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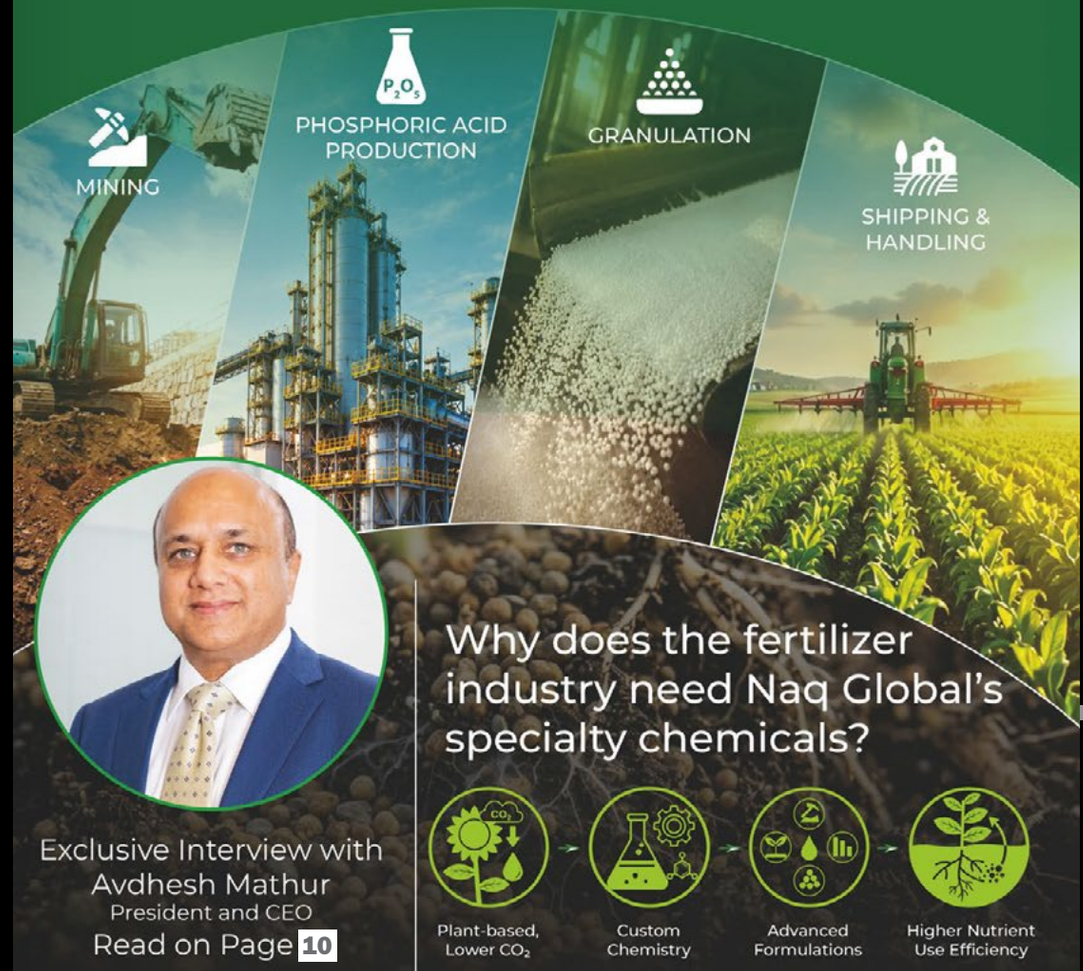
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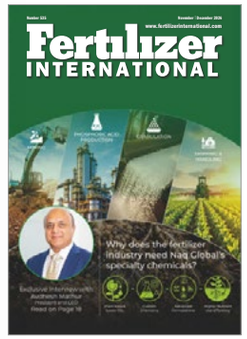
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PHOTO: CRU

Pranshi Goyal, CRU's senior analyst, urea market service.

Urea self-sufficiency: a moving target

While new urea plants have reduced India's import requirements, rising consumption continues to erode those gains. Indian urea self-sufficiency is therefore a moving target, as CRU's **Pranshi Goyal** explains.

> **"Would supporting relatively high-cost domestic production cost the Indian government less than importing urea? The construction of new urea plants may strengthen supply security – but it does not guarantee fiscal savings."**

Successive Indian governments have tried to champion fertilizer self-sufficiency to reduce exposure to international supply disruptions, price volatility and the subsidy burden associated with imports. Urea, the country's most widely used nitrogen fertilizer, has been central to that ambition.

Yet the challenge is not simply how much urea India can produce, but how efficiently it is used, and how heavily subsidised prices will continue to shape demand.

The 2012 New Investment Policy (NIP) sought to attract investment in new urea capacity. Three years later, the New Urea Policy (NUP) 2015 focused on increasing output and improving efficiency at existing gas-based plants, while revising their operating framework.

Together, these policies helped lift domestic capacity from 23.3 million tonnes in 2012 to 31.5 million tonnes in 2023. Additions included Matix's Panagarh plant and Gadepan III, alongside the revival of facilities at Ramagundam, Barauni, Sindri and Gorakhpur.

The investment delivered tangible results: in 2024, urea import requirements fell to their lowest level in more than a decade, declining to 5.3 million tonnes versus the 2011-23 import average of 8.1 million tonnes. These lower imports did not, however, prove to be a lasting turning point. Annual imports subsequently rose to 9.3 million tonnes in 2025 on the back of continued consumption growth.

Driving this trend is the affordability of urea relative to other fertilizers. Farmers pay a statutory maximum retail price of INR 242 per 45-kg bag of urea (equivalent to approximately $60/t). Although this shields them from international price shocks, it also encourages a preference for urea and contributes to overapplication.

Domestic urea sales reached almost 40 million tonnes in 2025, up from 29.4 million tonnes in 2019. As a result, the gap between domestic production and consumption currently stands at roughly 10 million tonnes, despite substantial capacity additions over the preceding decade.

The problem is therefore not a lack of capacity additions. It is that production is chasing demand supported by a subsidy system designed to keep fertilizers affordable.

Against this backdrop, the government unveiled the 2026 National Investment Policy for Urea (NIPU 2026) in July this year. The policy supports the construction of another wave of around 8-9 domestic natural-gas-based urea plants over the next decade.

Changes in China's export policy, disruptions in the Arab Gulf and volatility in global urea prices have reinforced India's focus on domestic supply security. But the next wave of capacity remains largely prospective.

For now, CRU's base case includes only the revival of the Talcher project in Odisha, expected in 2028. Other announced projects include early-stage proposals from Assam Valley Fertilizer and Chemical Company Limited (AVFCCL), Matix Fertilizers and National Fertilizers Limited (NFL).

How financially attractive these urea projects will prove to be remains an open question. India sits above the 75th percentile of the global site cost curve, due in part to the country's heavy dependence on imported liquefied natural gas. Therefore, while additional domestic urea capacity may reduce India's reliance on imports, it does not eliminate its exposure to international energy markets.

The fiscal case for new capacity is also not straightforward. The government subsidises domestic production as well as imports, meaning that replacing imported tonnes does not automatically reduce its subsidy bill. A central question therefore remains: would supporting relatively high-cost domestic production cost the Indian government less than importing urea?

The experience of the past decade illustrates the limits of a predominantly supply-side approach. Investment has raised capacity and periodically reduced imports, but consumption growth has repeatedly absorbed the gains.

Demand presents an equally persistent challenge. Expanding crop acreage and continued overapplication could drive up urea consumption. Recent government efforts have therefore sought to reduce overapplication while maintaining crop productivity.

Without parallel progress in nutrient use efficiency and more balanced fertilizer application, India risks repeating the same cycle: adding capacity, briefly narrowing the deficit, and then watching demand push self-sufficiency further out of reach. ■

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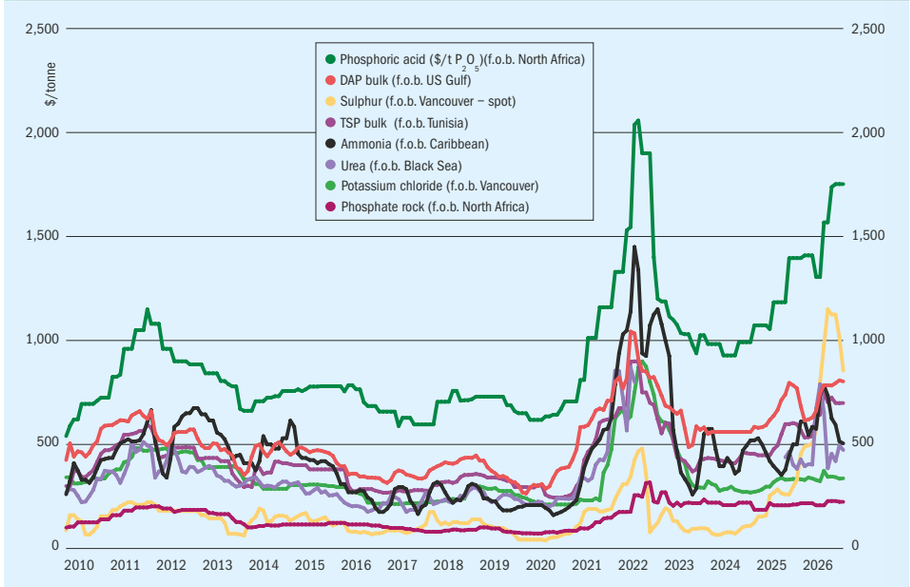
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Market Insight

Historical price trends $/tonne



Source: CRU

PRICE TRENDS

Market snapshot, 22nd October 2026

Urea steadies as market awaits fresh Indian tender: Granular urea prices continued to stabilise on tighter supply fundamentals, despite sluggish activity. Anticipated European and Brazilian demand is supporting sentiment. Market attention is also turning to the prospect of an imminent Indian purchase tender from National Fertilizers Limited (NFL).

However, India's opening stocks for October – a comfortable 8.1 million tonnes of urea – suggest that any fresh purchases will be used to build stocks ahead of Rabi season, rather than to address any immediate urea shortage.

China's September urea exports reached a record 2.45 million tonnes, including 1.59 million tonnes to India. Chinese suppliers are currently targeting netbacks around $350/t f.o.b. for prilled urea from the next Indian tender.

Elsewhere in Asia-Pacific, Brunei Fertilizer Industries (BFI) reportedly sold a November granular urea shipment to Australia at just below $440/t f.o.b. Buying in Oceania is buoyant.

In the Middle East, four vessels carrying around 212,000 tonnes of urea were located west of the Strait of Hormuz as of 22nd October, Kpler data suggest. Just under 2.25 million tonnes of urea aboard 51 vessels has now run the Hormuz gauntlet since the onset of hostilities between the US and Iran in late February.

In North Africa, Egypt's Mopco achieved a $535/t f.o.b. sale for November shipment. Egyptian prices have risen by around $55/t in recent weeks, partly driven by European enquiries.

Brazilian prices are on hold at $470-490/t cfr, with buying delayed by soyabean planting, presidential election uncertainty and credit concerns. In the US, NOLA November and December barges traded at $430/st f.o.b., while Midwest offers eased to $490-515/st f.o.b.

Ammonia prices rise amid North African supply constraints: Ammonia prices have moved higher, led by a sharp rally west of Suez together with firmer Indian and East Asian cfr values.

Algeria is understood to be sold out with volumes committed into December. Sorfert made a recent sale of 6,000 tonnes of ammonia at $655/t f.o.b., while another Algerian producer was said to have sold a cargo to a European buyer at $670/t f.o.b.

In NW Europe, ammonia values rose to $710-730/t cfr, up from the low-to-mid $600s/t cfr range in early October. The latest front-month Dutch TTF gas price of €91/MWh ($29.89/mmBtu) has pushed Europe's domestic ammonia production costs to more than $1,000/t, with further production curtailments expected in the coming weeks.

East of Suez, Indian prices strengthened to $500-550/t cfr. Although Chinese ammonia supply to India has thinned since July, a recent 15,000 tonne cargo is said to have traded at $500/t f.o.b.

Some phosphate benchmarks fall: While DAP/MAP prices in many regions were stable, some key benchmarks moved lower, with further falls expected.

The DAP spot price for India, the world's largest DAP import market, declined to $890-900/t cfr, its lowest level since April.

Market price summary $/tonne – late-October 2026

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phos Acid
f.o.b. Caribbean	505	-	f.o.b. NW Europe 323	f.o.b. US New Orleans	802	-	-
f.o.b. New Orleans*	-	430		f.o.b. N. Africa	914	699	1,752
f.o.b. Middle East	491	434	-	cfr India	895	-	1,700
f.o.b. Black Sea	-	475					
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**		**Sulphur**		
f.o.b. Vancouver	335	-	cfr US Gulf 325		f.o.b. Vancouver	855	
cfr India	383	-			f.o.b. Arab Gulf	800	
f.o.b. Western Europe**	-	675			cfr China	865	
f.o.b. Baltic	322	-			cfr India	910	

*Prices are on a bulk, spot basis, unless otherwise stated. Phosphoric acid is in terms of $/t P_2O_5 for merchant-grade (54% P_2O_5) product. Sulphur prices are for dry material. n.a. = not available. *$/short ton. ** €/t*

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This price benchmark, having started 2026 at $668-669/t cfr, subsequently increased by about 40% to peak in late-July at $935/t cfr – its highest level since July 2022.

Spot prices for MAP cargoes to Brazil, the world's largest MAP import market, remained steady at $830-850/t cfr for the eighth consecutive week, with limited overall liquidity.

The New Orleans price premium for MAP barges over DAP barges increased. MAP was up at $815-835/st f.o.b NOLA, its highest level since July 2022, while DAP was assessed at $800-803/st f.o.b. NOLA, down slightly on its mid-September price of $808/st f.o.b.

China exported 187,001 tonnes of DAP/MAP during January-September 2026, a 95% y-o-y decrease, according to Global Trade Tracker (GTT) data. No DAP/MAP exports were recorded during August while just 61 tonnes were reported in September.

Potash prices weaken in Asia on bearish sentiment: Potash prices declined in Southeast Asia and China, while Brazilian and European prices remained stable.

China's wholesale port price for MOP fell to an average of RMB2,700/t ($404/t) fca. China imported 1.38 million tonnes of MOP in September, bringing the January-September total to 12.9 million tonnes. This already exceeds 2025 annual imports, being 47% up on the first nine months of 2025, according to GTT data.

Brazilian MOP prices remain stable at $355-375/t cfr currently, as market participants held off buying ahead of the presidential elections. In Southeast Asia, standard MOP prices edged downwards to the $370-416/t cfr range, after Pupuk Indonesia awarded its 85,000-tonne potash tender to Canpotex, BPC and Uralkali at $416/t cfr for November delivery.

Indian MOP prices were unchanged at $383/t cfr. September arrivals (532,268 tonnes) were down 26% on August, according to IDT vessel data.

The US NOLA benchmark remained steady at $345-350/st f.o.b. during a quiet week.

Sulphur prices ease as buyers wait for lower offers: Sulphur prices weakened across several import markets this week, as buyers held back and sought further reductions. Export availability is tight with most November cargoes already sold in North America and the Middle East.

The Tampa fourth-quarter sulphur contract settled at $615/t f.o.b. While this is down $90/t from the record third-quarter price of $705/t, it is still nearly double the $310/t level seen in the fourth-quarter last year.

Spot assessments in North America were steady. The average Vancouver sulphur price does, however, remain around $70/t below that of the US Gulf, reflecting greater sulphur availability on the west coast.

Middle East sulphur prices were unchanged at $770-830/t f.o.b., with sellers having placed most volumes for November. Shipping remains a constraint. Currently, around 400,000 tonnes of sulphur across nine vessels are thought to be awaiting passage through the Strait of Hormuz.

Sulphur import markets in Asia weakened further. China's sulphur import demand remained muted and domestic port prices dropped sharply, as phosphate producers favoured locally available material.

OUTLOOK

Chinese supply to temper urea price upside: Looking ahead, a fresh import tender from India, as well as demand from Europe and Brazil, should provide some impetus for the granular urea market, while the spectre of Chinese supply continues to linger over the prilled market. Urea prices should be supported during the fourth-quarter by regional demand and high European production costs. A broader price reset is forecast in early 2027, coinciding with the arrival of seasonal demand in the US, Europe and Turkey, and China's expected exit from the export market.

Ammonia forecast firms on gas squeeze either side of Suez: In the short term, sold-out North African ammonia supply and persistently high gas costs should drive the NW Europe cfr price and the November Tampa settlement upwards. Indian and East Asian values look set to remain firm on limited Chinese export availability. Gas issues east of Suez are also beginning to hit the market. Ammonia prices are forecast to push higher across the board during December.

Phosphate prices to fall further but downside limited: With poor affordability slowing demand, key granular phosphate price benchmarks have declined in recent weeks. While further declines are expected in coming months, tight supply and high raw material prices will limit any downward corrections. Any declines are likely to be gradual and limited, particularly as Chinese exports are set to remain scarce.

Potash prices set to fall on excess supply and subdued buying: Prices are expected to decline in key markets due to lower demand and the potential for excess supply linked to a slowdown in Chinese imports, high inventory levels and new capacity additions.

Sulphur demand recovery hinges on lower prices: Sulphur prices are expected to continue easing in the near term as affordability pressures keep buyers cautious. A recovery in consumption will, however, depend on prices falling to levels that end users can absorb. ■

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NETHERLANDS

Yara opens Europe's largest carbon capture project



PHOTO: YARA

The seven carbon dioxide storage tanks at Yara's Sluiskil site have a combined storage capacity of 15,000 tonnes.

Yara International began industrial-scale carbon capture and storage (CCS) at its flagship Sluiskil ammonia and fertilizer plant in the Netherlands on 7th September.

The CCS unit at Yara Sluiskil – Europe's largest ammonia and fertilizer plant – will capture and liquefy up to 800,000 tonnes of CO_2 annually.

This makes Sluiskil Europe's largest CCS project. It is also the world's first example of industrial-scale capture of carbon dioxide (CO_2) in one country for cross-border transport and storage in another.

Project partner Northern Lights will ship the liquefied carbon dioxide from the Netherlands to Øygarden on the west coast of Norway, where it will be transferred to onshore storage tanks. The liquefied CO_2 will then be transported offshore via a 120-kilometre pipeline and injected into a saline aquifer 2,600 metres below the seabed for permanent storage.

The CCS project was officially opened in an inauguration ceremony attended by Norwegian Prime Minister Jonas Gahr Støre and Dutch Prime Minister Rob Jetten. Svein Tore Holsether, Yara's president and CEO, and Wopke Hoekstra, the European commissioner for climate, net zero and clean growth, were also present.

"This is an important day for Yara and for European industry. The carbon capture facility in Sluiskil proves that large-scale industrial decarbonization is possible today. As global competition intensifies, Europe must find ways to cut emissions while keeping industry, jobs and critical value chains in Europe. That is exactly what this project is about," Svein Tore Holsether said.

"Europe needs practical climate solutions that deliver real emissions reductions while strengthening industrial competitiveness. The carbon capture and storage project at Sluiskil shows what is possible when innovation and cross-border cooperation come together. This is exactly the kind of project Europe needs to combine climate ambition with a strong and resilient industrial base," said Wopke Hoekstra.

"We are proud to start operations together with Yara and to see the agreement signed in 2023 become reality. Together, we are demonstrating that capture and cross-border CO_2 transport and storage is a viable solution for European industry. This is an important step in the development of Europe's carbon management market and shows what is possible when industry and governments work together to build the infrastructure needed for Europe's transition," added Tim Heijn, managing director of project partner Northern Lights.

Yara Sluiskil has been in operation since 1929 and employs more than 700 people. Located on the Ghent-Terneuzen canal, the production complex has an annual product output of 4.5 million tonnes – equivalent to 15% of Yara's total production volume. The site has reduced its net CO_2 emissions by 63% (3.4 million tonnes CO_2 equivalent per annum) since 1990 while almost doubling its output, according to Yara.

Having made the final investment decision in 2023, Yara now plans to capture and liquefy 12 million tonnes of CO_2 at Sluiskil over the next 15 years at an estimated capex cost of €200 million.

The CCS unit at Sluiskil captures CO_2 from Yara's world-scale ammonia plant (1.9 million tonnes per annum capacity) using MDEA absorption technology. The CO_2 is then liquefied at up to 125 tonnes per hour and temporarily stored in seven on-site storage tanks with a total capacity of 15,000 tonnes (see photo).

Yara will transfer liquid CO_2 from these storage tanks into ships owned by project partner Northern Lights for onward transport to Norway. These have a CO_2 capacity of 7,200 tonnes each and will operate on a twice-weekly schedule.

Yara's key equipment suppliers and engineering partners for the Sluiskil CCS project were:

- Linde Engineering – engineering and procurement for CO_2 liquefaction
- Baker Hughes – compressors
- Famet – air cooler banks
- MBG, Ferris, Equans and Fincimec – construction for CO_2 liquefaction
- Geldof – storage tank
- Bilfinger – pipe rack
- Wiese – loading arms.

Yara says it will use CCS at Sluiskil to produce lower-carbon fertilizers, shipping fuels and ammonia for industrial and energy applications. The lower-carbon Climate Choice fertilizers produced by Yara at Sluiskil using CCS technology will, for example, have a 40% lower carbon footprint compared to conventional fertilizers. ■

CANADA

Canpotex makes its biggest ever supply chain investment



PHOTO: CANPOTEX

Neptune Bulk Terminals, Port of Vancouver, Canada.

Canadian potash export consortium Canpotex has launched a CAD 500 million ($350 million) modernisation project at Neptune Bulk Terminals in the Port of Vancouver.

The project will replace and upgrade essential marine and terminal infrastructure. This includes replacing the shiploaders, conveyors, and the dumper pit used to unload railcars and load shipping vessels.

It is Canpotex's largest ever investment in its supply chain – and has been commissioned in response to growing demand for potash from overseas customers.

The announcement was made at a groundbreaking ceremony in Vancouver on 25th September. This was attended by representatives from Neptune Bulk Terminals, the Canadian federal government, the government of Saskatchewan, the Port of Vancouver and Canpotex's supply chain partners.

Neptune, which is jointly owned by Canpotex and Elk Valley Resources (EVR), is the world's largest potash export terminal. Canpotex originally acquired an interest in the 29-hectare terminal in 1979.

The latest CAD 500 million investment in Neptune adds to the nearly CAD 1.5 billion ($1.1 billion) Canpotex has invested in the two-berth potash terminal over the past twenty years. A major 2009-2011 upgrade by Hatch increased Neptune's annual potash capacity by about 30% to 11.5 million tonnes.

Canpotex is owned by Nutrien and Mosaic and acts as the overseas potash export arm of both companies. More than 15 million tonnes of Canadian potash move through the Canpotex supply chain annually to customers in more than 40 countries.

