizer customer base.

Regional distribution of Fertilizer Focus recipients



Argus events

- Fertilizer Latino Americano (FLA)
- Argus Asia Fertilizer
- Argus East Europe Fertilizer
- Argus Europe Fertilizer
- Argus Clean Ammonia
- Argus Vehicle Emissions and DEF Summit USA
- Argus Paris Grain Conference
- Argus Green Marine Fuels Conference

Global and regional industry events

- AFA Annual Fertilizer Forum & Exhibition, Egypt
- FAI Annual Seminar, India
- IFA Annual Conference
- IFA Crossroads
- Southwest Fertilizer, USA
- TFI Annual Meeting, USA
- TFI World Fertilizer, USA

Advertising rates 2025

Cover rates	
	USD
Outside front package	6,000
Inside front cover	3,740
Inside back cover	3,530
Outside back cover	4,080

Run of press rates	1 Issue	2 Issues (10% discount)	3 -5 Issues (20% discount)	6 Issues (30% discount)
	USD	USD	USD	USD
Double page	6,460	5,748	5,100	4,464
Full page	3,120	2,808	2,496	2,184
Half page	2,640	2,376	2,112	1,848
Third page	1,860	1,674	1,488	1,302
Quarter page	1,740	1,566	1,392	1,218

For more details or to discuss our requirements please contact Stefan Worsley: stefan.worsley@argusmedia.com

Advertising specifications

Editorial & advertising schedule 2025	
Edition	**Due date**
January/February	6 December
March/April	14 February
Maj/June	11 April
July/August	13 June
September/October	11 August
November/December	10 October

SIZE & POSITION

Once you have booked your advertisement please ensure you supply the artwork at the correct size, as below. Please note: 'Trim size' is the actual size that the advertisement will appear in the publication. 'Bleed size' is the size your advertisement needs to be supplied to us including the required 3mm bleed (if full page). 'Type area' is the suggested area that any text or important information should sit within to ensure details have some clear space around them for clarity.

TECHNICAL SPECIFICATION

Please ensure your advertisement is produced professionally, and in accordance with the following criteria:

- All artwork should be CMYK colour (No Pantone/Spot colours)
- All fonts should be embedded or outlined
- All images within the artwork must be at least 300dpi resolution and in CMYK colour
- For Full Page adverts please include 3mm bleed and crop marks

FILE FORMAT & SUPPLY

Our preferred file type is a high resolution PDF to the the following specification when exported from Adobe InDesign:

- Adobe PDF Preset: PDF/X-4:2008
- Colour Profile: Coated FOGRA39 (ISO 12647-2:2004)

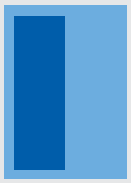
The above will ensure your advertisement appears in the best possible quality, however if you are unable to supply as a PDF we will accept a 300dpi JPEG or TIFF file in CMYK colour format.

Full page

Trim size:
297mm(h) x 210mm(w)
Bleed size:
303mm(h) x 216mm(w)
Type area:
275mm(h) x 185mm(w)

HALF PAGE (Horizontal)

Trim size:
128mm(h) x 180mm(w)
Type area:
118mm(h) x 170mm(w)



HALF PAGE (Vertical)

Trim size:
250mm(h) x 86mm(w)
Type area:
240mm(h) x 76mm(w)

THIRD PAGE (Horizontal)

Trim size:
62mm(h) x 180mm(w)
Type area:
54mm(h) x 172mm(w)

THIRD PAGE (Vertical)

Trim size:
122mm(h) x 112mm(w)
Type area:
114mm(h) x 104mm(w)

Please note: Bleed is not required for Half Page and Third Page advertisements as these formats sit within the page, however we do recommend your advertisement includes a keyline/border if it has a white background.

If you have any queries regarding our specifications or to send us your files, please contact: Kate.Shanley@argusmedia.com

Fertilizer Focus

For advertising and editorial information please contact:
stefan.worsley@argusmedia.com

Brought to you by Argus Media

Fertilizer Focus

INDEX TO ADVERTISERS

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IN THE NEXT ISSUE...

SPECIAL FOCUS: FERTILIZER SUSTAINABILITY

- Soil health and balancing carbon emissions
- Balancing food security with sustainability
- Greener SOP production

SUPPLEMENT: EUROPE

- Sulphur demand and supply in Europe
- CBAM update
- Sustainable nutrients market in Europe

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Daily Fertilizer Price Assessments

Nitrogen

- **Prilled:**
  - China fob
- **Granular:**
  - Egypt fob
  - Brazil cfr
  - Nola (US Gulf) fob $/st

Ammonia

- East Asia cfr *(excluding Taiwan)*
- Middle East fob

Phosphates

- DAP fob China
- DAP cfr India
- MAP cfr Brazil
- DAP barges fob Nola
- MAP barges fob Nola

Sulphur

- China cfr granular $/t
- China domestic (ex works) Yn/t

Work smarter with groundbreaking daily fertilizer price assessments from Argus

Argus daily price assessments provide you with unique benefits, including

Greater certainty

Increased price frequency gives you immediate clarity for volatile markets.

Lower risk

Additional data points ensure your business calculations are more robust.

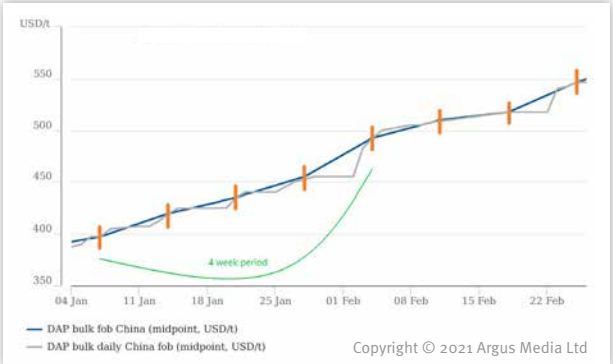
Smarter outcomes

Daily data powers the most sophisticated data analysis and algorithmic trading tools.

Increased confidence

Access editorial staff in key global fertilizer hubs: Widest geographical reach and rigorous methodological adherence.

Sharp price action captured earlier with daily assessment



Over the highlighted 4 week period (7 Jan to 4 Feb 2021) the price of DAP fob China grew from $397.50/t to $492.50/t, an increase of 24%. The blue line on the graph, marked by the 5 weekly prices over this period (orange) clearly highlights this price growth. However, the 21 daily prices over this same period (grey line) provide greater detail on how this price growth was achieved.

For more information please contact us: fertilizer-m@argusmedia.com www.argusmedia.com/fertilizer

Fertilizer
illuminating the markets

Market Reporting
Consulting
Events