"The world will need more potash, and Canada should be the country that supplies it," said Gordon McKenzie, Canpotex's president and CEO. "That starts with reliability. Customers need confidence that Canadian potash will arrive when they need it, year after year. Canpotex has delivered on that promise for over 50 years, and this investment helps ensure we can continue delivering on that promise for decades to come."

The announcement by Canpotex comes at a time when the US administration has expressed interest in buying more Belarusian potash, potentially at the expense of Canadian-sourced material. Although he didn't specifically refer to this development, Peter Xotta, the president and CEO of Vancouver Fraser Port Authority, did link the new port investment with Canada's drive to boost exports to non-US markets.

"Port of Vancouver terminals, such as Neptune, are playing an outsized role moving more of what Canadians make to overseas markets in support of Canada's goal to double exports to non-U.S. markets," Xotta said. "Canpotex's significant investment to upgrade Neptune Terminals will better connect Saskatchewan potash to key markets in South America, the Indo-Pacific and beyond. Investments like Canpotex's are crucial as we continue to grow exports through Canada's largest port."

Canpotex says major supply chain investments bolster its reputation as a reliable potash supplier. The company highlights the purchase of more than 8,500 custom railcars, mostly built in Hamilton, Ontario, the construction of a dedicated railcar maintenance yard in Saskatchewan and its route to market via three port terminals in North America. Canpotex even charters vessels to deliver potash overseas.

The modernisation project at Neptune Bulk Terminals should support 400-500 jobs. Around 85-90% of project expenditure will also go to Canadian suppliers and contractors, according to Canpotex.

The project is due to be completed in 2028 – with shipments continuing as normal throughout construction.

Hatch starts feasibility study for Kapuskasing critical minerals project

Hatch has commenced work on a processing plant feasibility study (FS) for the Kapuskasing project in Northern Ontario, Canada, on behalf of developer KAP Minerals Inc.

The study will examine the economics and practicality of the project's proposed processing operation. KAP's current development plan for Kapuskasing focuses on the beneficiation and production of phosphate concentrate, rare earth elements, scandium and other strategic minerals from millions of tonnes of previously mined surface material.

The FS will cover process design, metallurgical performance, environmental and permitting considerations, infrastructure requirements, capital and operating costs, as well as other key elements needed to move the project forward. It will build on technical and metallurgical programmes completed by KAP earlier this year.

The Kapuskasing project is located on a previously mined site, allowing it to benefit from pre-existing infrastructure and utilities, such as roads, rail, power and natural gas. These are already in place or readily available, according to the company.

The project plans to process 14.7 million tonnes of previously mined material located at the surface. This material – having already been mined and milled – contains a higher grade of P_2O_5 and more critical minerals than many conventional Canadian deposits. Extra to this surface material, a large under-

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PHOTO: KAP MINERALS



Tailings at the Cargill carbonatite complex, 35 kilometres southwest of the town of Kapuskasing, Northern Ontario, Canada.

ground deposit (of a similar or higher grade) remains to be mined.

KAP is planning to develop Kapuskasing more quickly than a conventional greenfield project, thanks to these advantages.

"The initiation of the Feasibility Study with Hatch marks an important transition for KAP from technical development to project execution," said Geoff Hampson, the CEO of KAP Minerals. "Our objective is to demonstrate that the Kapuskasing Project can be a capital-efficient, near-term Canadian source of critical materials for domestic and allied industrial supply chains. Hatch brings the engineering depth and major-project experience needed to help us translate that opportunity into an executable development plan."

The FS is timely, suggests KAP, as it comes at a moment when Canada is looking to shorten and secure its critical mineral supply chains by increasing domestic processing capacity. In that context, KAP is hoping to develop the Kapuskasing project as a "Canadian strategic-materials processing platform with potential applications across defence, aerospace, advanced manufacturing, battery materials and other industrial markets".

To finance the project, KAP Minerals is exploring a combination of government backing, non-dilutive funding, indigenous participation, strategic investment and private capital. The FS will provide the technical and economic foundation for these financing discussions, the company said.

"This is about more than completing an engineering study," added Hampson. "The Feasibility Study is a critical step toward converting an established Canadian resource and brownfield infrastructure into qualified products, commercial partnerships, and a financeable project. Our focus is now firmly on execution."

UNITED STATES

OCP and CHS plan to build Louisiana phosphate plant

OCP North America and US farmer-owned cooperative CHS have unveiled plans to construct a 1.1 million tonnes per annum (t/a) capacity phosphate fertilizer plant in Louisiana.

The proposed US phosphate plant would be the first of its kind in more than 40 years.

Its construction will depend on both funding approval and project-related permissions. A funding application has, however, already been submitted to the US Department of Agriculture through its Fertilizer Investment & Expansion for Long-term Domestic Supply (FIELDS) programme, according to CHS.

The joint venture (JV) was announced by the CEOs of both companies at a Louisiana ceremony on 26th August, alongside US Secretary of Agriculture Brooke Rollins and Deputy Secretary Stephen Vaden. Louisiana Governor Jeff Landry was also present, as was Faris Derrij, the chair and CEO of OCP Nutricrops.

PHOTO: CHS



Plans by OCP North America and US cooperative CHS to build a large-scale phosphate plant in Louisiana were announced by the CEOs of both companies at a ceremony in Waggaman on 26th August.

The two companies plan to build the $450 million plant at Cornerstone Energy Park in Waggaman, Louisiana. CHS expects construction to take around 24 months to complete, with a potential start-up date of 2028, although this is contingent on securing funding and the granting of permissions.

The project's announcement coincides with a major US government push to reduce fertilizer import reliance by expanding domestic production via the FIELDS initiative. The US currently imports around 40% of its phosphate fertilizers to meet farmer demand. The new plant could potentially reduce this import dependency by almost half, according to CHS.

Production will not rely on domestic or imported supplies of phosphate rock and sulphuric acid, as OCP Group will directly supply phosphoric acid to the plant. The plant's exact phosphate fertilizer production mix has not been disclosed.

Finished fertilizers will be distributed by both CHS and OCP North America. CHS currently supplies crop nutrient products to cooperatives, retailers and farmers across the United States through its extensive wholesale and retail network. The proposed plant's Waggaman location offers access to raw materials and the ability to transport products via the Mississippi River system.

"This is an exciting moment for American agriculture," said Jay Debertin, president and CEO of CHS. "As a farmer-owned cooperative, we exist to help farmers succeed. Together with OCP North America, we have the opportunity to build the first phosphate fertilizer plant in the US in more than 40 years. This investment has the potential to create more value for our owners by bringing fertilizer production closer to the American farmer and the cooperative network."

"This project represents a milestone in OCP North America's commitment to serving American agriculture," added Kevin Kimm, CEO of OCP North America. "Together with CHS, we aim to build lasting infrastructure that strengthens U.S. food security and delivers a reliable, domestically produced supply of the crop nutrients American farmers need."

The announcement follows the US government's recent temporary suspension of countervailing duties (CVDs) on Moroccan phosphate fertilizer imports. OCP has since resumed shipments to the US, with Moroccan phosphate arrivals increasing since CVDs were lifted.

OCP North America and OCP Nutricrops are both fully owned subsidiaries of OCP Group.

PHOTO: MOSAIC



South Fort Meade pit operator working remotely from Mosaic's Integrated Operations Center at FishHawk, Florida.

Mosaic idles South Fort Meade mine

Mosaic plans to temporarily idle its South Fort Meade phosphate mine in Florida due to ongoing challenges with domestic sulphur availability and affordability, the company told CRU on 9th October.

South Fort Meade is the second-largest of Mosaic's three phosphate rock mines in the US, with an annual nameplate capacity of 5.5 million tonnes, according to CRU's Asset Platform. The mine has operated at approximately 40-44% utilisation in recent years, producing around 2.2-2.4 million tonnes per annum (t/a) of phosphate rock. CRU expected its 2026 production to reach 2.21 million tonnes.

The mine, located in Hardee County, employs approximately 250 workers, according to Mosaic. The company has not confirmed workforce reductions or provided a timeline for resuming operations.

"Mosaic is navigating ongoing challenges related to the availability and affordability of domestic sulfur, an essential raw material for phosphate fertilizer," the company said in a statement to CRU. "This reality has required the difficult decision to temporarily idle operations at our South Fort Meade facility."

Mosaic said it will continue evaluating opportunities to safely resume full operations when market conditions allow.

The decision follows a series of phosphate production curtailments across Mosaic's US and Brazilian operations. The company first announced partial curtailments at its Louisiana and Bartow facilities on 11th May, alongside the withdrawal of its 2026 phosphate production guidance. Further cuts followed on 8th July, affecting facilities in Florida, Louisiana and Brazil (*Fertilizer International* 534, p8).

On 27th August, Mosaic confirmed workforce reductions at its Uncle Sam and

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PHOTO: WOODSIDE

Woodside Energy's Beaumont New Ammonia (BNA) plant in Texas.

Faustina phosphate plants in Louisiana, where production remains idled due to sulphur supply constraints. Employees were furloughed and given notice of dismissal. Only maintenance crews remain, alongside sulphur and ammonia plant staff.

Mosaic's Bartow, New Wales and South Pierce production sites in Florida have also been operating at reduced rates, while several Brazilian operations remain curtailed or idled.

Reporting by **Justin Rackleff**, CRU's Americas lead, fertilizer value chain.

Beaumont New Ammonia plant under review

Woodside Energy has launched a strategic review of its Beaumont New Ammonia (BNA) plant in Texas.

This potentially opens the door to its divestment.

The Australian-headquartered company made the announcement in a 25th August briefing accompanying its half-year results.

Liz Westcott, Woodside's CEO, told analysts that, since the Beaumont blue ammonia plant is now operational, it is "the optimal time to review its place in our global portfolio". The company "will explore all options to determine the best value for Woodside", she added.

"The reality is that markets for emerging lower carbon opportunities, including hydrogen, ammonia, and carbon capture and storage, have developed more slowly than anticipated. Therefore, the targets no longer align with evolving technology, current policy settings and customer demand," Westcott said.

When asked directly by UBS analyst Tom Allen whether the review points toward a full divestment or a partial sale, Westcott said there was currently "no determined pathway".

The review sits alongside Woodside's decision to abandon plans to commit $5 billion of capital to new energy projects by 2030. The company is also retiring its Scope 3 investment and emissions abatement targets.

Woodside assumed operational control of Beaumont in March. The company confirmed that its production during the first half of 2026 was "constrained by third party feedstock availability", a situation that was expected to continue into 2027. Woodside is, however, continuing to deliver ammonia cargoes to domestic and international markets from the plant, the company said.

Responding to a separate question on hydrogen, Westcott said Woodside continues to explore new energy opportunities, including hydrogen and CCS alongside ammonia, but that any further investment "will need to compete for capital" and deliver "strong returns for the benefit of all our shareholders".

Woodside bought BNA from OCI Global in 2024 for $2.35 billion. The plant has an ammonia production capacity of 1.1 million tonnes per annum (t/a), according to CRU's Asset Platform.

Role of fertilizers in feeding the world largely unrecognised

Only one in five US adults knows that roughly half of global food production relies on mineral fertilizers, according to a new poll released for Global Fertilizer Day.

A YouGov survey of 1,271 US adults, commissioned by the International Fertilizer Association (IFA), found that while most people understand what fertilizers do, far fewer recognise the role mineral fertilizers play in global food security.

Of those questioned, two-thirds had a basic understanding of fertilizers. 66% of respondents correctly identified that their main purpose is to provide crops with the nutrients they need to grow, when presented with a list of options. Furthermore, 60% selected nitrogen, phosphorus and potassium as the nutrients required by crops in the largest amounts.

But when asked what proportion of global food production they thought depended on mineral fertilizers, only 20% correctly selected "around half". More than a third (36%) said they did not know, while the other responses were distributed both above (24%) and below (20%) the correct figure.



PHOTO: TFI

Global Fertilizer Day takes place on 13th October each year to celebrate mineral fertilizers and raise public awareness.

Public understanding was limited in other ways. The survey revealed, for example, that roughly one in every twelve people (8%) believed the main purpose of fertilizers was to kill insects and other crop pests.

The poll also found considerable uncertainty about the wider contribution of mineral fertilizers:

- 44% thought mineral fertilizers were essential to feeding the existing human population, while 43% did not know and 13% thought the statement was false.
- 31% thought mineral fertilizers could reduce the need to use additional land to grow food, while 53% did not know and 16% thought they could not.

Commenting on the polling results, Alzbeta Klein, IFA's CEO and director general, said:

"These findings show that much more needs to be done to explain the essential role mineral fertilizers play in feeding today's population and enabling farmers to produce more food from limited agricultural land.

"By working with our members across the global fertilizer supply chain, we want to encourage a much broader and better-informed conversation about what it takes to feed the world."

The polling research, undertaken on 28-30th September 2026, was carried out to support the launch of IFA's #FoodStartsHere social media campaign. This nine-month campaign will highlight the essential contribution of mineral fertilizers to feeding the world via a series of short films, visual media and explainers.

Global Fertilizer Day takes place on 13th October each year to celebrate mineral fertilizers and raise public awareness.

ALGERIA

Integrated phosphate megaproject officially launched

Algeria's large-scale integrated phosphate project (IPP) was formally inaugurated during a visit by a ministerial delegation to Annaba, Souk Ahras and Tébessa provinces on 23-24 September.

The delegation was led by Algeria's hydrocarbons minister Mohamed Arkab. He was accompanied by Abdelkader Jalaoui, the minister of public works, and Mourad Hanifi, the minister of mines, together with Noureddine Daoudi, the CEO and chairman of state oil company Sonatrach.

Sonatrach and its partner the Algerian Fertilizers Company (AFC) are developing a 2.4 million tonnes per annum (t/a) capacity phosphate plant at Oued Keberit in Souk Ahras province as part of the first



PHOTO: ALGERIA PRESS SERVICE

Algeria's hydrocarbons minister Mohamed Arkab lays a foundation stone at the Bled El Hadba mining site to mark the official launch of the country's integrated phosphate project (IPP).

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phase of the IPP project. This will source phosphate rock from the Bled El Hadba deposit in Tébessa province.

The phosphate megaproject involves:

- The mining of 5.5 million t/a of phosphate rock at Bled El Hadba and the construction of an on-site beneficiation plant with the capacity to produce 3.2 million t/a of phosphate rock concentrate.
- The construction of a production complex at Oued Keberit with the capacity to manufacture 2.4 million t/a of phosphate fertilizers and 570,000 t/a of urea. The complex will also produce intermediates such as sulphuric acid, phosphoric acid and ammonia on site.
- The construction of a dedicated export terminal at the Mediterranean port of Annaba.



Profertil's existing urea plant at Bahía Blanca, Argentina.

PHOTO: SAIPEM

The ministerial delegation visited all three project locations to formally launch the start of construction. Minister Arkab laid foundation stones at both the Bled El Hadba mining and Oued Keberit production sites as part of the official ceremonies.

Sonatrach and AFC signed engineering, procurement and construction (EPC) contracts for the first phase of the IPP project with Italy's Saipem and China Harbour Engineering Company (CHEC) on 12th August. Saipem's €500 million EPC contract covers phosphate processing at Bled El Hadba and fertilizer production at Oued Keberit. CHEC will build the dedicated port facilities at Annaba.

SPAIN

Fertiberia launches new Trixia biotechnology platform

Fertiberia is rebranding its existing agricultural biotechnology company Trichodex® as Trixia®. The launch is part of a new global growth strategy for its biologicals business.

Trixia plans to scale up its market presence across the Iberian peninsula, Europe, the Middle East, Africa and Latin America, as well as expand into new geographies.

The new business will capitalise on Trichodex's scientific and technological track record and combine this with Fertiberia's financial backing, industrial scale and commercial reach.

The branding change is a natural evolution, according to Fertiberia:

"TRICHODEX® is evolving and becoming TRIXIA®, an identity that better reflects our vision for the future and our role as a biotechnology partner for farmers, distributors and companies in the agricultural sector. The same scientific knowledge, the same experience in agricultural biotechnology and the same commitment to innovation, now under an identity designed to continue driving the agriculture of the future."

In a further sign of continuity, Khalid Akdi Elaroussi has been appointed Trixia's general manager, having previously led Trichodex.

"The technologies integrated into the TRIXIA® platform regenerate soil health by activating and balancing its microbiome, improve plant nutrition and nutrient availability, enhance crop performance and resilience to stress, and support the transition towards more productive, sustainable and regenerative farming systems," Khalid Akdi Elaroussi said. "TRIXIA® is not starting from scratch; it is the evolution of TRICHODEX®, now equipped with greater ambition and ready to bring more than three decades of expertise and innovative spirit to a global stage."

Trichodex was founded in 1991 and has spent more than 35 years researching, developing and manufacturing products based on microorganisms and biological processes. These are designed to improve soil health, crop yields and the sustainability of agricultural systems.

Trixia will continue to operate from Trichodex's existing Dos Hermanas site in Seville and develop products aimed at:

- Improving soil and microbiome health
- Boosting crop yield and quality
- Promoting resilience to adverse conditions
- Promoting more efficient, healthier and sustainable agricultural models.

Trixia offers more than 25 products designed to boost plant performance and health and improve soil health and productivity. The company's microbial biostimulants (biofertilizers) include Velltrix®, a registered biofertilizer formulated with *Trichoderma asperellum*, and Vibacter® and Bacnifos®, both of which contain plant growth-promoting rhizobacteria (PGPR).

In February, Trichodex and the University of Lisbon published a scientific study showing how microbial biostimulants can boost crop growth and help crops withstand water scarcity from their earliest stages of development.

"We are facing a structural shift in agriculture. The challenge is no longer just providing nutrients, but ensuring crops can utilize them as efficiently as possible. That is why we develop solutions with consistent and scalable results available to farmers independently or built directly into our fertilizers as embedded technology, maximizing their agronomic and environmental efficiency," said Juan Pablo Llobet, CEO of Grupo Fertiberia.

He added: "What sets TRIXIA® apart is its technology, which is capable not only of developing superior products, but also of integrating them into major agricultural production systems, such as solid fertilizers, fertigation, seed treatment, or integrated management programs. This combination enables us to scale biological innovation and turn it into effective, sustainable solutions ready to address the real challenges of agriculture."

FERTILIZER INDUSTRY NEWS

ARGENTINA

Profertil selects Saipem for Bahía Blanca expansion study

Profertil SA has awarded Saipem a technical evaluation and design services contract for a planned expansion of its fertilizer complex in Bahía Blanca, Argentina.

The project to develop a new urea plant with a production capacity of 4,450 tonnes per day (t/d) was announced on 29th September. It will integrate Topsoe's ammonia production technology, Saipem's proprietary urea technology and thyssenkrupp Uhde's granulation technology.

Saipem's contract is expected to last 11 months and covers technical services, licensors' design packages and a structured proposal for subsequent development phases. Saipem will execute the contract in partnership with Techint Engineering & Construction.

Profertil's existing plant at Ingeniero White, Bahía Blanca, has a granulated urea capacity of approximately 1.44 million tonnes per annum (t/a). The company completed a $90 million turnaround of the existing complex in December 2025.

Profertil's announcement follows a separate decision by Pampa Energía in July to go ahead with the construction of a $2.7 billion fertilizer complex at Bahía Blanca (*Fertilizer International* 534, p8). Its subsidiary Fértil Pampa is set to build an ammonia plant and two urea trains with a combined production capacity of 2.1 million t/a (6,000 t/d).

Saipem says Profertil's new expansion plan at Bahía Blanca is a "strategic initiative aimed at increasing local urea production capacity and supporting the country's agricultural value chain". The extra capacity will target growing demand for fertilizers in Argentina and the wider regional market.

AFRICA

€1.3 million K+S project offers support to 10,000 East African farmers

K+S Minerals and Agriculture GmbH and its implementation partner DEG Impulse gGmbH have jointly launched the €1.3 million 'Grow Eastern Africa' project in Kenya and Uganda.

The two-year project is funded equally from public and private contributions and will run until December 2028. It is being co-financed by the develoPPP programme of the German Federal Ministry for Economic Cooperation and Development (BMZ).



The 'Grow Eastern Africa' project in Kenya and Uganda will help farmers increase their crop yields by more than 20%.

PHOTO: K+S

The joint project aims to help at least 10,000 smallholder farmers in Kenya and Uganda increase their crop yields by more than 20%. This will be achieved by:

- Offering hands-on training on climate-smart agriculture.
- Providing at least 2,000 soil analyses and developing crop-specific fertilization recommendations based on the results.
- Promoting the use of organo-mineral fertilizers on more than 100 farms.

The project will also establish sustainable fertilizer distribution routes in partnership with local agricultural dealers, cooperatives and other organisations. An overarching aim is to make the region's smallholder farmers more resilient to the impacts of climate change.

"Productive and climate-resilient agriculture is an important prerequisite for food security and improved economic opportunities in rural areas. Public-private partnerships such as Grow Eastern Africa combine the strengths of development cooperation and the private sector, helping to advance sustainable solutions locally," said Dr Miriam Amine, project manager at DEG Impulse.

K+S has been active in East Africa since 2013 (*Fertilizer International* 469, p36) and operates local subsidiaries in the region through K+S Fertilizers Kenya and Grainpulse Limited. These companies work in close collaboration with farmers and support the development, production and distribution of crop-specific fertilizer solutions tailored to local needs.

"With Grow Eastern Africa, we aim to combine our expertise in plant nutrition with the knowledge and needs of farmers on the ground. Balanced fertilization tailored to both soil conditions and specific crops can help sustainably increase yields while strengthening resilience to climatic changes," said Dr Carin-Martina Tröltzsch, deputy chair of the board of executive directors of K+S.

By delivering higher yields, encouraging more efficient nutrient use and promoting climate-smart farming practices, Grow Eastern Africa aims to improve both food security and economic opportunities for participating smallholder farmers.

"Agriculture in Kenya and Uganda faces challenges such as low and unbalanced fertilizer use, limited access to agronomic knowledge, soil degradation, and increasingly frequent weather extremes. Grow Eastern Africa addresses these challenges by combining science-based plant nutrition with practical know-how and strong local networks," commented project manager Florian Pickert, director Fertilizer Africa at K+S.

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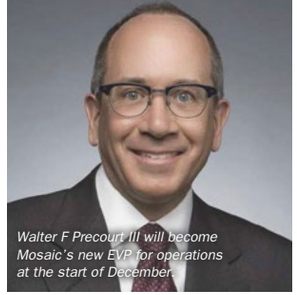
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People



Walter F Precourt III will become Mosaic's new EVP for operations at the start of December.

PHOTO: MOSAIC

The Mosaic Company has announced that **Karen Swager**, executive vice president (EVP) for operations, plans to retire. She will be replaced by **Walt Precourt**, senior vice president (SVP) and chief administrative officer (CAO), from 1st December.

Ms Swager will continue to serve as a senior adviser until her retirement in the second quarter of 2027.

Mr Precourt joined Mosaic in 2009. He has led the company's phosphate and potash businesses, with additional responsibilities for environmental, health and safety (EHS) and strategy. In his current role as CAO, Walt leads the company's procurement, human resources, public affairs and global business services groups.

He has been a member of Mosaic's executive leadership team since 2014.

"I am pleased that Walt will lead our operations as we continue to navigate challenging business conditions, especially in phosphate," said Bruce Bodine, Mosaic's president and CEO. "Walt's thoughtful leadership and thorough knowledge of Mosaic's complex operations are well known and widely appreciated across the company. I have every confidence that he will build on Karen's legacy of steady improvements at our operating sites."

As well as leading global operations, Mr Precourt will be in charge of the company's EHS function. He will continue to be based in Mosaic's Tampa executive office.

Ms Swager's career at Mosaic and predecessor companies spans over three decades. She served as general manager of several Mosaic operating plants, led the potash business and the company's supply chain, and assumed the role of EVP for operations in 2023.

"Karen has had a remarkable career at Mosaic," Mr Bodine said. "Her legacy of leading with heart and courage, and of driving safety, efficiency and value, will be forever etched in our company's history. I know that everyone at Mosaic joins me in wishing her all the best in retirement."

Stephanie Vrakas Bagshaw became the new CEO of TIMAC AGRO's United States subsidiary on 24th September. She will lead the company's next phase of development in the US, with a focus on growth, customer proximity and operational excellence.

"The U.S. is an important market for TIMAC AGRO and one where we see significant potential for further development. Stephanie brings strong experience in leading businesses, driving growth and strengthening execution, together with a deep understanding of the U.S. market. Her appointment will help us build on what has already been achieved and take TIMAC AGRO USA into its next phase. I am very pleased to welcome her to TIMAC AGRO," said Guillaume Jouslin de Noray, CEO of TIMAC AGRO International.

Stephanie Vrakas Bagshaw brings to the company more than 15 years of experience in business leadership, strategy and growth. She has led regional and global businesses (valued at up to $350 million), with responsibilities spanning business performance, strategic marketing, innovation, pricing and cross-functional leadership.

Most recently, Vrakas Bagshaw served as the global market leader at Arclin for personal protection and its Nomex® and Kevlar® brands. Before joining Arclin, she spent five years at DuPont in global and North American market leadership roles for Nomex® and Kevlar®. Previously, she held business development roles at Arkema and began her career at DuPont as a research chemist.

Stephanie is a named inventor on patents for soil-conditioning and crop-protection technologies. She holds an MBA from Temple University, Philadelphia, Pennsylvania, an MSc in materials science and engineering from the University of Delaware, and a BSc in chemistry from Bryn Mawr College, Pennsylvania.

"I am excited to join TIMAC AGRO USA and to have the opportunity to lead the business at such an important stage in its development. My first priority will be to spend time with our teams, in our operations and in the field, and seek input from growers and partners. I look forward to building on the experience and expertise already in place and working together to unlock the opportunities ahead of us in the U.S. market," Stephanie Vrakas Bagshaw said.

Daniil Bazdyrev resigned as the CEO and vice-chairman of the board of directors of Fertilizantes Heringer on 13th October. **Fernando Yagura Maeda**, the company's current CFO and investor relations officer, will take on the additional role of CEO until further notice. **Georgii Grachev** will fill the vacant vice-chairman position on the board of directors.

The company wished Mr Bazdyrev success in his new endeavours and expressed its sincere gratitude for his valuable service and dedication throughout his tenure. ■

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FAI Annual Seminar 2026, NEW DELHI, India
Contact: Secretary, The Fertiliser Association of India
Tel: +91-11-46005204
Email: secy@faidelhi.org

DECEMBER

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AFA/Prayon Fertilizers Re-Engineered, Technical Workshop, LIEGE, Belgium
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Tel: +202-23054464 / 67
Email: events@arabfertilizer.org

JANUARY 2027

17-20
CRU/Argus Fertilizer Latino Americano 2027, RIO DE JANEIRO, Brazil
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MARCH

16-18
CRU Phosphates+Potash Expoconference, ROME, Italy
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16-18
CRU Nitrogen+Syngas Expoconference, ROME, Italy
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16-18
CRU Future Fertilizers Summit 2027, ROME, Italy
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Fertilizer INTERNATIONAL
COVER FEATURE

Naq Global – green chemistry for the entire fertilizer value chain

Naq Global supplies vegetable oil-based additives across the fertilizer value chain – from flotation reagents in the mine to coatings that protect fertilizers all the way to the field. In an exclusive interview, *Fertilizer International* speaks to **Avdhesh Mathur**, the company's President and CEO, about market turbulence, green chemistry, cost-effectiveness and Naq Global's customised product offering, one that covers every step of the value chain.

Introducing Naq Global

It's a pleasure to speak to you, Avdhesh, ahead of the Fertiliser Association of India's Annual Seminar in New Delhi. **Although CRU knows the company well, Naq Global may be new to some of our readers. Can you therefore introduce the company, please?**

"Naq Global develops and manufactures specialty chemicals that improve fertilizer quality. What sets us apart is our 'Green Technology': instead of petroleum-based chemistry, our products are based on vegetable oils and fats.

"We have six manufacturing plants – three in Brazil and one each in the United States, India and Morocco – and sales and technical service offices in ten countries across the Americas, Europe, Africa, the Middle East and Asia. Today, we offer around 250 formulations and serve more than 200 fertilizer companies globally."

A dynamic market

2026 has been one of the most turbulent years on record for the fertilizer market. Conflict in the Middle East has disrupted shipments through the Strait of Hormuz – a route that, according to IFA, carried 34% of global urea trade and 49% of traded sulphur in 2024 – while China has restricted phosphate exports and sulphur prices have soared. **How do you see the situation? I imagine reducing product losses and maximising process efficiency are more important than ever in times when supply is constrained.**

"Yes, this is an extremely dynamic time for the fertilizer industry globally. You're right: when supply is tight and raw materials are expensive, every tonne of fertilizer counts – and so does every tonne of rock, acid and finished product that is lost along the way.

"We are pleased to offer the best high-performance solutions to optimise cost-effectiveness. For every step of the fertilizer supply chain, we have new technologies that maximise productivity at the lowest cost.

"These provide better recovery in the mine, more stable operation in the acid plant, higher-quality granules, and product that arrives at the farm in the same condition it left the factory. Having our own plants close to customers in four countries also means we can keep supplying them reliably when global logistics are under pressure."

Preserving quality is paramount

It's great to feature Naq Global on the front cover of our November/December magazine. **On the cover, you specifically ask why the fertilizer industry needs Naq Global's specialty chemicals. So, what's your answer?**

"It's because fertilizer quality is decided long before the product reaches the farm. A granule may be stored for months, handled many times, shipped across oceans and moved by truck before it is applied.

"Along that journey, caking, dust and moisture uptake cause real problems – product losses, reprocessing, customer complaints, cargo claims and unsafe working conditions. That matters to the producer, and it matters just as much to the traders, importers and blenders who handle the product afterwards.



PHOTO: NAQ GLOBAL

Naq Global President and CEO Avdhesh Mathur.



PHOTO: NAQ GLOBAL

Naq Global's production plant in Delta, Minas Gerais, Brazil, one of six worldwide.

"Upstream, it is the same story. In the mine, the right collector or frother decides how much phosphate you recover. In a phosphoric acid plant, foaming, scaling and poor filtration cost production every day.

"Specialty chemicals are a small line in a producer's budget, but they protect a very large value. Remarkably, our experience is that for every dollar invested in Naq Global products, the fertilizer industry saves at least 100 dollars."

That is a strong claim. Where do those savings come from?

"From avoiding losses that are often invisible until something goes wrong. Caked product has to be broken up or reprocessed. Dusty product means material lost to the air, cleaning costs and health and safety issues. Off-spec cargoes lead to claims and discounts.

"In the plant, better flotation recovery, fewer shutdowns for descaling and faster filtration translate directly into extra tonnes and better margins. When you add all of that up, the cost of the additive is very small in comparison."

Pioneering 'Green Technology'

Naq Global is well known in the industry as a pioneer in plant-based fertilizer additives. Why did the company decide to move away from petroleum-based chemistry?

"Most conventional additives are based on mineral oil and other fossil-derived chemicals, and some have relied on heavy metals or formaldehyde. That is not ideal for the environment, for the soil or for the people who handle these products every day. We asked ourselves a simple question: if fertilizers exist to feed crops, why should the chemicals that treat them work against soil health?

"So we replaced heavy metals, formaldehyde and fossil fuels with sustainable vegetable oils and fats. Our products are biodegradable, and because we manufacture our own high-purity vegetable oils and surfactants, we control quality from the raw material to the finished product."

Are there sustainability benefits beyond biodegradability?

"Yes, our model is based on the circular economy. We take by-products from the vegetable oil industry and turn them into additives that go back into agricultural production.

"That reduces the use of fossil fuels and lowers CO_2 emissions compared with petroleum-based alternatives. For fertilizer producers who are now being asked about their carbon footprint by regulators and by the food companies they supply, that matters more every year."

Innovation and application

I'm guessing innovation is a priority for Naq Global. How do you keep your product portfolio moving forward?

"We have a very wide range of products, with multiple products in each range – all using plant-based, ultra-safe chemistry. More importantly, our technical teams are constantly innovating new products and developing the existing ones.

"Our customers bring us new challenges every day, and we are proud to have highly experienced and qualified technical experts with decades of experience to solve them."

You mentioned your technical experts. How do they support customers once a new product reaches the plant?

"In our experience, a good product is only half the job. What really makes a large difference for our customers is how that product is applied. Even the most innovative technology may not work well, or may not work at all, if it is not applied properly.

"That is why our technical services team is so important to us. For each customer, our engineers look at how and where the product goes into the process, at what rate and under which conditions, and then optimise the application for that particular plant.

"They work very closely with the client's own people, from the first trial through to full production, and they stay involved afterwards. When an innovative product is applied in the best way, the customer gets the full package, and that is when they see the biggest benefits."

Customised solutions

Naq Global's products are bespoke with an emphasis on customised solutions, rather than off-the-shelf products. Why is that important?

"Because no two fertilizer plants are the same. The rock, the process water, the granulation technology, the climate, the storage time and the route to the customer are all different. A product that works perfectly in one plant can fail in another.

"So we start with detailed chemical and engineering analysis – of the fertilizer, the raw materials and the process – and then tailor the formulation to that specific situation. Our technical team works on site with the customer, and we follow the product from the factory to the farm.

"That is how we help producers maximise their margins: the right chemistry at the right dose, no more and no less."

Protection from plant to field

Caking and dust are long-standing headaches for the industry. How do your coatings protect fertilizer throughout the supply chain?

"A coating has to last for the whole life of the product, not just the first few weeks. In Brazil, for example, fertilizer may be imported or produced, stored at the port, moved hundreds or even thousands of kilometres inland and stored again before the planting season – often in hot and humid conditions.

"Our anti-caking and anti-dust coatings are designed to keep granules free-flowing and dust-free through production, storage, handling and application."

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The need for nutrient use efficiency

Nutrient use efficiency (NUE) is all about ensuring that the nutrients applied through fertilizers are taken up by the crop instead of being lost to the environment. How do Naq Global's products contribute to NUE?

"Directly, through our controlled-release coatings and nitrogen stabilisers, which help keep nutrients available in the root zone for longer and reduce losses to the air and to water. Our nitrogen stabiliser technologies are unique because they deliver multiple benefits in a single product.

"The same treatment that stabilises the nitrogen also provides dust control, caking control and colouring. That not only gives high nutrient use efficiency but also brings real cost benefits – through one product and one application step instead of several.

"They can also contribute indirectly through quality: a fertilizer that arrives intact and spreads evenly is used more efficiently than one that is caked or dusty. Better nutrient use efficiency means more crop per tonne of fertilizer – that's good for the farmer's income and good for the environment."

Brazil at the centre

Brazil is central to Naq Global's strategy. Why is this Latin American agricultural powerhouse so pivotal for the business?

"We have been in Brazil since 2007, and today three of our six factories, our largest investments and most of our workforce are here. We are well positioned and growing together with the Brazilian industry.

"Brazil is one of the world's largest fertilizer markets. But according to ANDA, the national fertilizer association, it still imports around 85% of the fertilizers it uses – some 41.3 million tonnes in 2024 against 7.2 million tonnes of domestic production – and its logistics costs are high.

"We therefore help producers, importers and blenders overcome some of these structural bottlenecks – with products that protect quality over long distances and long storage times, and with local manufacturing and technical support close to the customer."

Beyond Brazil, you manufacture in the United States, India and Morocco. What role do those markets play?

"Each of them is strategic in its own way. Morocco holds around two-thirds of the world's phosphate rock reserves, so being there puts us at the heart of the global phosphate industry – from beneficiation to phosphoric acid and finished fertilizers.



PHOTO: NAQ GLOBAL

Naq Global team and workers at the company's Delta production plant, Minas Gerais, Brazil.

"India is one of the world's largest fertilizer consumers and importers. In the last financial year, its urea imports rose by more than 80% and its DAP imports by more than a third, so product quality on long sea voyages and in storage is critical.

"The United States relies on imports for more than 90% of its potash and about a third of its urea and phosphate fertilizers, and in late 2025 it added potash and phosphate to its list of critical minerals.

"In all of these markets, producers want the same things: higher productivity, lower costs and more sustainable inputs. That is exactly what we offer."

> **"For every dollar invested in Naq Global products, the fertilizer industry saves at least 100 dollars."**

Looking ahead – expansion and innovation

What are Naq Global's plans for the business over the next few years?

"We are expanding rapidly in multiple regions of the world, including North America, Europe, the Middle East and Asia, and we will keep investing in new technologies. Naq Global has always been the technology leader in this field, and we will continue to push the boundaries.

"We also have a wide variety of exciting new product ranges coming up. Innovation is the key to our success: we keep working on technologies, products and processes that reduce costs and increase efficiency and sustainability.

"Demand for fertilizers will keep growing, driven by the expansion of agriculture and the world's growing need for food, energy and housing. Brazil will remain a protagonist in that story, and so will Naq Global."

Finally, what message would you like to leave our readers with?

"Fertilizers are strategic inputs for global food security and economic development. My message to the industry is that it does not have to choose between performance, cost and sustainability – with the right chemistry, it can have all three.

"And to the farmers at the end of our value chain, I want to say this: as fertilizers keep evolving, their economic viability will keep improving. After all, they carry the great moral responsibility of feeding a constantly growing population. We are moving towards a more sustainable future, and we hope everyone will join us on our journey." ■

Water-soluble fertilizers – delivering nutrients efficiently

Farmers and the wider agricultural value chain are increasingly looking beyond conventional fertilizers to water-soluble fertilizers (WSFs) and other specialty products that improve nutrient efficiency. What does this mean for food security, crop performance and overall sustainability? **Royie Mashiah** of ICL Growing Solutions provides some answers.



PHOTO: ICL

Staff celebrating the grand opening of ICL's new large-scale water-soluble fertilizer (WSF) plant at Supa, Maharashtra, India, in May. The plant will produce 30,000 tonnes of WSFs each year.

Globally, agriculture is facing increasing volatility – from a geopolitical perspective and in terms of climate change. This is affecting both the supply and price of conventional fertilizers, a situation which is not being matched by firmer farm commodity markets. This is squeezing producers' margins at a time when they are under pressure to produce more, from less, and with a lower carbon footprint to boot.

There are also pressures from a growing global population. This has jumped from two billion to eight billion over the past century, and is expected to reach 10 billion by 2050. Crop yields will therefore need to increase sharply, aided by developments in fertilizer technology.

"We need to grow a lot more food with a lot less arable land," comments Royie Mashiah, specialty fertilizers marketing and portfolio director at ICL Growing Solutions.

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GROWERS TURN TO ENHANCED EFFICIENCY FERTILIZERS

Lower nutrient losses, better nutrient availability

Enhanced efficiency fertilizers (EEFs) are designed to reduce nutrient losses to the environment and increase nutrient availability to crops. They are part of the general drive for more sustainable options in agriculture and food production.

"EEFs include controlled-release fertilizers (CRFs), slow-release fertilizers (SRFs) and stabilised nitrogen fertilizers (SNFs). The latter contain chemical additives that slow the conversion of urea to ammonium (urease inhibitors) and ammonium to nitrate (nitrification inhibitors)," notes Royie.

Precise nutrient release

While SRFs release nutrients at a slower rate than normal, overall release is not well controlled. CRFs, in contrast, offer precise control of the rate, pattern and duration of nutrient release, for a given temperature.

Conventional commodity urea breaks down in the soil releasing ammonia and nitrate. Nitrogen is available to the plant but is also leached and lost to the atmosphere through volatilisation. CRFs reduce these emissions and nitrogen losses by controlling the release of nutrients so they match crop needs much more closely.

"With ICL's new CRF eqo.x, moisture penetrates the coating at a given temperature, releases the nutrients over a defined longevity and then biodegrades," says Royie. "You only need to apply it once to cover the entire growing season, unlike conventional fertilizer which needs topping up as the crop grows. And the availability of nutrients is entirely based on the soil temperature, irrespective of soil type, moisture, pH and so on."

Although commodity urea still dominates the market, demand for EEF products (SRFs, CRFs and SNFs) is rising more rapidly, as growers shift their focus towards nutrient use efficiency.

Market outlook

So what is the market outlook for EEFs? In the EU, there is strong environmental awareness and legislation, meaning urea must be treated and CRF coatings must be biodegradable from 2028. There is also a high level of EEF adoption in Europe's ornamental sector.

Across in the US, the CRF market is growing due to the scale of commodity crop production, with some large production facilities under construction. "Although there is no need for biodegradable coatings [in the US yet], I believe it will get there," comments Royie.

In China, there is high domestic production of CRFs for local use. The use of CRFs in palm oil production is also on the rise in Southeast Asia. In Japan, there is increasing demand for biodegradable fertilizer coatings. Brazil is a good fit for CRFs, thanks to the country's climate and soil types, with usage for cash crops such as coffee and vegetables on the increase. In Africa, there are opportunities for CRF growth from current low levels, although market risks remain. ■

Specialty products are formulated to address the specific nutrient needs of plants, soils and the prevailing application conditions. In doing so, they support crop uptake and reduce environmental losses.

"Every element of our lives is becoming more specialised, from the way we watch television to razors for specific skin types," says Royie. "The world is moving from a product-based one to a solutions-based one: we're selling solutions to fit your specific needs.

"Ultimately, growers need solutions to help them grow more with less, and to cope with more extreme weather. And the specialty nutrient world aims to give growers the relevant solutions."

Value for money


PHOTO: ICL

Royie Mashiah, specialty fertilizers marketing and portfolio director at ICL Growing Solutions.

Falls in affordability driving efficiency

The consequences of this year's Middle East conflict are still playing out. Infrastructure damage, for example, will result in almost 20% of Qatar's LNG capacity remaining offline for 3-5 years. This is going to have a significant impact on gas-based sulphur production, given that Qatar, the world's largest LNG producer, is responsible for placing over one million tonnes of sulphur on the market annually.

Sulphur prices have already rocketed, with a resulting impact on phosphate fertilizer prices and production margins.

"This will affect the entire farming industry," warns Royie. "Grower affordability is very challenging."

He adds: "On the one hand, farmers are having to pay more for inputs and, on the other, they're not receiving strong crop prices. In such volatile times, you need to look at the benefit of products on a per hectare basis, not at cost per tonne – and that's where specialty fertilizers come into play."

One advantage of specialty fertilizers is that they are slightly more insulated from the extremes of price volatility. They are also more sustainable than conventional fertilizers, helping crops to cope with climate change and water scarcity, as well as reducing emissions and losses to the environment, while meeting consumer demands within a regulatory framework.

"Although they may cost more than a commodity fertilizer, they offer better value for money," advises Royie.

For example, a potato grower in the Netherlands might use 660 kilograms per hectare (kg/ha) of calcium ammonium nitrate (CAN) to grow the crop, split over two to three applications. Alternatively, one single application of a controlled-release fertilizer (CRF) at 420 kg/ha reduces field passes and boosts yields by delivering nutrients when the crop needs them.

In various potato trials, the use of CRFs boosted yields by around 4% – from 50 tonnes per hectare (t/ha) to 52 t/ha. At a potato selling price of €250/t, this equates to €500/ha extra income for the same input cost.

"Across 100 hectares, that adds up to an extra €50,000," calculates Royie. "Of course, potato prices can vary but the value equation will always be beneficial for CRF."

By their very nature, specialty fertilizers are not one-size-fits-all. A small-scale rice farmer in India will require a very different product to a large arable unit in Poland, for example, or a greenhouse producing vegetables in Spain. Some products will be applied by hand, others by large-scale equipment or via drip irrigation.

Royie does predict, however, that fertigation – the application of nutrients via drip irrigation systems – will become more widespread as the climate changes.

It is also becoming an ever more attractive opportunity as regulations tighten.

"Fertigation is more efficient compared to the application of solid granules or sprinkler irrigation systems. The continuous application of water and nutrients increases the availability of nutrients to crops, reduces nitrate emissions and saves water," observes Royie.

Nutrient-efficient water-soluble fertilizers (WSFs)

Nutrients must, of course, be fully soluble to be water-applied. Water-soluble NPKs are typically blended from water-soluble specialties such as monoammonium phosphate (MAP), monopotassium phosphate (MKP), calcium nitrate (CN), potassium nitrate (NOP) and potassium sulphate (SOP), observes Royie, together with water-soluble commodities like urea and potassium chloride (MOP).

"The choice between blending water-soluble salts and using a prepackaged NPK depends on various factors," says Royie. "That includes the crop mix, variation and nutritional requirement, the scale of the market and operation, agronomic knowledge, timing and the ability to store product, and finally price sensitivity."

There is also a need to differentiate between the foliar application of WSFs via leaf spraying and their delivery via fertigation, advises Royie, as they are two very different systems. While foliar application will never replace fertigation, in his view, it remains an extremely valuable method for correcting deficiencies and enhancing crop production and quality.

"Water-soluble fertilizers need to be applied based on the specific conditions," Royie advises. "In high-pH soils, you could apply acidic fertilizers, for example, but in greenhouses using a substrate you'd use a water-soluble NPK with less ureic nitrogen, as the substrate can't break urea down into plant-available ammonia."

WSF formulations also need to vary according to crop needs and growth stage. Crops need phosphate for early root development, then nitrate for vegetative growth, followed by potassium as they reach flowering, explains Royie: "You can get an all-in-one mix, or something that's tailor-made, with high trace elements and low chloride content, for example."

What are the market drivers for WSFs?

China, the world's largest WSF market, is pushing for local production for local use. It has a zero NPK growth policy, meaning growers need to improve fertilizer efficiencies rather than using more.

India is the second largest market. The increasing unpredictability of the subcontinent's monsoon rains is driving a shift from irrigation to fertigation, observes Royie. Indeed, the Indian government is subsidising drip irrigation systems in some states. "There is huge growth potential here," he says.

To meet this demand, ICL Growing Solutions has opened a new, large-scale water-soluble fertilizer plant in India. This is helping to improve food security for millions of people at a time when crop production is under serious threat.

The seven-acre facility in Supa, Maharashtra, will produce 30,000 tonnes of WSFs each year, helping local and international farmers to adopt more efficient and sustainable growing practices, while


PHOTO: ICL

ICL's new, large-scale water-soluble fertilizer (WSF) plant at Supa, Maharashtra, India.

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increasing yields and strengthening long-term food security.

"With geopolitical tensions disrupting global trade routes and delaying fertilizer shipments through such a key corridor as the Strait of Hormuz, building local production capacity is essential," says Nir Ilani, President of ICL Growing Solutions. "This facility enhances India's supply resilience and ensures farmers have consistent access to high-quality solutions."

The launch comes at a critical time, as the country relies heavily on fertilizer imports and is facing supply disruptions due to geopolitical tensions.

"These delays are already affecting fertilizer availability worldwide and could pose long-term risks to food security if not addressed," says Nir. "By manufacturing WSFs within India, we aim to reduce dependence on cross-border supply chains, diversify production routes and ensure more reliable access to essential agricultural inputs."

The investment also reflects ICL's long-term commitment to India's agricultural market, and its belief in the role specialty fertilizers can play in supporting food security. "This is an important step forward in our mission to help farmers produce more, improve quality, and use resources more efficiently," sums up Nir.

While Brazil, with its big focus on foliar applications, is third in the global WSF rankings, the availability of credit is limiting growth potential currently.

The US market sits in fourth place. With WSF use driven by water scarcity and fertilizer import tariffs, the country's growers are looking to improve nutrient use efficiency to help improve affordability.

Across the Atlantic, the EU's developed agricultural market is seeing extra growth for WSFs triggered by the bloc's 'Green Deal' policy. This aims to reduce nutrient losses by at least 50% by 2030 and cut chemical fertilizer use by at least 20% over the same timescale. In addition, the introduction of the EU's carbon border adjustment mechanism (CBAM) at the start of the year has imposed a carbon tax on certain fertilizer imports.

"That is driving more efficient practices and a move away from urea to less CBAM-intensive NPK products," comments Royie. "And the heating climate is driving more drip irrigation, even in Eastern Europe."

The consumption of WSFs is also growing in other countries and regions, he says.

SPOTLIGHT ON BIOSTIMULANTS: A VERY CROWDED MARKET

Biostimulants and biological crop protection products, by complementing and enhancing fertilizers, play a vital market role, says Royie: "A biostimulant is any substance and/or micro-organism that is applied to plants, with the aim of enhancing nutrient efficiency, abiotic stress tolerance and/or crop quality traits, regardless of its nutrient content."

Biostimulants are typically biological agents like humic acids, amino acids, seaweed, bacteria, fungi and molecules derived from their metabolic activity that increase the plant's natural capabilities.

Non-microbial products have a larger market with slower growth potential, while their microbial counterparts are more niche but offer greater growth opportunities.

"There are so many different companies in this area; it's a very crowded market," explains Royie. "I believe there will be some consolidation eventually, and those who can prove outcome-driven results – based on data – will prevail."

Market drivers for biostimulants include the push for sustainability and reduced emissions, rising demand for organic and premium food, and climate change adaptation. Royie predicts the recent EU Fertilising Products Regulation (FPR), by providing clear standards and legitimacy for biostimulants, will further boost growth.

Combining biostimulants with fertilizer or crop protection products also creates added value, Royie notes: "You benefit from synergistic effects, and reduce the number of passes in the field."

In Saudi Arabia, the government is targeting the development of greenhouses as it invests heavily to boost food security. Water scarcity in Africa, meanwhile, is driving water and nutrient use efficiencies – although market risks are capping growth opportunities. Mexico is another growing market, particularly for water-soluble NPKs, while Vietnam is increasing its adoption of fertigation systems.

Innovative fertigation and foliar options

So which WSF products are most suited to fertigation? For those seeking chloride-free options in ICL's range, Royie says **Solinure** and **Solinure GT** are good choices, with the former also coming in a high trace-element (micronutrient) package. For open-field, chloride-tolerant crops, **Solinure FX** is high in chloride (>3%) and comes without added trace elements.

The introduction of specialty fertilizers like **Solinure Polymarine** reflects the move towards multi-functional crop nutrient products. This chloride-free NPK fertilizer combines trace elements with advanced phosphate technology and added seaweed.

Moving to foliar WSF products, ICL's **Nutrivant** combines a crop-specific nutrient mix with a unique adjuvant technology (fertivant) that breaks through the leaf cuticle. This ensures the nutrient spray is quickly taken up by the plant via a long-lasting, even product spread. "This is important – because if there are still droplets on the leaf after 15 minutes then these can cause scorch," explains Royie.

Developed in response to advanced agricultural technology, **Fertibuzz** is a new type of WSF specifically designed for foliar spraying by drones. Because these small flying devices can't carry much water, this is a low-volume, high-concentration product that doesn't cause leaf damage.

Summing up

So where does Royie see the greatest opportunity for growth in the specialty fertilizer market?

"Climate change is driving WSF use, but you can't discount CRFs or biostimulants either. Ultimately, it all comes down to efficiencies, which will drive growth in all markets," he predicts. "Growers who use specialty fertilizers keep using them because they see the value in them."

In addition, the drive to decarbonise agriculture and reduce emissions could potentially yield financial rewards for those using such products.

"We're not yet seeing carbon credits massively improving the value for farmers, but there is interest and greater co-operation within the supply chain," concludes Royie. "I'm very optimistic that in the coming few years we will get there."



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IFFCO: committed custodians of Indian agriculture

In an exclusive interview, *Fertilizer International* sat down with **K.J. Patel**, the Managing Director of Indian Farmers Fertiliser Cooperative Limited (IFFCO), India's largest fertilizer producer, ahead of the Fertiliser Association of India's Annual Seminar in New Delhi, 26-28 November.

A production giant and an innovator

IFFCO is a farmer-owned Indian cooperative established in 1967. It supplies fertilizers and agricultural services through a network of more than 35,600 member societies, reaching more than 50 million farmers.

Its main business is making and selling fertilizers, including urea and phosphate-based products. It also supports farming communities by offering insurance, rural finance and logistics services.

IFFCO produced 9.062 million tonnes of conventional fertilizers in 2025-26. This total was divided between 4.828 million tonnes of urea, produced at the company's Kalol, Phulpur and Aonla sites, and 4.234 million tonnes of phosphate, compound and water-soluble fertilizers (WSFs) from production centres at Paradeep and Kandla.

Paradeep produced a record 2.231 million tonnes of NP and diammonium phosphate (DAP) fertilizers in 2025-26. Kandla's 2.003 million tonnes output, meanwhile, was split between DAP, NP/NPKs and WSFs.

IFFCO has expanded its nanofertilizer output in recent years, producing nearly 27 million bottles of Nano Urea Plus and Nano DAP during 2025-26. The company operates five nanofertilizer plants across four locations: two units at Kalol and one each at Phulpur, Aonla and Bengaluru. The Bengaluru unit began commercial production in June 2025.

IFFCO combines its substantial manufacturing might with market reach via an extensive distribution network. The company continues to balance investment in specialty and innovative fertilizer products with its established role of supplying essential crop nutrients to farmers.



PHOTO: IFFCO

K.J. Patel, the Managing Director of IFFCO.

Commitment to supporting India's farmers and agriculture

K.J., it's a pleasure to interview you on behalf of *Fertilizer International* magazine.

Being managing director of India's largest fertilizer manufacturer – a massive cooperative that is farmer-owned – must be an honour and bring with it a wide range of special responsibilities. How would you best describe your leadership role at IFFCO?

"Leading IFFCO is both an honour and a profound responsibility because we are a farmer-owned cooperative serving a more than 50 million-strong farming community across India. I see my role as that of a custodian of the farmers' trust and faith and being a dedicated 'son of the soil' committed to serving their interests.

"Our responsibility extends beyond supplying fertilizers. We work across the agricultural value chain from seeds and soil health to agronomy, farmer education, demonstrations and next-generation crop nutrition. Our focus is to improve productivity while keeping farm inputs affordable and protecting the long-term health of India's soils.



PHOTO: IFFCO

IFFCO's state-of-the-art Nano Fertilizer Plant (NFP) at Phulpur, Prayagraj.

"IFFCO is also expanding from conventional chemical fertilizers towards biofertilizers, nanofertilizers and other specialty fertilizer solutions. Through our extensive cooperative network, our objective is not simply to supply products, but to remain alongside farmers through every stage of their agricultural journey."

Ensuring reliable fertilizer supplies in a challenging market

How does IFFCO's manufacturing capacity contribute to dependable fertilizer supply and high fertilizer availability?

"Reliable fertilizer availability is fundamental to India's food security – and is one of IFFCO's highest priorities. IFFCO currently contributes around 70% of India's DAP production, while our total fertilizer production reached 9.062 million tonnes in 2025-26.

"Our geographically diversified domestic manufacturing base gives us resilience and supports continuity of supply. Continuous improvements in operational efficiency, technology and reliability also enable our plants to respond effectively to the country's requirements.

"At the same time, IFFCO's international joint ventures in urea and phosphatic fertilizers complement our domestic manufacturing capabilities. Together, these strengths allow us to serve farmers with greater confidence and reliability. For IFFCO, manufacturing fertilizer is ultimately about ensuring that no farmer is left without the nutrients needed for the crop and livelihood on which their family depends."

Pursuing new product opportunities

What does the growth in specialty products, water-soluble fertilizers and biostimulants tell us about the changing face of Indian crop nutrition?

"Indian agriculture is becoming increasingly sophisticated, and farmers are seeking more precise and efficient ways of managing crop nutrition. At IFFCO, this reinforces our commitment to balanced nutrition, better nutrient use efficiency and improved soil health.

"Specialty and water-soluble fertilizers, biostimulants and other advanced products can provide targeted nutrition suited to particular crops, soils and growing conditions. They complement, rather than simply replace, conventional fertilizers.

"Our Innovation Hub at Coimbatore, the Nano Biotechnology Research Centre at Kalol and our seed research activities reflect this commitment to innovation. We are also seeing strong synergies between advanced fertilizers, precision agriculture and technologies such as drip irrigation.

"Our objective is clear: to place better science and better technology in the hands of farmers and help them sustainably produce more with greater efficiency and care for the soil."

> **"Our objective is clear: to place better science and better technology in the hands of farmers and help them sustainably produce more with greater efficiency and care for the soil."**

Nanofertilizers go from strength to strength

Innovative nanofertilizers have become a central part of IFFCO's product offering. Is the evidence base convincing – and what key benefits and practical value can they offer farmers?

"Nanofertilizers represent an important part of IFFCO's commitment to next-generation crop nutrition. Our portfolio now includes Nano Urea, Nano DAP, Nano NPK, Nano Zinc and Nano Copper, giving farmers a broader range of advanced nutrient options.

"We produced 26.996 million bottles in 2025-26, while our combined production capacity across five facilities is approximately 290 million bottles annually. Nano Urea Plus and Nano DAP are further expanding farmers' choices.

"The real value of any new agricultural technology, however, lies in its appropriate and responsible adoption. Field evidence, farmer training and correct application are essential. Advanced fertilizers can deliver greater efficiency when used according to recommended technical guidelines.

"Our commitment is therefore not only to develop and manufacture

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PHOTO: IFFCO

IFFCO's Paradeep fertilizer production complex in Odisha on India's east coast. A third sulphuric acid plant was inaugurated at the site in March this year.

nanofertilizers, but also to educate and handhold farmers so that they can use these technologies with confidence and obtain their intended benefits."

Continuous production upgrades

IFFCO has a strong focus on continuous improvement at its production sites. What are the main objectives, and does this approach deliver value for money?

"Continuous technological improvement is integral to IFFCO's manufacturing philosophy. Our objective is to enhance reliability, safety, energy efficiency and process performance while reducing resource consumption and operating costs.

"The Kalol unit is a good example. Our mother plant, commissioned in 1975, continues to demonstrate exceptional operational reliability, including sustained operation at full load or higher capacity.

"Such improvements reduce raw material and energy consumption, strengthen our cost position and contribute to lower carbon emissions. For us, continuous improvement is ultimately about using modern technology responsibly so that every resource is converted into greater value for the farmer and the cooperative."

Commitment to sustainability

Does sustainability remain a priority for IFFCO – and can investments in renewable power, cleaner fuels and water management translate into worthwhile outcomes for agriculture and the industry?

"Absolutely. Sustainability is not a separate initiative at IFFCO; it is increasingly embedded in the way we manufacture, conserve resources and serve agriculture.

"We also installed our first floating solar power plant with a capacity of 100 kWp in 2022-23.

"IFFCO has been committed to water conservation for decades. We have undertaken groundwater-recharge initiatives for around four decades to make better use of rainwater. We have also pursued wastewater recycling and renewable-energy initiatives, including a floating solar project in Odisha.

"These measures demonstrate that industrial efficiency and environmental stewardship can progress together. Our responsibility is to support Indian agriculture today while protecting the natural resources on which future generations of farmers will depend."

> **"Reliable fertilizer availability is fundamental to India's food security – and is one of IFFCO's highest priorities."**

Successful production investments

Which recent projects best demonstrate IFFCO's confidence in the future of domestic fertilizer production and innovation?

"Our recent investments reflect strong confidence in both India's fertilizer sector and the potential of agricultural innovation.

"The Paradeep Sulphuric Acid Plant–III, inaugurated by the honourable Union Home & Cooperative Minister in March 2026, strengthens our domestic manufacturing capabilities. Our Bengaluru nanofertilizer facility began commercial production in June 2025, further expanding our capacity in advanced crop nutrition.

"We are also progressing well with a nanofertilizer manufacturing initiative in Brazil likely to be commissioned in November 2026 – demonstrating IFFCO's growing international presence in this technology. At the same time, the IFFCO-Nanoventions Innovation Hub is strengthening our research and innovation capabilities.

"These investments share one objective: to build manufacturing strength and develop technologies that ultimately serve farmers better."

Continuing success in 2027 and beyond

Looking ahead to 2027 and beyond, what does future success look like for IFFCO and Indian agriculture?

"For IFFCO, success means building a stronger and more resilient fertilizer system that provides Indian farmers with reliable access to crop nutrients while advancing India's journey towards greater self-reliance.

"We see the future in more balanced and efficient nutrient use, wider adoption of innovative and specialty products, stronger domestic manufacturing and continued alignment with national priorities for food security, farmer prosperity and sustainable agriculture.

"Our commitment also extends to strengthening the cooperative movement. We are exploring new cooperative initiatives, including work towards a cooperative for life insurance, while continuing diversification and expansion initiatives such as JIFCO and DAP capacity.

"We firmly believe in the vision of Aatmanirbhar Bharat. This includes developing innovative products from domestic resources, for example, exploring products such as direct application phosphate rock (DAPR) and using India's substantial gypsum resources, including the approximately 50 million tonnes of gypsum stock, for calcium magnesium sulphate.

"Ultimately, our measure of success is simple: stronger agriculture, healthier soils, better productivity and a more secure future for the farmer. IFFCO will continue to stand with India's farmers – with technology, innovation and, above all, an unwavering commitment to their service." ■



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PHOTO: JUSTIN LA BERGE/FLICKR

Nitrogen, potassium and sulphur are better together – here's why

Coordinated nitrogen-potassium and nitrogen-sulphur management offers an opportunity to increase nutrient recovery by the crop, sustain photosynthesis, improve crop quality and reduce the environmental losses associated with unused nitrogen. In this article, Nutrien's Director of Agronomy, **Dr Karl Wyant**, explains how synergies with potassium and sulphur can improve nitrogen fertilizer use efficiency.

Rapeseed crop, Germany.

Introduction

It is widely known that crop productivity depends on the supply of individual nutrients. What also deserves recognition is how much it is also influenced by the synergies between nutrients.

Three nutrients – nitrogen (N), potassium (K) and sulphur (S) – are particularly interconnected. This is because collectively they influence:

- Nutrient acquisition and transport
- Protein synthesis
- Photosynthesis
- Osmotic regulation
- Last but not least, sugar and starch production – which has a strong influence on crop yield and therefore profitability.

Key crop processes (photosynthesis) and the creation of storage compounds (proteins and starches) are influenced by N, K and S, both separately and interdependently. Vitally:

- Nitrogen is incorporated into amino acids, proteins, nucleic acids and chlorophyll.
- Potassium, while not directly incorporated into organic structures, is essential for enzyme activation, ion charge balance, membrane potential and stomatal regulation, as well as the transport of water and sugars.
- Sulphur is required to produce amino acids containing sulphur (cysteine, methionine), iron-sulphur proteins, coenzymes and numerous defence compounds.

Therefore, when N, K and S are applied together as part of a balanced nutrient management programme, this tends to drive higher nitrogen use efficiency (NUE) as the crop can produce more yield per measure of input. Conversely, insufficient K or S supply can restrict the crop response to the applied N input, reducing overall yield and NUE.

Setting the stage

Improved NUE therefore needs to be viewed as an *emergent property* of the whole plant-soil system, rather than as a function of the efficiency of a single nutrient in isolation. NUE includes nitrogen acquisition and transport, as well as the conversion of assimilated nitrogen into harvestable yield. Each of these stages is affected by the availability of other nutrients and by environmental conditions.

Because balanced K and S nutrition supports crop N uptake and utilisation, deficiencies in these two nutrients can result in:

- Reduced nitrogen uptake and photosynthesis
- A decline in yields
- Greater risk of applied N loss from the rooting zone, as it is not being used by the crop.

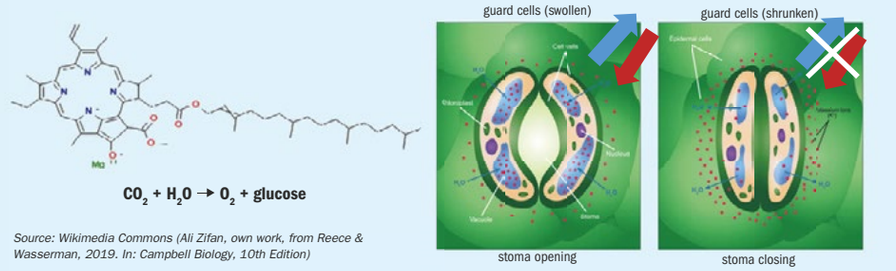
In this article, we explore these beneficial synergies between N and K and between N and S in more detail.

Potassium and nitrogen uptake

The interaction between K and N begins at the root-soil interface. Crops absorb N primarily as the anion nitrate (NO_3^-) while K is absorbed in cation form (K^+). Their dual uptake and transport therefore contribute to electrical neutrality and ionic balance within the plant.

In fact, potassium frequently serves as the counter-ion accompanying nitrate movement through root cells and into the xylem. Without adequate potassium supply to counterbalance nitrate, nitrogen fertilizer uptake can therefore be reduced under K-deficient conditions. Furthermore, switching to sodium (Na^+) as a counterbalancing ion, in the absence of potassium, can be toxic to the plant and limit yield.

Fig. 1: **Nitrogen and potassium are linked during photosynthesis. Nitrogen is required to build chlorophyll (left, top), which helps plants convert sunlight into energy that can be used to grow and make sugars (left, bottom). Potassium helps regulate movement of carbon dioxide (red arrow) and oxygen (blue arrow) – the two essential ingredients for photosynthesis – in and out of the plant. Without adequate potassium, the crop cannot properly regulate gas exchange and the plant loses its photosynthetic efficiency (right).**



Source: Wikimedia Commons (Ali Zifan, own work, from Reece & Wasserman, 2019. In: Campbell Biology, 10th Edition)

Potassium effects on nitrogen assimilation and crop growth

Once N has entered the plant, K supports its conversion into plant biomass. Potassium activates numerous enzymes and contributes to protein synthesis, photosynthetic activity and carbohydrate metabolism.

Adequate K can therefore increase the crop's capacity to assimilate absorbed nitrogen into amino acids and proteins, compounds usually present in high concentrations in the harvested portion of the crop, such as the grain, kernel or beans. Conversely, K deficiency can reduce growth and carbon supply, leaving less metabolic energy available for N assimilation. This can lower the overall return from applied N fertilizers – in terms of the crop yield (kg/ha) per unit of applied nitrogen (kg/ha).

The synergies between N and K are clearly shown during photosynthesis (Figure 1).

Nitrogen is heavily represented in the chlorophyll structure and N shortages can therefore reduce the rate of photosynthesis. Potassium, meanwhile, helps maintain leaf water status, osmotic adjustment and the transport of photosynthates. It also regulates gas movement in and out of the plant. This involves the influx of carbon dioxide (CO_2) – the source of carbon for plant molecules – and the efflux of oxygen (O_2, the waste product).

When K is short, gas exchange can become compromised and the ingredients for photosynthesis can become limiting (e.g., gaseous CO_2). Balanced N and K can thus support both the biochemical capacity for carbon fixation and the physical processes controlling CO_2 entry into leaves. Together they help improve photosynthetic nitrogen use efficiency, meaning that more carbon is fixed per unit of N invested in photosynthetic tissue (Figure 1).

Potassium also promotes the movement of sugars from source leaves to the growing roots, reproductive organs and – importantly – the storage tissues that we usually harvest. This function is highly relevant to N uptake because actively growing roots require carbohydrates for respiration, nutrient assimilation and root production. Better carbohydrate supply, by building and sustaining the root network within the soil profile, helps support the continuous uptake of N, K and other crop nutrients.

Furthermore, improved sugar movement can also enhance the conversion of absorbed N into grain, seed, tuber or fruit yields, versus its retention in vegetative tissues.

The benefits that K provides for N utilisation can be managed using soil testing and other agronomic best management practices. Adding K where supply is already sufficient is likely to have a negligible effect. Indeed, applying excessive N in a K-limited system can be counterproductive, as it can increase vegetative growth without supporting adequate water regulation, stalk strength, carbohydrate transport or reproductive development. Meanwhile, severe N deficiency can limit the crop's response to applied K by restricting growth and root demand.

What emerges here is a central agronomic principle: the supply of both nutrients, N and K, should be synchronised with crop demand to help improve NUE (Figure 2).

Nitrogen and sulphur uptake

Plants acquire sulphur through their roots as sulphate (SO_4^{2-}).

The nitrogen-sulphur relationship is strongly biochemical because both nutrients are required for protein synthesis. The supply of N and S in adequate amounts ensures proper amino acid and protein production in the crop.

This integration means that the plant cannot efficiently convert absorbed N into complete proteins if S supply is inadequate. Likewise, strong S assimilation without sufficient N uptake can limit plant growth as the synthesis of S-containing amino acids and proteins cannot be sustained.

Sulphur is also needed to help proteins fold into their final shape through interactions called disulphide bonds (S-S bonds). Without enough S, plants cannot make the required amino acids or fold proteins properly, even when N supply is adequate (Figure 3).

Sulphur deficiency can disrupt nitrogen metabolism even before visible symptoms develop. When S is insufficient, protein synthesis is constrained because cysteine and methionine (sulphur-containing essential amino acids) cannot be produced in the amounts required. Thus, if S is missing from the ingredient list, supplying more N does not always result in more protein and yield.

Nitrogen supply can also affect sulphate uptake and assimilation. Rapid nitrogen-driven growth increases the requirement for sulphur-containing proteins and metabolites. If sulphate availability and plant uptake do not increase along with crop N demand,

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nitrogen fertilization can effectively induce or intensify sulphur deficiency. Conversely, adequate S allows a greater proportion of absorbed N to be incorporated into functional proteins and allows more 'work' to be done per unit of applied nitrogen.

Their interaction is therefore reciprocal: nitrogen stimulates demand for sulphur, while sulphur determines how effectively nitrogen can be metabolised (Figure 4).

Integrated agronomic implications

Nitrogen-potassium and nitrogen-sulphur interactions share a common agronomic principle: overall nitrogen efficiency depends on the supply of nutrients that support uptake, energy production and yield. Therefore, if we want to get the most out of our nitrogen fertilizer programmes, potassium and sulphur should also be applied when soil or environmental conditions call for them.

The main interdependencies are as follows:

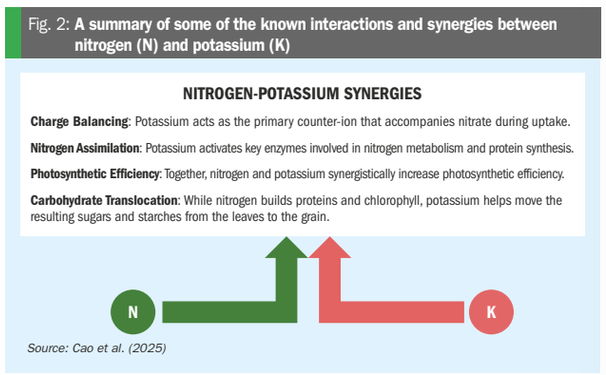
- Potassium is central to ionic balance, water relations, enzyme activation, photosynthesis and the transport of assimilates (e.g., sugars).
- Sulphur is central to the biochemical incorporation of nitrogen into proteins, redox compounds and cofactors.
- Potassium deficiency can therefore restrict nitrogen acquisition, photosynthetic productivity or the movement of assimilates, whereas sulphur deficiency can obstruct the conversion of N into complete proteins – and so limit plant growth.

Nutrient diagnosis should combine soil testing, plant analysis, expected yield, fertilizer history, irrigation or rainfall conditions, and knowledge of rooting depth. Tissue testing is a good complement to routine soil testing and can help identify potential imbalances during the growing season.

Nitrate and sulphate can move with soil water and may be vulnerable to loss below the rooting zone, while potassium movement is more dependent on diffusion, soil cation exchange properties, mineralogy and root proximity.

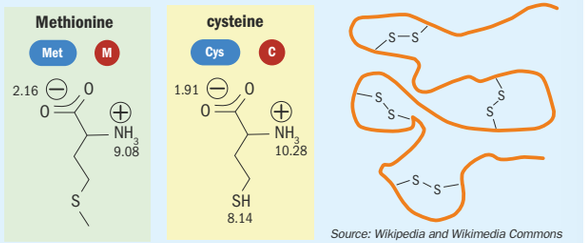
Fertilizer management should synchronise nutrient availability with the period of crop uptake, supplying nutrients when required, rather than rely solely on large pre-planting applications. This is particularly true of nitrogen and sulphate – which are prone to leaching (environmental loss) – and splitting N and S applications can help reduce

Fig. 2: **A summary of some of the known interactions and synergies between nitrogen (N) and potassium (K)**



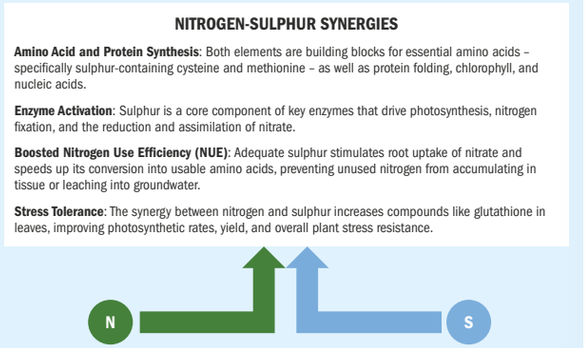
Source: Cao et al. (2025)

Fig. 3: **Sulphur is required to build proteins via two essential amino acids – methionine (left) and cysteine (middle) – as well as to fold proteins into their final useful shape via S-S bonds (right). Nitrogen is also needed to make large amounts of amino acids and proteins in the crop.**



Source: Wikipedia and Wikimedia Commons

Fig. 4: **A summary of some of the known interactions and synergies between nitrogen (N) and sulphur (S).**



Source: Cao et al. (2025)

the temporal mismatch between nutrient supply and crop demand.

Sulphate sources directly provide sulphur in plant-available form, while elemental S requires oxidation by soil microbes before sulphate becomes available. As a result, the time delay between elemental sulphur application and sulphate becoming available to the crop needs to be factored into the fertilizer management plan.

Potassium management should account for the amount of K shown in soil tests, the expected K removal by the crop, rooting conditions and water availability. The application of potassium fertilizers must also avoid salt injury and keep to locally validated recommendations. These management principles should also conform with regional agronomic guidance.

Conclusion

Potassium (K), nitrogen (N) and sulphur (S) form an interconnected crop nutrient management system. Potassium supports the uptake and utilisation of N by maintaining membrane potential, ionic balance, enzyme activity, stomatal function, photosynthesis and the transport of assimilates. Nitrate (NO_3^-) and potassium (K^+) transport are closely coordinated due to the need for ion balancing.

Sulphur also supports N utilisation by enabling the synthesis of cysteine, methionine, proteins, glutathione, cofactors and other essential metabolites. Inadequate S can leave absorbed N in non-protein forms and reduce crop yield, protein formation and the environmental benefits expected from nitrogen fertilization.

From an agronomic perspective, applying more N cannot consistently overcome limitations caused by deficient K or S. Practitioners and policymakers alike should recognise that known nutrient synergies, as outlined in this article, can improve nitrogen management outcomes by driving increased uptake of applied nitrogen.

Balanced nutrition should always aim to match nutrient supply with crop demand, soil availability, environmental conditions and realistic yield potential. Coordinated nitrogen-potassium and nitrogen-sulphur management offers an opportunity to increase nutrient recovery, sustain photosynthesis, improve crop quality and reduce the environmental losses associated with unused nitrogen.

For more information on nitrogen, potassium and sulphur crop nutrition, please visit www.nutrien-ekonomics.com. ■

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Activated humic substances: the biostimulant driving innovation in global plant nutrition

Monty's Plant Food, a business unit of AgroLiquid, continues to extend the reach of its humic technology across both Latin and North America, backed by scientific research and field results in Brazil, Central America and the United States. Brazil Operational Director **Gabriel Prado de Barros** provides an overview.



PHOTO: MONTY'S PLANT FOOD/AGROLIQUID

Applying Monty's Liquid product in the field.

The term biostimulant describes substances that have positive effects on growth and stress tolerance when applied to plants. The fact that these effects cannot be explained by nutrient content is what sets biostimulants apart from conventional fertilizers: they support natural plant processes without feeding the plant directly.

The phenomenon of biostimulation was highlighted at the 2023 Fertilizer Latino Americano (FLA) conference in Rio de Janeiro, Brazil, by Professor Luciano Canellas of Darcy Ribeiro State University of Northern Rio de Janeiro (UENF).

Biostimulation, said Professor Canellas in his presentation, is a change in metabolic processes that allows plants to use environmental resources efficiently, grow and yield more, and better tolerate adverse conditions. This biological phenomenon depends on the interaction between external stimuli and cells at molecular level.

Biostimulants trigger a sequence of events when applied to plants:

- Initially, the plant recognises the stimulus and transmits it internally through cell signalling.
- This is followed by effector responses: changes in gene expression, in metabolism and in the characteristics of the cells themselves.

In other words, biostimulants 'talk' to the plant and the plant responds by adjusting how it functions.

Biostimulation is becoming more relevant due to the many challenges facing global agriculture. On the one hand, growers need to produce more using the same (or lower) amount of fertilizer. On the other hand, they have to cope with increasingly frequent droughts, erratic rainfall and extreme temperatures.

Against this backdrop, biostimulants have quickly moved from the margins to become strategic products at the very centre of plant nutrition. Indeed, Professor Canellas singled out biostimulants as "the future of agriculture" in his FLA presentation precisely because they address two agronomic problems simultaneously: by providing both better nutrient use efficiency and protection against stress.

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Among the different products available for biostimulation, humic substances hold a special place. (Other types of biostimulants include seaweed extracts, amino acids, plant extracts and beneficial microorganisms.) They also form the foundation of Monty's Plant Food, a company which has worked with activated humic substances since 1997 and is today part of AgroLiquid.



PHOTO: CRU

Biostimulants were a central theme of the 2023 Fertilizer Latino Americano conference hosted by CRU in Rio de Janeiro, Brazil, in January/February that year (Fertilizer International 513, p20). That included a keynote presentation by Professor Luciano Canellas of Darcy Ribeiro State University of Northern Rio de Janeiro (UENF). Conference regulars Monty's Plant Food also exhibited. More than 1,000 delegates were in attendance.

How and why humic substances work

Humic substances are natural constituents of soil organic matter. They result from the decomposition of plant, animal and microbial residues, as well as from the metabolic activity of soil microorganisms themselves. They are a heterogeneous group of compounds – rather than a single molecule – traditionally classified (according to their solubility) into humins, humic acids and fulvic acids.

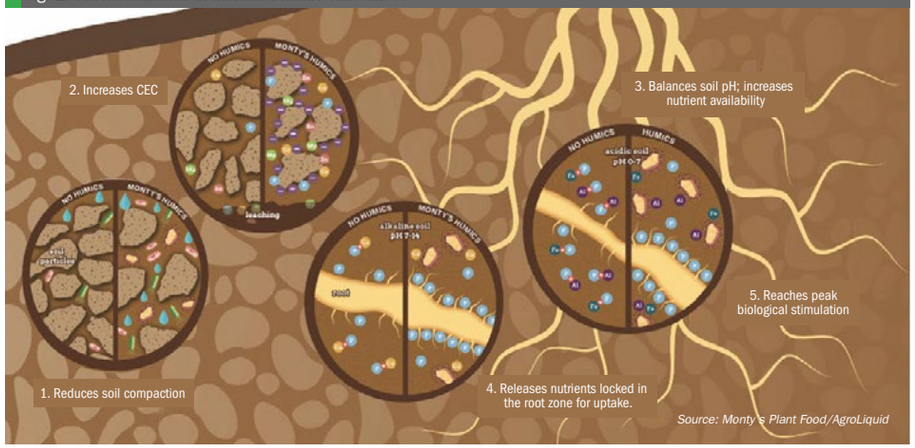
There is strong research evidence that humic substances measurably improve plant health and vitality. The main commercial sources are leonardite, peat, composts and vermicomposts.

According to data presented by Professor Canellas at Fertilizer Latino Americano, the direct use of humic substances at low concentrations increases shoot and root growth by an average of around 20% under controlled conditions and by 18% under field conditions. The main mechanisms behind these positive effects, as described in the literature, are as follows:

- Humic substances stimulate the plasma membrane proton pump (H^+-ATPase) in root cells. This strengthens the electrochemical gradient that powers nutrient transporters, favouring nitrate uptake, for example.
- They also have an auxin-like effect, stimulating the emergence of lateral roots and root hairs and expanding the volume of soil the roots can explore.
- In addition, they activate the plant's antioxidant system and stress-response genes, resulting in greater tolerance to drought and extreme temperatures.

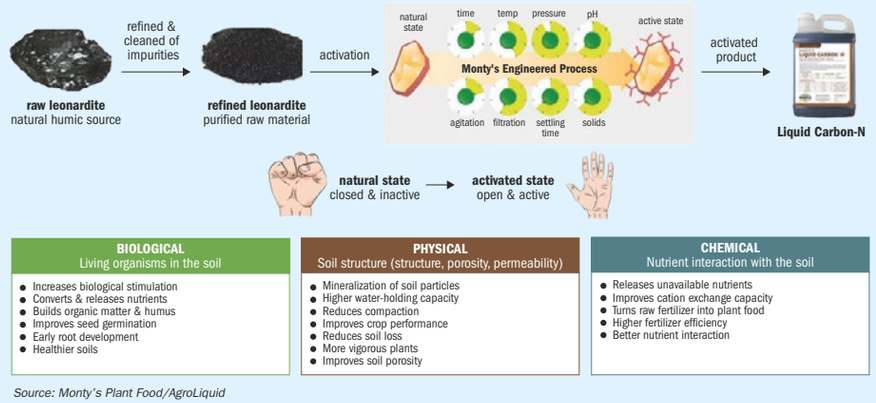
In the soil, the effects are equally important. Humic substances increase cation exchange capacity (CEC), help neutralise acidity and raise nutrient availability. They also help reduce compaction, stimulate microbial activity and speed up the breakdown of crop residues (Figure 1).

Fig. 1: **Soil mechanisms of activated humic substances**



BIOSTIMULANT MARKET PLAYERS AND PRODUCTS

Fig. 2: **How Monty's humic activation process works**



Source: Monty's Plant Food/AgroLiquid

Not all humic substances are equal

The source and processing of the raw material determine how effective humic substances are – an important fact that is often overlooked. Carbon-13 nuclear magnetic resonance (^{13}C NMR) analyses carried out by Professor Canellas show that each humic source has its own profile for functional groups, such as carboxylic, phenolic and aromatic compounds. It is this profile that defines bioactivity and, consequently, the application rate needed to obtain a plant response.

That is why Monty's focuses on four key factors in humic substances:

- The right starting material
- The right process
- The activation of the humic substances
- The right use – meaning the right product for each situation.

The company uses leonardite as its humic substance source and applies its own proprietary activation process. Leonardite, a naturally-occurring material, is derived from brown coal and is rich in humic substances.

Molecules of different sizes can affect plants and soils in different ways. Lower molecular weight fractions, richer in fulvic acids, penetrate cells and carry nutrients, forming soluble chelates with calcium, magnesium, copper, iron and manganese. Higher molecular weight fractions, typical of humic acids, instead act on the walls and membranes of root cells and on soil structure and health.

The activation process

Activation is what sets Monty's technology apart.

In the company's activation process, leonardite is refined to remove impurities, then processed under controlled conditions of time, temperature, pressure, pH and agitation, followed by filtration and settling. The result is activated humic substances which enhance biological activity, help reduce soil compaction, increase cation exchange capacity and raise nutrient availability (Figure 2).

Research confirms: more roots, more nodules

Brazil is the world's largest producer and exporter of soybeans and biological nitrogen fixation is one of the pillars of the crop's competitive position. The contribution biostimulants can make to fixing nitrogen was highlighted in a 2023 study published in the journal *Agronomy*[4].

Researchers at UENF's Centre for the Development of Biological Inputs for Agriculture (NUDIBA), led by Professors

Fig. 3: **Soybean nodulation results: control (T1) versus treatments with Monty's Liquid Carbon (T2-T6) applied at different rates**



Source: 2024 trial conducted by Kasuya Inteligência Agronômica in Luís Eduardo Magalhães, Bahia, Brazil.

** T2 to T6: Monty's Liquid Carbon applied at different rates, according to each treatment.*

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PHOTO: AGROLIQUID

Nick Bancroft, AgroLiquid's CEO

Luciano Canellas and Fábio Olivares, evaluated the effect of humic substances on soybean, when combined with inoculation using the nitrogen-fixing bacterium *Bradyrhizobium japonicum* and the plant growth-promoting bacterium *Herbaspirillum seropedicae*. Greenhouse trials were carried out on a natural low-fertility soil using humic substances extracted from leonardite and supplied by Monty's.

The results obtained were striking. Co-inoculation with humic substances increased shoot fresh weight by 145% and root fresh weight by 321%, compared with plants inoculated with *Bradyrhizobium* alone; when *Herbaspirillum* was added to the treatment, the gains reached 180% and 393%, respectively. The number of nodules per plant, just nine in the control, more than quadrupled in the humic substance treatments, while nodule weight also increased.

The study also found higher gene expression linked to carbon and nitrogen metabolism in the treated plants, including malate dehydrogenase, nitrate reductase and the plasma membrane H^+-ATPase itself. The authors conclude that co-inoculating soybeans with humic substances is a valuable additional tool for increasing soybean yields at low cost. (Note: Monty's simply supplied the product and played no part in the study design, data analysis or writing of this paper.)

Monty's and AgroLiquid: a new chapter

Since January 2025, Monty's Plant Food has been part of AgroLiquid, a manufacturer of high-efficiency liquid fertilizer solutions headquartered in St. Johns, Michigan, and a well-established brand in the North American market. AgroLiquid likes to work in harmony with soil biology, a shared approach that connects the two companies: AgroLiquid's strength in crop nutrition complementing Monty's expertise in soil health and humic technology.

"This strategic combination allows us to bring crop nutrition technologies to growers that wouldn't otherwise be available to them," said Nick Bancroft, AgroLiquid CEO, at the time of the acquisition.

In Latin America, Monty's continues to operate with its own brand as a business unit of AgroLiquid – preserving its portfolio and its well-established relationships with growers, distributors and researchers. At the same time, AgroLiquid's ownership brings greater manufacturing and research capacity, without altering existing technology that is well recognised in the United States and across Latin America, including Brazil.

A strategy designed for Brazil

Brazil has all the conditions that make humic biostimulants especially strategic:

- Highly weathered tropical soils
- Heavy dependence on imported fertilizers
- Increasingly severe weather events
- An agricultural sector that has already adopted biological inputs on a large scale.

In this context, technologies that increase fertilizer efficiency, support soil biology and help plants cope with stress are no longer an add-on: they are becoming part of standard crop management.

Market conditions reinforce this trend. With fertilizer costs and supply uncertainties, growers are looking for practical, smart alternatives suited to Brazilian soils – favouring accessible technologies with scientifically and commercially proven results and an attractive return on investment. In Brazil, activated humic technology is here to stay and becoming firmly established in the country, helping growers produce better quality crops at higher yields, more efficiently, and in a way that fits their budget.

Activated humic substances in Brazil

In Brazil, **Monty's Liquid Carbon-N** is already standing out in the market thanks to its unique activated humic substances. As a soil-applied product, it delivers the following benefits for both soil and crop:

- Reduces soil compaction
- Increases plant nutrient uptake
- Improves crops' usage of applied nutrients
- Raises soil organic matter
- Boosts microbial activity
- Helps retain soil moisture
- Speeds up the breakdown of crop residues
- Supports vegetative growth and yield.

The product is tank-mix compatible with herbicides, fungicides and insecticides, as well as seed treatments, foliar fertilizers and biological inputs. It does not clog spray nozzles and reduces the number of field passes, fitting easily into the grower's existing management programme.

Looking ahead

Biostimulants are here to stay. They address two major challenges in agriculture today: improving nutrient use efficiency and helping crops tolerate stress. Brazil's scale, tropical soils and openness to biological innovation make it one of the world's most promising markets for this technology. Humic substances, part of soil organic matter itself, are a natural fit for agriculture in Brazil and across Latin America.

Against this backdrop, Monty's activated humic substances are making a difference to agricultural productivity. Controlled activation, research conducted by Brazilian scientists and proven field performance have placed Monty's at the forefront of humic technology in Brazil and Latin America. Now backed by the strength of AgroLiquid, Monty's continues to expand its presence in Latin America and invest in partnerships with universities and research centres, bringing growers solutions that put the soil to work for maximum productivity and yield. ■

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Sulphur-coated urea: a question of temperature control

Ballestra has carried out a pilot campaign to produce sulphur-coated urea (SCU) using its proprietary bi-fluid drum granulator (BFDG) at semi-industrial scale. **Nita P Samant**, **Ilio Sebastiani** and **Svetoslav Valkov** of Ballestra (NEXTCHEM, MAIRE Group) describe the technology and the test results obtained. In their view, manufacturing SCU correctly is, above all, a thermal problem.

Background

Urea is the most widely used nitrogen fertilizer globally. It is also one of the least efficient – as crops rarely take up more than half of the nitrogen applied. The remainder is lost to the environment via leaching, ammonia volatilisation and denitrification.

This is costly to the farmer and pollutes ground and surface waters. Today, the pressure to reduce these nitrogen losses comes from two directions at once – being both an agronomic and regulatory priority.

Slow- and controlled-release fertilizers (SRFs and CRFs) are designed to reduce nutrient losses. They function by helping to close the gap between the amount of nutrient applied and the amount that ends up in the crop.

Within the large family of CRF products, sulphur-coated urea (SCU) is generally the most affordable. The fact that the coating is itself a nutrient also makes SCU unique.

The breakdown of the outer shell of SCU in the soil supplies elemental sulphur, an essential secondary nutrient that is particularly valued by crops such as oilseeds and pulses. This is a desirable characteristic, given the growing sulphur deficit in many agricultural soils globally.

A fertilizer producer able to manufacture SCU can therefore market a product that combines two distinct advantages: the slower release of nitrogen and the supply of sulphur as a second nutrient. The coating cost for SCU is also well below that of polymer-coated CRFs.


PHOTO: BALLESTRA

Ballestra's pilot bi-fluid granulation plant (BFGP), Milan. This was commissioned in 2025 and is rated at about 500 kg/h – close to semi-industrial scale.

This article describes the production of SCU using Ballestra's bi-fluid drum granulator. It sets out the thermal difficulties of coating urea with sulphur and suggests how these can be overcome. The results of a successful 2025-2026 pilot test campaign for SCU production using a bi-fluid drum granulator are also highlighted.

The product: core, shell and sealant

A sulphur-coated urea granule has a simple structure (Figure 1). The urea core, the nitrogen source, is surrounded by a continuous solid shell of elemental sulphur. This acts as a low-permeability barrier that delays contact between water and the soluble urea core.

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WHY SULPHUR-COATED UREA (SCU) MATTERS

The use of SCU can address three problems at the same time: nitrogen use efficiency, nutrient losses and soil sulphur deficiency. It is this combination of characteristics that makes the product interesting both commercially *and* agronomically. SCU can offer:

- **Better nitrogen use efficiency** – nitrogen becomes available over time instead of arriving as a single soluble dose that the root systems are unable to take up.
- **Lower nitrogen losses** – slower dissolution reduces losses due to leaching and ammonia volatilisation.
- **Dual crop nutrition** – one granule carries nitrogen from the urea core and elemental sulphur from the coating.
- **Fewer field operations** – prolonged nutrient availability can reduce the number of fertilizer applications, depending on the crop and field site.
- **Lower cost than polymer coatings** – sulphur is typically far cheaper than the polymers used in other CRF products.

Field validation of SCU remains essential in every market, however, as performance depends on the product formulation and on soil and climate conditions. ■

Fig. 1: **Structure and release mechanism of a sulphur-coated urea granule: urea core, continuous sulphur shell, and progressive water ingress through defects in the coating**



Source: Ballestra

Nitrogen is only released when water finds a path through the shell. This point deserves emphasis, as the speed of nitrogen release will depend on the integrity of the sulphur shell, not its thickness alone. That means a thicker sulphur coating with defects will perform less well than a thinner coating without flaws.

Biuret is a common but undesirable impurity in urea-based fertilizers. The quality of the urea used to manufacture SCU determines the biuret content of the finished product.

A third layer, while optional, is commonly used. A sealant – a wax, resin or low-viscosity polymer – is applied over the sulphur to close microcracks and make barrier performance more consistent. A final dusting with an inert powder, such as talc or bentonite, prevents caking in storage.

Typical commercial specifications for SCU are given in Table 1. These are indicative only. It should not be assumed that a specification written for one market will be accepted in another destination. SCU characteristics and criteria (product category, permitted coating and sealant materials, contaminant limits, declarations, etc) must therefore all be verified for each market and final formulation.

Raw material quality is equally important. Urea and sulphur feedstocks are both tightly specified (Table 2). This is necessary as sulphur with high moisture or acidity, for example, will behave differently at the nozzle during spraying.

Table 1: **Typical sulphur-coated urea product specification***

Parameter	Typical value	Comment
Total nitrogen	35-38 wt-%	Diluted by the sulphur coating
Elemental sulphur	17-23 wt-%	Sets coating thickness and S supply
Moisture	≤ 1 wt-%	Critical for caking and coating integrity
Biuret	≤ 1 wt-%	Driven by urea quality and by thermal history

Source: Ballestra **Values are indicative: product specification remains market- and project-specific.*

The real difficulty: three temperatures that are too close together

Sulphur coating looks like a simple operation: melt the sulphur, spray it onto the granule and let it solidify. In practice, the operation is squeezed between three critical temperatures belonging to two different materials (Table 3). These temperatures deserve careful scrutiny – being within a few tens of degrees of each other – as they will ultimately determine the choice of coating technology.

The difficulty can be summarised as follows:

- Liquid sulphur must leave the nozzle at a temperature above the melting point of the material onto which it is being sprayed.
- Below about 135 °C, the sulphur is too viscous to be atomised into fine droplets.
- Above about 159 °C, it polymerises and becomes unsprayable.
- The spraying window is therefore closed at both ends – while urea melts at just 132.7 °C.

The coating operation can therefore fail in two opposite directions:

- **Too cold**. If the urea granule surface is too cold, sulphur droplets freeze on impact before they can spread properly. The resulting sulphur coating is rough, flaky and porous, with poor adhesion. The sulphur content may be correct, but if the barrier is not continuous the slow-release effect is lost.
- **Too hot**. If the granule surface approaches the melting point of urea, the urea softens. The two materials (urea and sulphur) begin to mix instead of forming a clean interface. Granules agglomerate into lumps, and biuret forms. Product quality is lost and, in the worst case, the granulator becomes blocked.

In practice, both types of failure are easily confused, as they appear as the same thing on the certificate of analysis: a sulphur content falling outside of specification.

Table 2: **Typical urea and sulphur feedstock quality for SCU**

Parameter	Urea	Sulphur
Moisture	1 wt-% max	0.5 wt-% max
Main component	Total nitrogen 46 wt-% min	Sulphur 99.5 wt-% min
Free amine	0.02 wt-% max	–
Biuret	1 wt-% max	–
Acidity (as H_2SO_4)	–	0.05 wt-% max
Ash	–	0.1 wt-% max

Source: Ballestra

Table 3: **The characteristic temperatures that define the SCU operating window**

Transition	Temperature (°C)	Consequence for the process
Sulphur, solid-solid transition (α → β)	~95	Crystal form of the coating changes as it ages
Sulphur, melting	~115-120	Lower boundary: below this the sulphur is not sprayable
Practical spraying window for liquid sulphur	**~135-150**	**Viscosity is at a minimum and atomisation is clean**
Urea, melting point	**132.7**	**The substrate melts below the spraying window temperature**
Urea, decomposition and biuret formation	From the melting point upwards	Off-spec biuret, ammonia release, granule agglomeration
Sulphur, λ-transition (polymerisation)	~159	Upper boundary: viscosity rises by orders of magnitude

Source: Ballestra

Successfully coating urea with sulphur therefore needs to do two apparently contradictory things at once: it must keep sulphur hot and in a fluid state up to the nozzle tip, while keeping urea granules cool and removing the heat of solidification immediately after the sulphur droplets land.

Clearly, one single temperature zone set uniformly across the coating equipment cannot satisfy both requirements. What is needed instead is a machine with two temperature zones that can be set independently.

The bi-fluid drum granulator

Bi-fluid drum granulation (BFDG) produces spherical granules by spraying a melt, solution or suspension onto seed particles circulating inside a rotating drum (Figure 2).

The granulator is a horizontal drum fitted with internal lifters that raise the product to the top of the drum. From this high point, the product then falls back under gravity as a curtain. Centrally located within the drum is a slightly inclined perforated plate – supplied with ambient, hot, cold or recycled air – that acts as an integrated fluidised bed. Spraying, meanwhile, is carried out through bi-fluid nozzles (Figure 3).

Two features of the machine are particularly important for coating.

First, the urea granule is built up through successive spray applications, with crystallisation taking place within each layer. This gives the finished granule its hardness and smooth surface and allows a continuous coating to form.

Second, the removal of heat released as the sulphur coating solidifies. For a water-soluble granule core such as urea, evaporative cooling with a water spray is clearly not an option because product moisture is limited to a maximum of 1%. The internal fluidised bed therefore removes the heat by air instead.

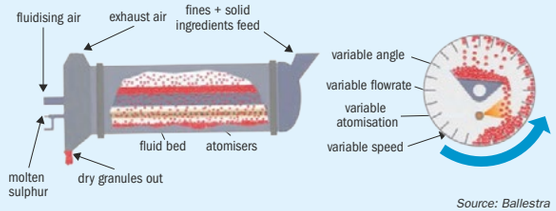
Atomisation is achieved through bi-fluid nozzles. The melt is mixed with atomising air just before it leaves the nozzle, producing very fine, uniform droplets (Figure 3). Droplet size is critical: fine droplets are desirable as these allow a thin, smooth and continuous film to form on the granule.

Two independent temperature zones

Within a single machine, the spraying and conditioning zones are physically separate and controlled independently. This is how the BFDG addresses the thermal problem.

In the spraying zone, the granules pass through the spray as a falling curtain. Contact with the liquid is brief, and the deposited film is thin. Droplet size is controlled

Fig. 2: **Working principle of the BFDG: lifters raise the granules and create the falling curtain; the atomisers spray into the curtain; the internal fluid bed then conditions the layer before the next cycle.**



Source: Ballestra

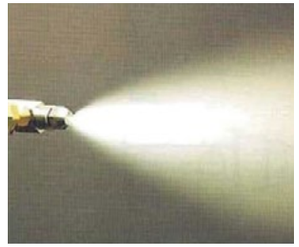


PHOTO: BALLESTRA

Fig. 3: The bi-fluid spraying nozzle in operation. Atomising air produces fine, homogeneous sulphur droplets which form a smooth layer on the granule

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by the atomising air pressure rather than the melt flow. Liquid temperature, liquid pressure and atomising air pressure can therefore be set to best suit the viscosity window for sulphur, without compromising these settings to protect the urea.

On the fluidised bed, air velocity and temperature are set separately. The sulphur layer crystallises on this table at a bed temperature suited to sulphur coating but safely below the softening point of urea.

The fluidising air carries away the heat of solidification as it is released from the granules. This prevents the bulk granule temperature from drifting upwards from one cycle to the next. This is not a minor detail. For a successful coating operation, the temperature must remain correct throughout the residence time, cycle after cycle.

The sulphur coating is built as a stack of thin, fully solidified films rather than one thick layer applied in a single pass. These thin, successive layers develop fewer internal stresses and crack less on cooling. For the same total sulphur content, they provide a more continuous barrier with fewer defects.

The overall result is a machine that sprays at the temperature sulphur requires and crystallises the coating at a temperature urea can tolerate, in the same drum and at the same time. This is the reason why a bi-fluid drum granulator is much better suited to this task than a plain coating drum.

Table 4: **Key operating parameters in SCU production by BFDG**

Group	Parameter	Main function
Drum dynamics	Rotation speed	Granule movement, mixing and curtain formation
	Drum angle and residence time	Axial transport, coating uniformity and build-up
	Granule hold-up	Material in the coating zone; stable curtain
Spray and mass balance	Urea / sulphur ratio	Coating thickness and final sulphur content
	Nozzle type and number	Droplet size, spray distribution and coverage
	Atomising air pressure	Atomisation quality and spray pattern
	Liquid pressure	Liquid flow rate and spray stability
Thermal and fluidised bed	Liquid temperature and viscosity	Sulphur fluidity — must stay inside the window
	Granule temperature	Solidification and adhesion of sulphur to the urea surface
	Fluidised-bed air velocity	Particle fluidisation and coating stabilisation
	Fluidised-bed air temperature	Solidification rate and final product temperature

Source: Ballestra

The SCU process

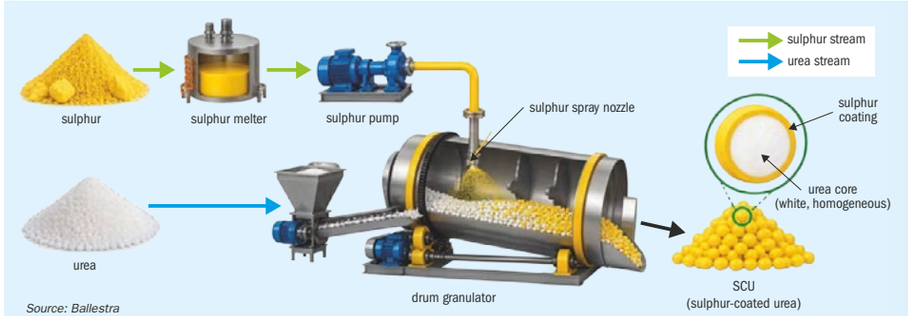
The complete process scheme is shown in Figure 4. Sulphur is melted in a heated tank and brought to a controlled temperature and viscosity. It is filtered, then pumped to the spraying headers and sprayed onto the urea granules circulating in the drum. The coating solidifies immediately on the granule surface, forming a continuous layer. A second layer – wax, resin or another low-viscosity polymer – is then applied to close any cracks in the sulphur. An inert powder is added as an anti-caking conditioner, and the product is cooled, screened and sent to storage.

One feature of the Ballestra process scheme deserves highlighting. The granulator delivers on-specification SCU directly in a single pass. It does not depend on the large internal product recycle which conventional granulation plants need in order to meet their size specification.

Off-specification granules and screen rejects are not downgraded or sold at a discount either: they are routed to a dedicated device in which the sulphur and the urea are separated from each other, allowing both to be returned to the process. The design of that device is also proprietary to Ballestra.

For a fertilizer producer, the practical meaning is simple enough: material which does not meet specification is not lost; neither does the plant carry the cost of circulating several times its own production output through the granulator.

Fig. 4: **Ballestra SCU process scheme: sulphur melting, pumping and spraying onto urea granules in the bi-fluid drum granulator, and the resulting coated granule**



Source: Ballestra

ADVANCED COATING TECHNOLOGY

The parameters governing SCU coating quality and process stability fall into three groups (Table 4):

- Drum dynamics
- Spray and mass balance
- Thermal and fluidised bed.

Every parameter in Table 4 was varied during the pilot trial before the operating window was fixed. The desired process outcome is easy to state yet demanding to achieve: a stable spray gives a uniform coating, and a uniform coating under controlled solidification gives a consistent product.

From the pilot plant to an industrial design

In 2025, Ballestra built its own bi-fluid granulation pilot plant (BFGP) in Milan (see first page photo). This was constructed to strengthen the company's fertilizer know-how, extend its proprietary technology and run pilot tests on clients' own products. The SCU campaign was among the pilot plant's first tasks.

The scale of this unit needs stating clearly – because this determines confidence in the results obtained. Importantly, the BFGP is not a laboratory device. Its product output is rated at about 500 kg/h, which places it close to semi-industrial scale.

Granulation and coating are notoriously difficult to scale up from bench tests, since the behaviour of the falling curtain, the residence time and the air-side heat balance all depend on the real geometry of the drum and on a realistic bed of material. Working at 500 kg/h means that the atomisation settings, the thermal balance and the residence-time window identified in these tests are already representative of industrial operation.

These are therefore *not* laboratory results which still have to survive a scale-up step. Anyone who has seen a promising bench result fail on the first industrial drum test will know the difference this makes.

The pilot plant campaign was organised in two phases. The first phase was devoted to the selection of the nozzle design and to the optimisation of the operating parameters – in practice, to finding and mapping the thermal and atomisation window described above.

The second phase was a validation run. Selected parameters were held in steady-state conditions and three samples were taken during the run: at 40 minutes (SCU 1), 80 minutes (SCU 2) and 120 minutes (SCU 3).

The target specification for the campaign was 35-38% total nitrogen and 17-21% elemental sulphur, with moisture and biuret each below 1%.

Sulphur content

Sulphur content was determined gravimetrically. The three samples taken (SCU 1, SCU 2 and SCU 3) gave values between 19.0-21.0 wt% – a narrow band across a run of two hours – with an average close to 20% (Table 5). The consistency of these figures, and their agreement with the mass balance of the sprayed sulphur, gave the campaign its first finding. The coating rate was stable and reproducible in steady-state operation, which is precisely what a producer needs if the product is to be sold against a declared analysis.

Water-barrier performance

The second part of the SCU characterisation was a dissolution test. This is critical as the whole point of coating urea with sulphur is to slow down dissolution.

An internal (and deliberately severe) dissolution test was developed, as a suitable standard method was not available. In the Ballestra test, a sample of SCU is stirred vigorously in demineralised water at room temperature for 90 minutes, alongside a blank of uncoated urea run under identical conditions.

Three measurements are then taken: firstly, the electrical conductivity of the water is logged throughout the test to follow dissolution behaviour (Figure 5); secondly, the undissolved portion is recovered by filtration and weighed; thirdly, the urea dissolved in the water is determined analytically, as an independent cross-check on the gravimetric analysis.

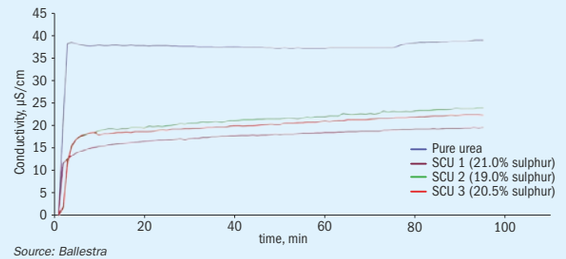
The different dissolution behaviour of the SCU samples against the urea blank is the clearest single finding of the campaign. The conductivity of the uncoated urea rises rapidly to a plateau (close to 38 µS/cm) within about three minutes: under this degree of agitation the granules simply dissolve. The conductivity of the three SCU samples, meanwhile, also rises quickly initially (to about 18 µS/cm) as water reaches the urea exposed via defects in the coating. But conductivity climbs slowly after this, ending the test at between 19.5-24 µS/cm after 90+ minutes.

Therefore, for the whole duration of the test, the conductivity of coated SCU products never approached the high plateau shown by the uncoated urea blank. One qualification needs to be attached to this result: conductivity is used here as a comparative indicator and not as a quantitative measure of dissolved urea. These values therefore cannot be converted into percentages. Despite this, the difference between the two sets of dissolution curves is stark and leaves little room for discussion.

Dissolution test conditions are also very much a 'worst case', as they are far more aggressive than anything a granule would meet in the field. This was intentional as the aim was to see whether the sulphur barrier survived the harsh experimental conditions – which it does – not to reproduce agronomic release of nitrogen through the coating of the SCU.

After 90 minutes of intensive stirring, 33-36 wt% of the material on average was still undissolved, as verified by two

Fig. 5: **Conductivity trends during Ballestra's dissolution test (sample stirred in demineralised water at room temperature for 90 minutes): results for three SCU samples vs the uncoated urea blank. While the conductivity for the blank rises rapidly and reaches a plateau within minutes, none of the coated samples approach this conductivity value, even by the end of the test.**



Source: Ballestra

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Table 5: **Pilot campaign results: sulphur content and undissolved fraction after 90 minutes of intensive dissolution testing**

Sample	Sulphur content, wt-%	Undissolved urea, gravimetric, wt-%	Undissolved, urea analysis, wt-%
SCU 1 (40 min)	21	32	30
SCU 2 (80 min)	19	40	37
SCU 3 (120 min)	20.5	35	32
Average	**20.2**	**36**	**33**

Source: Ballestra

independent methods of analysis (Table 5). The spread of results between samples is attributed to sampling variability.

Two qualifications need to be attached to these findings.

First, all three SCU samples were unsealed with no wax or polymer layer applied. The dissolution test results therefore reflect the performance of the sulphur shell alone; a sealed product should perform better.

Second, the dissolution method is non-standard and was developed internally for screening and comparative purposes. While it measures the barrier properties of sulphur coatings reproducibly, the method requires fine-tuning with the results benchmarked against commercial slow-release products.

Scale-up

The pilot campaign, due to its 500 kg/h scale, provides a good basis for the design of an industrial SCU plant. For a campaign of this kind, the deliverables are representative product samples, a test report, an operating package and the design basis for scale-up. The latter includes mass and energy balances, equipment sizing, air flow and temperature profiles, and the recycle strategy for off-spec product.

The BFDG is already used industrially for a wide range of granulation and coating duties. These cover urea fattening and products such as ammonium nitrate (AN), ammonium sulphate (AS), calcium ammonium nitrate (CAN), calcium nitrate (CN), phosphogypsum (PG) and urea ammonium sulphate (UAS), as well as polymer- and urea-formaldehyde-coated grades. That means the scale-up pathway from validated pilot operations to a full-size granulation/coating machine is a well-travelled one.

There is also a potentially important commercial consideration. Demand for sulphur-coated urea is policy-driven in several of its largest markets. Such policies can, however, change over the lifetime of a fertilizer plant. This is where production flexibility becomes advantageous. A producer who installs a BFDG for sulphur-coated urea has installed a granulator which can also be used for other coating and granulation duties. The investment is safer as it is not tied to the fortunes of one single product.

Conclusions

Sulphur-coated urea (SCU) is a longstanding, mature product. While encapsulating urea granules within a layer of sulphur is a potentially attractive idea, it involves an awkward manufacturing step. The difficulty is heat-related, not chemical.

For sulphur coating, molten sulphur needs to be sprayed at a temperature above the melting point of the urea granule yet inside a viscosity window between 135 °C and 150 °C. When applied too cold, below this temperature range, the sulphur coating is porous. Conversely, when applied too hot, above this temperature range, urea granules agglomerate and biuret forms. The margin available is a matter of a few degrees.

The bi-fluid drum granulator (BFDG) addresses this manufacturing challenge directly. It does this by separating the sulphur spraying zone from the urea conditioning zone and controlling the conditions in each independently. The sulphur is sprayed at its own optimum temperature through bi-fluid nozzles which produce very fine droplets, and each thin layer is crystallised on the internal fluidised bed, at a temperature chosen to protect the urea core, before the next layer is applied.

Ballestra's 2025-2026 pilot campaign demonstrated the success of this approach. This SCU production pilot was run close to semi-industrial scale at an output of about 500 kg/h. This produced SCU samples with a sulphur content of 19-21 wt% under steady-state conditions. This sulphur content was consistent across a run of two hours and in agreement with the mass balance.

In dissolution tests, an uncoated urea blank dissolved within three minutes during intensive stirring in water, as shown by a steep rise in conductivity to a plateau. For the SCU samples, in contrast, conductivity stayed far below this plateau for the full 90 minutes. Around 33-36 wt% of the SCU samples remained sealed and undissolved at the end of the test, as confirmed by two independent analytical methods.

Work continues on the characterisation methods and on benchmarking against commercial products. These results will be reported when they are available. The evidence already in hand, however, is sufficient for the main conclusion.

In summary, the Ballestra-Nextchem BFDG design offers a reliable and effective route for the production of SCU granules. This equipment has been demonstrated at close to industrial scale. The sulphur coatings obtained have also been shown to act as an effective barrier preventing rapid urea dissolution.

BFDG is available to fertilizer producers who wish to enter the SCU market – providing them with a technology that has been fully tested instead of relying on assumptions. As a next step, Ballestra is planning to fine-tune the characterisation methods and benchmark the SCU results against commercial slow-release products. ■

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About the company

Ballestra is now part of NEXTCHEM, the sustainable technology business unit of MAIRE Group. The Milan-headquartered company is a technology licensor and engineering contractor, with a leading position in detergents, surfactants and soap, and chemicals such as sulphuric acid, phosphoric acid, hydrogen fluoride and fertilizers. Notably, the addition of Ballestra's sulphur, phosphate and potassium technologies complements the Group's long-standing nitrogen technology portfolio.

About the authors

Nita P Samant and **Svetoslav Valkov** are with the Chemicals Business Unit at Ballestra. **Ilio Sebastiani** is the company's head of R&D.

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PHOTO: K+S

Werra 2060: transforming European potash production for the decades ahead

K+S's Wintershall site, part of the company's integrated Werra plant, is located in the German state of Hesse near the border with Thuringia. The Werra 2060 transformation project will see Wintershall become the centre of production for the company's fine-grade Korn-KALI® product.

K+S is transforming potash production at its integrated Werra production site in Germany via the Werra 2060 project. The company is investing €600 million in new mining and processing technologies to ensure Europe has a secure supply of potassium and magnesium fertilizers in future decades. **Marcus Janz** and **Dr Heike Thiel** of K+S shine the spotlight on one of the largest transformation projects in the company's history.

Potassium and magnesium are essential nutrients for high-yielding, resilient agriculture. Yet, for European growers, the reliable supply and availability of these nutrients can no longer be taken for granted.

Geopolitical tensions, trade restrictions, disruptions to international shipping routes and volatile energy markets have highlighted the strategic importance of maintaining a competitive European production base. At the same time, fertilizer manufacturers must substantially reduce the environmental footprint of mining and processing.

K+S is addressing both challenges through Werra 2060 – one of the largest transformation projects in the company's history.

Werra 2060 combines long-term security of supply with new mining and processing technologies. These technologies are designed to reduce resource consumption, emissions and production residues.

The project also supports the continued manufacture of specialty fertilizers such as Korn-KALI® in Germany.

Cooperation between K+S management and employee representatives is central to the success of Werra 2060. Through social partnership, both are working to advance the project's industrial and environmental objectives. They also share a long-term commitment to skilled employment and the creation of regional economic growth.

The integrated Werra plant is K+S's largest production site and lies on the border between the German states of Hesse and Thuringia. Its Wintershall, Hattorf and Unterbreizbach operations extract and process approximately 20 million tonnes of crude salt (mined ore) annually to produce around 3.1 million tonnes of finished products.

The Werra plant accounts for approximately half of the potassium- and magnesium-containing fertilizers produced in the European Union. About 4,400 people work at the plant – including around 300 trainees – making Werra a large source of skilled employment and a major contributor to the regional economy.

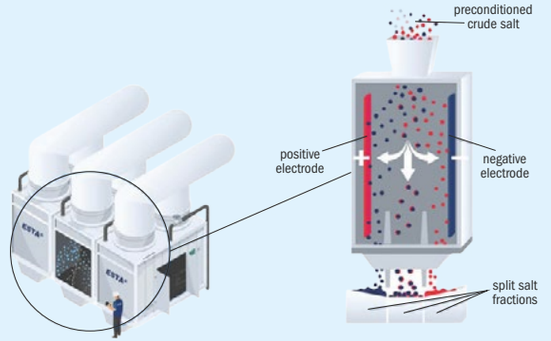
Investing in long-term competitiveness

K+S is channelling approximately €600 million of investment into the integrated plant through the Werra 2060 project. This investment will extend the plant's operating life until at least 2060 and improve its long-term competitiveness.

The project will enable K+S to continue mining the Werra deposit and fully exploit its reserves over the next three to four decades. Ore extraction at the Hattorf-Wintershall mine will form the long-term backbone of the new integrated operation.

At Unterbreizbach, the plan is to continue with underground extraction until around 2040, when the mine's available reserves are expected to be exhausted. Unterbreizbach's role as a modern processing plant is, nonetheless, secure until 2060 – almost 30 years longer than previously envisaged. Its production focus will be on fertilizer granulation.

Fig. 1: **K+S is expanding the use of 'ESTA' electrostatic separation in ore beneficiation. This dry process avoids the need for energy- and water-intensive hot-leaching and froth flotation**



Source: K+S



PHOTO: K+S

K+S is transitioning to 'ESTA' electrostatic separation for ore beneficiation. This dry process avoids the need for energy- and water-intensive hot-leaching and froth flotation.

A key part of the Werra 2060 project is the further development of K+S's ESTA electrostatic separation process (Figure 1). Unlike conventional wet processing, ESTA separates the valuable mineral components of crude salt in a dry state.

K+S has refined ESTA technology so that a much larger proportion of the raw material can be processed entirely dry. This removes the need for the energy- and water-intensive hot-leaching and froth flotation stages currently used at Wintershall.

The transition to dry processing will significantly change the way materials flow between different sites within the integrated plant. Wintershall will become the central production location for fine-grade Korn-KALI®, while Unterbreizbach will specialise in granulating this material into the finished fertilizer product.

Crude salt extracted from the Unterbreizbach mine will be transported underground to the Hattorf-Wintershall mine, where it will be brought to the surface for processing at the Hessian production sites. The fertilizer will then be transported by rail to Unterbreizbach for further processing.

Through greater integration, this new approach to mining, processing and production makes much more efficient use of the existing infrastructure and expertise found at each location.

A new approach to environmental impact reduction

The expanded dry processing system will work hand-in-hand with a new approach to underground mining: secondary extraction with dry backfill.

In conventional room-and-pillar mining, large pillars of potash-bearing rock are left in place to support the mine workings. The introduction of secondary extraction, however, allows some of this valuable material to be recovered.

In secondary extraction, before a pillar is mined through, neighbouring openings are tightly filled with dry salt residues to stabilise the surrounding area. K+S has used the method successfully at Unterbreizbach for more than a decade. Since late 2024, the company has also been trialling the method at Hattorf-Wintershall, with extensive monitoring and scientific supervision.

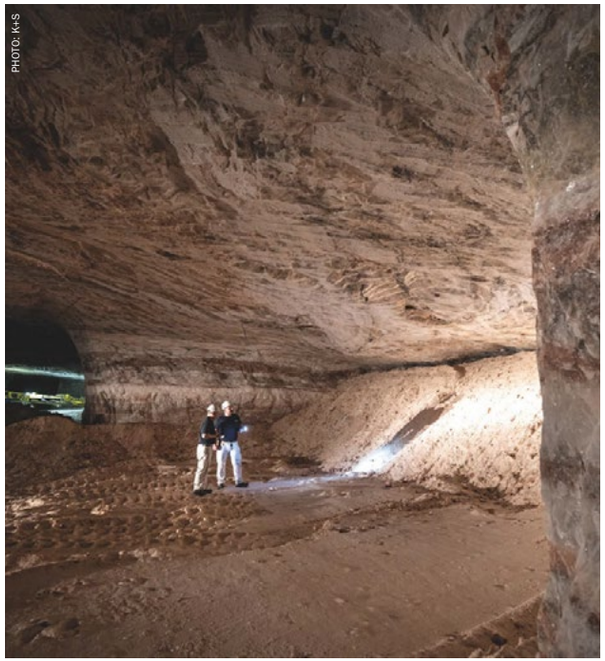
In future mining districts, backfill will increasingly comprise of dry production residues from the expanded ESTA process at Wintershall.

These two innovations are therefore mutually supportive, as they form a closed material flow: dry ESTA processing supplies suitable backfill for secondary extraction, which in turn boosts resource efficiency by allowing more of the deposit to be recovered. Residues that would otherwise be stored on the surface are also returned underground.

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PHOTO: K+S

Underground mining of potash ore in Germany. K+S is shifting to a resource efficient secondary extraction method to recover more ore.

Werra 2060 is expected to reduce carbon dioxide emissions at Wintershall and Unterbreizbach by approximately 50%. It will also substantially reduce the amount of process water requiring disposal. Additionally, K+S expects to reduce the volume of material deposited on the Wintershall tailings pile by around 90%, once the new system is fully operational.

These measures build on the approximately €1 billion that K+S has already invested in environmental protection at the Werra plant since 2008.

From planning to implementation

The implementation of Werra 2060 is now clearly visible above ground. Construction of the new processing facilities at Wintershall, for example, began in the summer of 2026.

The new production building will require approximately 4,000 tonnes of structural steel. Its weight will be supported by 160 bored piles which will anchor the structure into the underlying sandstone to a depth of 15 metres.

Underground, preparatory work for the secondary extraction backfilling and material-handling system is already well advanced.

Planning the Werra 2060 transformation has taken longer than originally anticipated. That is not surprising for a production site that has grown organically over more than a century. Fertilizer production also needs to continue during project construction.

K+S therefore recently adjusted the project schedule. The changeover to the new production system will now take place during the regular summer maintenance shutdown in 2028. This timing will minimise disruption and protect the plant's production output.

Despite the new schedule, the total investment budget of approximately €600 million remains unchanged.

Overall, the new mining and processing system introduced by Werra 2060 will structurally reduce the environmental footprint of K+S's operations by:

- Eliminating major wet-processing stages
- Lowering energy use and carbon dioxide emissions
- Reducing process wastewater
- Recovering more valuable minerals from the deposit
- Minimising the surface accumulation of tailings in future.

Securing Europe's fertilizer supply

For European agriculture, Werra 2060 is more than the modernisation of a single production site. In reality, it is an investment in a regionally based fertilizer supply chain.

The project brings together the resource efficient mining of ore reserves, specialised mineral processing expertise, modern environmental technologies and downstream fertilizer granulation. In effect, K+S is creating the production basis to supply European growers with potassium- and magnesium-containing fertilizers for decades to come.

Korn-KALI® illustrates how this transformation connects industrial innovation with practical plant nutrition. K+S is expanding its product portfolio to offer three new variants of Korn-KALI® for different applications and international markets.

The K+S portfolio is growing – Korn-KALI® available in three different variants

Korn-KALI® is the main product at the heart of the Werra 2060 project. The multi-nutrient fertilizer has demonstrated its value for many years, especially in European markets. As a potassium, magnesium and sulphur fertilizer, Korn-KALI® combines potassium chloride (supplying 38% K_2O) with kieserite (supplying 6% MgO and 12% SO_3).

Being fully water-soluble, these nutrients are immediately available to plants irrespective of the soil pH. Uniform grain-size distribution also supports easy and even field application. Korn-KALI® is therefore recommended as a potash fertilizer for chloride-tolerant crops that also require additional nutrients.

The Korn-KALI® portfolio comprises three product variants for different applications. **Korn-KALI®+B** with boron is available alongside **classic Korn-KALI®**. Both are granulated fertilizers. In addition, the fine-grade product **Korn-KALI® Fine** has now been introduced as a new member of the Korn-KALI® product family.


PHOTO: K+S

Korn-KALI®, a potassium magnesium sulphate fertilizer, is the main product at the heart of the Werra 2060 project.

Korn-KALI®+B additionally contains 0.25% boron in a water-soluble, readily plant-available form, enabling crops to absorb it efficiently through the soil.

From a European success story to a global portfolio

Korn-KALI® is making strong progress on its journey from a well-established European fertilizer to a global product. Building on its long-standing success, the product has now been successfully introduced in overseas regions.

Korn-KALI®+B continues to strengthen its presence in international growth markets, reflecting the increasing global demand for efficient multi-nutrient fertilizers.

A further milestone in the global roll-out is the introduction of Korn-KALI® Fine. Developed to meet specific regional application and processing requirements, the product is opening new opportunities globally and supports the continued international expansion of the Korn-KALI® portfolio. Building on the successful introduction of Korn-KALI®+B in several regions, Korn-KALI® Fine is now broadening the portfolio.

With these three products, Korn-KALI® is moving closer to becoming a globally established solution for balanced plant nutrition, efficient nutrient use and stable crop yields.

Healthy plant growth with natural nutrients

Germany's potash ore deposits are exceptional because they contain natural potassium-bearing minerals together with kieserite, a naturally occurring magnesium sulphate mineral. This geological combination makes it possible to provide potassium, magnesium, and sulphur from one domestic raw-material source. In Korn-KALI®, potassium is supplied as potassium chloride, while magnesium and sulphur originate from kieserite.

To realize their full yield potential, crops require an adequate and balanced supply of nutrients. Research shows, for example, that the combined application of the three nutrients present in Korn-KALI® enhances nitrogen uptake and promotes protein synthesis – two essential factors for success in modern agriculture.

In Korn-KALI®, crop nutrients are also present in a concentrated, fully water-soluble form and can therefore dissolve in the soil solution and become readily available for root uptake, independently of soil pH. ■

About the authors

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PHOTO: ELIXIR GROUP

From project to production: K+S and Elixir strengthen Europe's phosphate supply



A new technical monoammonium phosphate (tMAP) plant has been successfully commissioned at Elixir Group's Industrial Chemical Park Prahovo in Serbia.

A new technical monoammonium phosphate (tMAP) plant has been successfully commissioned at Industrial Chemical Park Prahovo in Serbia as part of a joint project between K+S and Elixir Group. tMAP from the plant is being sold and marketed by K+S under the soluMAP® brand. This new product offers customers in Europe a reliable in-region supply of high-quality water-soluble fertilizer. **Janosch Müller** and **Denis Höfner** of K+S Minerals and Agriculture GmbH and **Matthias Predojevic** of Elixir Group provide a project overview.

European quality rooted in reliability

Europe's fertilizer industry is facing an increasingly complex operating environment. Global phosphate markets, in particular, remain exposed to geopolitical tensions, trade restrictions, logistics disruptions and growing demand from industrial applications.

In agriculture, meanwhile, water scarcity is driving the trend towards greater use of irrigation and more efficient nutrient delivery to crops.

K+S and Elixir Group are overcoming these market challenges through a successful joint project that provides Europe with a new in-region source of high-quality water-soluble fertilizer (WSF). The project's completion comes at a time when reliable European production capacity is becoming ever more important.

At Elixir Group's Industrial Chemical Park Prahovo (ICPP) in Serbia, technical monoammonium phosphate 12-61 (tMAP) is now being produced and marketed by K+S under the soluMAP® brand. The plant at ICPP has an annual production capacity of 50,000 tonnes. It was built within an 18-month construction period and has now moved into regular operation, following commissioning and the delivery of its first commercial volumes.

The project is the tangible result of a strategic partnership between K+S and Elixir Group that began in 2023. What started as a shared ambition to establish an additional European source of tMAP has now become a successful supply platform, with a particular focus on customers in Europe, as well as those further afield in the Middle East.

Elixir contributes to the partnership through its integrated phosphate production platform and long-standing industrial expertise at Prahovo, while K+S brings its market presence, logistics network and expertise in water-soluble fertilizers. Together, the two companies are building a business proposition around a clear principle: European quality rooted in reliability.

Water scarcity is changing fertilizer demand

The demand for water-soluble fertilizers (WSFs) cannot be separated from one of agriculture's major challenges: water availability. Agriculture accounts for more than 70% of global freshwater withdrawals. Competition for freshwater sources is therefore placing pressure on farmers to produce stable crop yields with less water, against a backdrop of greater climate variability and recurring periods of drought.

One response has been the greater adoption of precision irrigation by growers, including drip irrigation and micro-irrigation systems. In particular, fertigation – the simultaneous supply of nutrients to crops together with irrigation water – allows water and fertilizer management to be closely coordinated. This farming method allows nutrients to be applied more precisely to closely match crop requirements, improving nutrient use efficiency and reducing nutrient losses to the environment.

Drip irrigation systems have specific fertilizer quality requirements. Products used in fertigation need to dissolve reliably, for example, and provide consistent nutrient concentrations, without compromising the irrigation equipment.

PHOTO: ELIXIR GROUP



K+S and Elixir Group teams at the Prahovo production site in Serbia during the first loading of soluMAP®.

A DISRUPTED PHOSPHATE MARKET

The need for resilient supplies of phosphate has become increasingly clear in 2026. The on-off closure of the Strait of Hormuz since the end of February has shown how quickly a geopolitical shock in one region can affect fertilizer value chains far beyond it.

The impact on phosphate production has been particularly marked. The Gulf region is a major source of sulphur, being generated on a large scale from the desulphurisation of sour gas and crude oil. Sulphur is used to manufacture sulphuric acid, a key feedstock used to generate phosphoric acid from phosphate rock. Phosphoric acid, in turn, is the central intermediate used in monoammonium phosphate (MAP) and diammonium phosphate (DAP) production. Constraints on sulphur supply and trade therefore transmit directly along the value chain to finally impact on phosphate fertilizer production.

The disruption in Gulf region supply has triggered a tremendous increase in sulphur prices. These have more than doubled since the beginning of 2026, reaching unprecedented levels during the year. This is having a direct impact on phosphate economics by substantially raising the production cost base for producers worldwide, not just those located in the Middle East (*Fertilizer International* 533, p4; *Fertilizer International* 534, p8).

Sulphuric acid prices have also risen sharply, with phosphoric acid and phosphate fertilizer prices experiencing significant upward pressure as well. The effects of these price movements are apparent across the phosphate industry.

The combination of limited sulphur availability and exceptionally high prices is already limiting phosphate fertilizer manufacturing, with producers in several major supply regions reducing operating rates and/or delaying raw material purchases.

These pressures are therefore no longer a regional issue. Instead, a disruption in one critical raw material (sulphur) has developed into a global availability and cost challenge for the entire phosphate value chain.

The current market disruption sits on top of longer-term structural pressures.

China remains the world's dominant tMAP producer, a situation that has left international customers vulnerable to export restrictions and changing domestic priorities, two factors which have repeatedly affected availability. At the same time, high-purity phosphates such as tMAP are increasingly required by non-agricultural industries, most notably the lithium iron phosphate (LFP) battery value chain.

For Europe, all of these pressures underline the value of supply diversification. While regional production cannot and should not replace global trade, it can reduce exposure to individual trade routes and provide an additional supply source when international markets become constrained.

This is where K+S and Elixir's joint project becomes a strategically vital lifeline. Valuably, Prahovo offers regional customers a European production source for high-quality, water-soluble tMAP in an increasingly volatile global market. ■

High-quality tMAP offers a suitable source of dissolved phosphorus and nitrogen for drip irrigation systems. soluMAP® contains 12% ammonium nitrogen and 61% P_2O_5 (12-61 composition) and is fully water-soluble. It is designed for fertigation and foliar application and is both chloride- and sodium-free.

The link between rising demand for WSFs such as soluMAP® and better water and nutrient usage is therefore straightforward: increasing pressure on water resources supports more precise irrigation, while more precise irrigation in turn requires fertilizers that can deliver nutrients efficiently and reliably through these systems.

From project to regular production

The tMAP plant at Prahovo represents the first major project outcome from the strategic cooperation between K+S and Elixir Group. Production started in February 2026 – following construction, commissioning, hot testing and product qualification – with the emergence of the first commercial volumes marking the transition from project implementation to market supply.

Prahovo has moved beyond the start-up phase and is now operating routinely. The project partners expect tMAP production to approach the plant's 50,000-tonne annual nameplate capacity from 2027.

While this progressive ramp-up in output matters, reliability in fertilizer supply is not defined by installed capacity alone. Customers also need consistent product quality, dependable availability and predictable logistics. The combination of Elixir's production expertise and K+S's market and distribution capabilities is designed to translate technical capacity into a stable supply proposition.

Integrated production at Prahovo

Industrial Chemical Park Prahovo is an established phosphate production site with decades of experience in phosphoric acid production and downstream processing. Elixir Group took over the site in 2012 and has since invested more than €500 million in its development.

Today, the site combines phosphoric acid production, fertilizer processing, logistics and shared utilities. The tMAP facility is integrated into this existing industrial environment, linking it closely with phosphoric acid production and established infrastructure.

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soluMAP® 12-61 in 25 kg bags.

PHOTO: ELIXIR GROUP

The location also offers access to the Danube and road connections to important regional markets. This provides flexibility in distribution and supports shorter, more predictable supply routes compared with long-distance imports. In fertilizer markets, where port congestion, freight volatility and geopolitical disruption can quickly affect availability, logistics has become part of the product's value proposition rather than a secondary consideration.

Building a more resilient phosphate supply

The market positioning of soluMAP® reflects this broader approach. Quality is essential for technical fertilizers used in precision application systems: full water solubility, consistent composition and predictable product behaviour are fundamental when fertilizers are applied through irrigation equipment.

Reliability goes further. It includes production stability, availability, packaging, logistics and the ability to serve customers consistently over time. For fertigation users, this is particularly important because nutrient programmes are often planned in advance and application windows can be narrow.

The Prahovo project meets these requirements, thanks to its European production location, integrated phosphate manufacturing, established logistics infrastructure and K+S's market access. It reflects a wider move towards more diversified supply chains in which resilience is increasingly valued and is now as significant as efficiency.

Serving European and neighbouring markets

The primary target market for soluMAP® is Europe, complemented by markets in the Middle East. In both regions, the product meets growing customer demand for high-quality, water-soluble phosphate and dependable supply.

For K+S, the new product strengthens its position in water-soluble fertilizers and expands its specialty product portfolio. For Elixir, the project further develops Prahovo as an integrated European phosphate production hub. For both companies, it demonstrates the value of combining complementary capabilities rather than developing an isolated production asset.

A foundation for further growth

With the start-up phase completed, the focus now shifts towards growing the product's market presence and moving production close to nameplate capacity from 2027.

The underlying market drivers remain firmly in place. Demand from growers for products that deliver on nutrient use efficiency is developing alongside a phosphate market increasingly shaped by geopolitics, trade policy, logistics, industrial demand and the availability and cost of critical raw materials such as sulphur.

Against this backdrop, the Prahovo plant is a concrete outcome of the partnership between K+S and Elixir Group that provides Europe with a valuable and much-needed in-region source of water-soluble phosphate.

From planning and construction through to commissioning and regular production, the project demonstrates what can be achieved when industrial expertise, integrated production and market access are combined. For customers looking for a consistent supply of water-soluble phosphate, the value proposition can be summarised in five words: European quality rooted in reliability. ■

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PHOTO: ELIXIR GROUP

Packaged soluMAP® being prepared for road transport from Prahovo.


Crystalline technical monoammonium phosphate (tMAP) 12-61 produced at Prahovo.

PHOTO: ELIXIR GROUP

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Potash project listing 2026

Fertilizer International presents a global round-up of current potash projects.

Plant/ project	Type	Company	EPC/EPCM contractor(s)	Equipment/technology	Location	Product	Capacity '000 t	Status	Start-up date
AUSTRALIA									
Lake Way	G, LBE	Sev.en Global Investments			Western Australia	SOP	200	C	2025
Mardie*	G, SE	BCI Minerals			Western Australia	SOP	140	UC	2028
BELARUS									
Nedra Nezhin Company	G, CM	Nedra Nezhin (former Slavkaliy)	China State Engineering Corp/ Deilmann-Haniel	Herrenknecht Shaft Boring Roadheader (SBR) system	Lyuban	MOP	1,800	C	2026
BRAZIL									
Autazes	G, CM	Brazil Potash			Autazes	MOP	2,400	P	N/A
CANADA									
Bethune expansion**	B, SM	K+S Canada			Saskatchewan	MOP	1,140	UC	2031-2040
Jansen S1	G, CM	BHP	Hatch-Bantrel Joint Venture (HBJV)	Herrenknecht Shaft Boring Roadheader (SBR) system	Saskatchewan	MOP	4,150	UC	2027
Jansen S2	G, CM	BHP	Fluor		Saskatchewan	MOP	4,360	UC	2031
Milestone***	G, SM	Western Potash	Artisan Consulting/AKITA Drilling		Saskatchewan	MOP	2,800	UC	On hold
Russel McAuley	G, SM	PADCOM		Beechy Potash Products Corp (BPPC)	Manitoba	MOP	250	?UC	2026
Tugaske	G, SM	Gensource/Helm			Saskatchewan	MOP	250	FS, P	N/A
Wynyard	G, SM	Karnalyte Resources/GSFC	Amec FW (Wood)		Saskatchewan	MOP	625	FS, P	N/A
ERITREA									
Colluli	G, CM	Sichuan Road & Bridge/ENAMCO	DRA Global		Danakil Depression	SOP	472	FS, P	N/A
ETHIOPIA									
Dallol	G, SM	Ethiopotash			Afar	SOP	600	FS, P	On hold
Danakil Potash	G, SM	Premier African Minerals			Danakil	MOP/SOP	2,000/750	FS, P	On hold
JORDAN									
Southern expansion project	B, LBE	Arab Potash Co			Safi, Dead Sea	MOP	740	UC	2030
LAOS									
Thakhek II	G, CM	Lao Kaiyaun			Nongbok	MOP	1,000	UC	N/A
Nongbok	G, CM	Sino-Agri Potash (Asia Potash)			Nongbok	MOP	1,000	C	2025
THAILAND									
Dan Khun Thot	G, CM	Thai Kali Company (Bangchak)	CCMC		Nakhon Ratchasima	MOP	500	UC	2028
Bamnet Narong	G, CM	ASEAN Potash Chaiyaphum Public Company Limited	CCMC		Chaiyaphum	MOP	1,100	FS, P	N/A
MOROCCO									
Khemisset****	G, CM	Emmerson			Khemisset	MOP	810	FS	On hold
PERU									
SalSud	G, LBE	Salmueras Sudamericanas			Sechura desert	SOP	100	P	On hold
REPUBLIC OF THE CONGO									
Kola	G, CM	Kore Potash	PowerChina		Kouilou	MOP	2,200	FS, P	N/A
Kanga	G, SM	Kanga Potash (Sarmin Mineral Exploration)			Kouilou	MOP	600-2,400	FS, P	N/A
Mboukoumassi	G, CM	Luyuan Mining			Kouilou	MOP	1,000	UC	2027-2028
RUSSIA									
Solikamsk II	B, CM	Uralkali			Perm	MOP	200	C	2025
Talitsky	G, CM	Acron (Verkhnekamsk Potash Company)			Perm	MOP	2,000	UC	2027
Usolskiy II	G, CM	Eurochem			Perm	MOP	1,800	UC	2028
SPAIN									
Muga	G, CM	Highfield Resources			Navarra & Aragón	MOP	500	FS, P	N/A
UNITED KINGDOM									
Woodsmith Mine	G, CM	Anglo American	DMC Mining/STRABAG AG/Jacobs	Herrenknecht Shaft Boring Roadheader (SBR) system	North Yorkshire	Polyhalite	13,000	UC	N/A
UNITED STATES									
Sevier Playa	G, LBE	Peak Minerals (EMR Capital)			Utah	SOP	195	FS, P	N/A
Evart	G, SM	Michigan Potash			Michigan	MOP	500-800	FS, P	N/A

NOTES:
Greenfield projects (G): generally, these must have reached the detailed/bankable feasibility study (FS) stage for inclusion. Brownfield expansions (B): capacity indicates incremental additions, not total capacity.

* Pilot plant only initially.
** Extra to existing 2.86 million tonnes of capacity. Raises total capacity to 4.00 million tonnes by 2040.
*** Delisted from the Toronto Stock Exchange and in restructuring talks with creditors.
**** Halted due to legal dispute.

PROJECT TYPE:
B Brownfield expansion
G Greenfield
CM Conventional mine
LBE Lake brine extraction
SE Seawater extraction
SM Solution mine

PROJECT STAGE:
FS Feasibility study
P Permitted
UC Under construction
C Completed/ commissioned

PRODUCT:
MOP Muriate of potash, KCl
SOP Sulphate of potash, K_2SO_4

START-UP DATE:
N/A Not available or provided



PHOTO: EBNER

Selective solution mining and advanced crystallisation

Ebner says its capabilities, by covering all process steps from engineering to start-up, allow potash projects to be optimised to their fullest extent.

Sebastian Ebner, Project Engineer, Ebner GmbH & Co KG, introduces an integrated process concept for efficient potash recovery with reduced surface impact.

Potash producers are under growing pressure to combine reliable output with lower energy demand, reduced water consumption and a smaller environmental footprint. Conventional underground mining remains indispensable to the industry, but it requires shafts, extensive surface infrastructure and large production capacities to justify the investment.

Traditional solution mining avoids some of this infrastructure. Yet the process – which uses freshwater to dissolve both potassium chloride (KCl) and sodium chloride (NaCl) – handles substantial volumes of salt, consumes considerable energy and can create large quantities of unwanted sodium chloride tailings.

Selective solution mining offers a different route. By combining horizontal drilling with the controlled circulation of brine, it targets KCl while leaving most of the NaCl underground.

Instead of a conventional ore processing plant, the surface operation is a carefully designed crystallisation and heat-recovery system. Its performance determines how much saleable KCl can be recovered, how efficiently the depleted brine can be reheated and returned underground, and whether the plant can operate reliably – despite the demanding characteristics of concentrated salt solutions.

Selective dissolution below ground

In selective solution mining, horizontal wells create an underground extraction chamber within the potash-bearing formation. A circulating brine is heated at the surface and injected into the well field. This brine is close to saturation with NaCl but undersaturated with KCl. As the solution contacts the ore body, it preferentially dissolves KCl. The KCl-enriched brine then returns to the surface for processing, while most of the NaCl remains in the formation.

Process selectivity for KCl over NaCl changes the environmental balance of the operation. It reduces the requirement for process water and avoids the large tailings piles and surface brine ponds associated with other production routes.

Surface wastes require long-term management due to erosion, seepage and the risk of salts entering surrounding soils and water bodies. Retaining NaCl underground therefore reduces both the physical footprint and future liabilities. Horizontal drilling can also limit the number of surface locations required to access the deposit.

In selective dissolution, the brine returning to the surface from underground has two important characteristics:

- Its temperature is lower than that of the hot liquor used in a conventional hot dissolution plant.
- It is not necessarily fully saturated with KCl.

These two characteristics are fundamental to the design of the surface plant. This is because they reduce the quantity of KCl that can be crystallised (per cubic metre of circulating solution) and make efficient heat integration essential.

Why crystallisation becomes the key process step

While the solubility of KCl is strongly temperature-dependent, NaCl solubility changes comparatively little over the operational temperature range. Cooling the enriched brine can therefore precipitate predominantly KCl while leaving NaCl in solution.

After solid-liquid separation, the KCl crystals obtained can be washed and routed to drying, compaction or another finishing step. The KCl-depleted mother liquor is then reheated and returned to the well field, closing the brine circuit.

While the principle is simple, achieving an efficient industrial process is not!

In a conventional hot-dissolution plant, the liquor enters the crystallisation section at approximately 95 °C and leaves at about 35 °C. Across this temperature interval, KCl solubility may decrease by roughly 8.5 percentage points by weight, providing a comparatively high yield per pass.

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In selective solution mining, the returning brine typically enters the surface crystallisation plant at only 60-80 °C and can have a lower KCl saturation level. Consequently, substantially less KCl could crystallise from each unit of brine, in comparison to conventional hot dissolution.

A lower yield per pass means that more solution must circulate through the wells, pipelines, heat exchangers, crystallisers and separation equipment for the same output. Hydraulic capacity, pumping power and heat-transfer area can all increase.

The crystallisation plant for a solution mine must therefore extract as much KCl as economically reasonable while returning brine with the correct composition and temperature for renewed underground extraction.

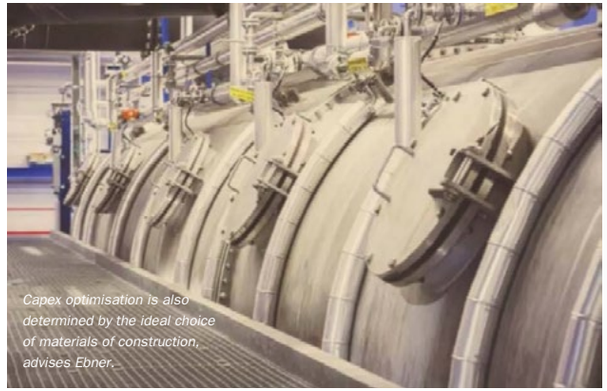


PHOTO: EBNER

Capex optimisation is also determined by the ideal choice of materials of construction, advises Ebner.

A hybrid crystallisation concept for higher recovery

Ebner has developed a dedicated process concept for selective solution mining. The concept combines staged cooling crystallisation, maximum practical heat recovery and a final direct-cooling step.

In the warmer part of the process, vacuum cooling can be used to reduce the brine temperature and generate crystallisation in a controlled manner. Water evaporates under reduced pressure, removing heat from the circulating suspension and concentrating the solution. The vapour and hot process streams also provide valuable opportunities for heat recovery within the surface plant.

In selective solution mining, to compensate for the lower inlet temperature and the lower KCl loading of brines, the mother liquor must generally be cooled below the practical final temperature limit of a conventional vacuum-cooling system.

There are also other problems. As the solution becomes more concentrated, its boiling-point elevation increases. Also, at the low absolute pressures necessary for further vacuum cooling, the available temperature difference becomes too small and the use of flash evaporation equipment becomes increasingly impractical.

Therefore, in Ebner's selective solution mining concept, the final crystallisation stage uses direct heat transfer with chilled brine or cold water, rather than relying on further flash evaporation.

This hybrid arrangement, with both vacuum and direct cooling, extends the usable cooling range and raises KCl recovery per pass without applying costly refrigeration to the entire temperature range. Higher-temperature heat is recovered and reused, while refrigeration is reserved for the colder section where it creates additional product yield.

The optimum transition between vacuum and direct cooling is project-specific and depends on brine composition, saturation, flow rate, return temperature, required recovery, cooling-water conditions and available utilities.

Heat integration is central to the concept. Heat removed from the KCl-rich brine is used, as far as practical, to preheat the depleted mother liquor before reinjection. A well-designed recovery network reduces both the external cooling duty and the heating duty before the injection wells.

This lowers operating costs and carbon emissions while supporting stable underground dissolution. Process modelling must consider the complete circuit – as isolated local improvements can shift energy demand, supersaturation or hydraulic load elsewhere in the plant.

Controlling crystal size and circulation

The crystalliser must do more than generate the required mass of solids. It must also produce crystals large and robust enough for efficient separation and downstream handling.

Excessive supersaturation promotes primary nucleation and creates fines. These are unwelcome as they are difficult to recover in a centrifuge and can increase product losses. Insufficient supersaturation, in contrast, limits crystal growth and may require excessive residence time and vessel volume.

Ebner's concept therefore manages supersaturation through controlled cooling, circulation and residence time. The suspension is kept well mixed without exposing the crystals to unnecessary mechanical stress.

Existing crystals provide a growth surface for the deposition of dissolved KCl, so avoiding the formation of a large population of new nuclei. During this stage, temperatures and solids concentrations are also selected to balance recovery, crystal growth and equipment size.

Where the product specification demands it, fines can be retained or internally classified so that they remain in the growth zone instead of leaving prematurely with the product stream. The result is a crystal-size distribution better suited to solid-liquid separation, washing and subsequent compaction.

Managing deposits during direct cooling

Direct cooling introduces one of the most difficult operating challenges in the process. The coldest heat-transfer surfaces create locally high supersaturation, making them natural sites for KCl deposition. Other salts or impurities in the circulating brine can also increase scaling. If deposition on equipment continues unchecked, heat transfer performance declines, increasing cooling power requirements and eventually requiring the plant to be stopped for cleaning. A nominally efficient crystalliser can therefore become uneconomic if scaling reduces availability.

Ebner's design addresses this issue by combining a specialised cooling surface arrangement with an operating concept that allows the relevant surfaces to be cleaned during plant operation. Cleaning is integrated into the closed process circuit and does not create an additional wastewater stream. This is especially important for selective solution mining, where avoiding surface brine disposal is part of the project's environmental rationale. Cleaning during routine operation stabilises heat transfer, limits the need for shutdowns and helps maintain predictable cooling profiles and crystal quality over extended campaigns.



PHOTO: EBNER

Ebner's evaporation and crystallisation plants are based on more than 60 years of experience.

An integrated route from brine to product

Selective solution mining makes it possible to closely integrate the well field and the surface process plant, a key factor in the technical and economic success of the project. The crystallisation section is the link between resource extraction, product quality and energy efficiency. It determines the KCl yield from each circulation cycle, the properties of the solids sent to downstream processing and the condition of the brine returned underground.

As a specialist in evaporation and crystallisation technology since 1965, Ebner combines process development, engineering, plant design, fabrication of key equipment, installation and commissioning. This integrated approach allows the crystallisers, heat exchangers, vessels, piping and control philosophy to be developed as one system.

For potash producers evaluating selective solution mining, the result is a surface plant designed around the actual characteristics of the deposit and brine circuit – with high KCl recovery, effective heat reuse, manageable fouling and dependable long-term availability as the principal design objectives. ■



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Is the next big potash story Congolese?

New capacity from the Republic of the Congo (RoC) has the potential to further upend what is set to be a heavily oversupplied potash market over the next decade. CRU's **Alexander Chreky** looks at current project prospects in the RoC and the history of potash mining and exploration in the country. The Mboukoumassi project being developed by Luyuan Mining Congo is the most advanced Congolese potash venture – and is included in CRU's current base case supply forecast.

Introduction

The world of potash is awash with projects. Nearly 12.7 million tonnes of new capacity is currently planned over the next five years, with even more slated beyond that period.

Most of the new capacity is being added in Russia and Canada, countries already well known for potash production. At the same time, a flurry of projects has been quietly advancing in the Republic of the Congo (RoC), home to one of the world's largest untapped potash deposits.

This new capacity from Central Africa has the potential to further upend what is set to be a heavily oversupplied market over the next decade. That said, there have been several attempts to mine potash in the region previously, with varying degrees of success.



PHOTO: KORE POTASH

Kola project drilling programme at Sintoukola near the Congolese coast.

Potash mining in the RoC has been a long time coming

Serious efforts to establish a potash mining industry in the RoC began after the country gained independence from France in 1960. These efforts built on French geological discoveries made after World War II. Exploration first focused on Gabon, where unfavourable salt tectonics made the deposits hard to exploit through conventional mining techniques.

Attention then shifted to French Congo. In 1957, geologists from the Société des Pétroles d'Afrique Équatoriale Française (SPAFE) found potassium-bearing rocks during oil exploration near Pointe-Noire. Later work confirmed a substantial deposit, estimated at more than one billion tonnes of probable reserves. It lies within a 400-750-metre-thick evaporite sequence, whose upper surface dips from a depth of around 260-280 metres inland to around 600 metres offshore.

This pivotal discovery led to the formation of the Compagnie des Potasses du Congo (CPC) in April 1964. CPC was a consortium of several French companies and the Congolese government, set up to secure the equipment and capital needed to bring a potash production project into operation.

The chosen site, Saint-Paul, near the village of Holle (Figure 1), had clear logistical advantages. Its location was around 40 kilometres from Pointe-Noire, a port close to the Brazzaville to Pointe-Noire railway, and reachable via the well-maintained Sounda–Pointe-Noire road.

Mine construction began in 1965, with ground freezing used to deal with the area's many aquifers and waterlogged ground.

After four years of development, muriate of potash (KCl, MOP) production finally began in 1969, with plans to eventually ramp up production to around 0.8 million tonnes per year (Mt/y). In reality, output at Saint-Paul never went above 0.5 Mt/y MOP before a devastating flood in 1977 forced the mine to close for good.

After CPC's Saint-Paul operation at Holle closed, potash mining in the RoC lay dormant until 1997. That year, Canadian company MagIndustries Corporation showed interest in the region, initially for a magnesium project.

After a two-year civil war put those plans on hold, MagIndustries switched its focus to potash – which it saw as the more profitable option. The company first planned a 0.6 Mt/y MOP solution mine at the Mengo deposit, later expanding the design to 1.2 Mt/y MOP. It also completed a feasibility study in 2008.

Although it managed to raise more than $100 million, MagIndustries did not secure full funding until 2011. This came through a major investment from Chinese conglomerate Evergreen Industries Holding Group, which bought a 75% stake. Construction of the mine and supporting infrastructure began but stopped abruptly in 2015.

MagIndustries then collapsed as funding dried up and allegations of bribing Congolese government officials emerged. This was followed by a police investigation in Canada.

Despite these failures to bring potash to market in Congo, interest in developing projects in the region has remained strong.



Fig. 1: All that remains of the Saint-Paul Mine at Holle

Source: Contains modified Copernicus Sentinel data [2026], processed by CRU NOTE: Geolocation: 4°33'2.61"S, 12°5'30.04"E

Potash project interest remains, despite chequered history

Despite a history of unsuccessful potash mining ventures in the RoC, the broader Central African region still hosts a range of projects (Figure 2). CRU currently counts at least 18 – although a significant number of these are dormant.

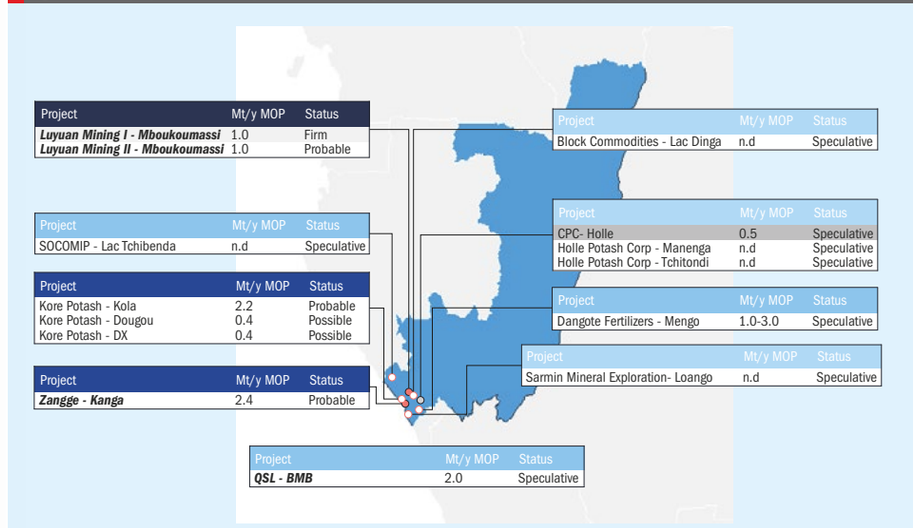
Of these projects, Luyuan Mining Congo's Mboukoumassi project is the most advanced, earning it a place in CRU's current base case supply forecast. Beyond Mboukoumassi, CRU tracks several less advanced projects in the region, including those being developed by Kore Potash and Kanga Potash in the Republic of the Congo and Millennial Potash in Gabon.

Luyuan Mining Congo

The Mboukoumassi project dates back to July 2018, when Luyuan Mining Congo signed a mining agreement with the Congolese government. This was ratified in December 2021 and gives Luyuan the right to mine and process potash across a 242 km² area of Mboukoumassi.

This zone holds around 1 billion tonnes of identified KCl resources. While Luyuan

Fig. 2: **Potash projects in the Republic of the Congo are numerous and at varying stages of development**



Source: CRU Potassium Chloride Report, Company Reporting

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plans to extract 2 Mt/y of MOP during the project's first phase, CRU only includes the first 1 Mt/y of MOP capacity in its base case.

The project has strong Chinese financial backing. After an ownership change in February 2026, lithium producer Ganfeng Lithium gained a minority stake in the project's holding company. It has also agreed to guarantee a RMB2.3 billion construction loan for the project, on top of the $1.27 billion Luyuan has already committed.

Project progress has been steady since site works began in June 2023. The mine will be accessed through four shafts: a main production shaft, a service shaft and two ventilation shafts.

By August 2026, the sinking of the main shaft had reached a depth of 350 metres, with ground freezing being used to prevent water ingress. This 450-metre-deep shaft is now more than three-quarters complete.

Above ground, the on-site processing plant, which will upgrade the ore using froth flotation, was more than 80% complete by August 2026. After processing, a 20-kilometre pipeline will carry the resulting slurry to a drying plant on the coast. The project's plans also include a granulation plant. This matters if Mboukoumassi is to compete in Brazil, which is mainly a granular market.

In September 2025, the government approved 577 hectares of coastal land for a dedicated export terminal, linked to the mine by road. Power will come from a planned connection to the 220 kV grid. The project is expected to employ 1,300 local workers alongside several hundred Chinese staff.

Luyuan originally set the end of 2025 as the target date for first production. The company now expects to start trial production by the end of this year, before producing potash commercially in early 2027. CRU is less optimistic, however, and expects start-up to happen a year later in 2028; the project also still carries a significant risk of delay or cancellation.

Kore Potash

Kore Potash, formerly Elemental Minerals, has been working towards potash production in the Republic of the Congo for more than a decade and has carried out studies at several coastal sites. The company holds rights to several projects, but it is currently developing only one: the Kola project at Sintoukola, near the Congolese coast.

The project hosts mineral resources comprising 848 Mt of sylvinite and around 2,000 Mt of carnallite. The current plan is to mine the sylvinite using conventional underground methods to produce 2.2 Mt/y MOP, mainly for export to Brazil and African markets.

Kore's relationship with the Congolese government has been turbulent. Most notably, two senior employees were arrested in 2022 and later released without charge. Nonetheless, the company has still obtained the necessary mining permits and completed all the studies required to develop the project further.

Kore signed a $1.9 billion fixed-price engineering, procurement and construction (EPC) contract for the Kola project with PowerChina International in November 2024. However, it was unable to fully finance the project subsequently and put the project up for sale in late 2025 while reviewing its options.

Kanga Potash (Zangge)

Kanga Potash, a Mauritius-registered company, became yet another Congolese potash player in 2016. It is proposing to develop the Kanga and Loango deposits, located on the country's coast, using solution mining.

The company has made steady progress through the permitting process since entering the fray. It was granted a 25-year mining licence covering 321 km² at Kanga in June 2022 and signed a mining convention with the government in August 2023. The venture at Loango, meanwhile, remains at the exploration stage.

The Kanga licence holds around two billion tonnes of contained KCl resources, including about 810 Mt in the indicated category. The project's feasibility study defined probable reserves of 131 Mt of carnallite containing 24 Mt of KCl. That is enough to support a mine life of around 40 years at the company's base case production of 0.6 Mt/y MOP.

The company has set out a flexible development path, beginning with a 0.4 Mt/y starter project and eventually scaling up to 2.4 Mt/y. To avoid freshwater constraints, Kanga plans to dissolve the carnallite with hot seawater ('hot leaching'). Although this could lower operating costs, CRU notes that impurities from the seawater could affect final product quality.

Like other prospective Congolese producers, Kanga Potash is building its business model around exports. It plans to run its own transshipment jetty and to ship mainly to Brazil and African markets. The company had targeted first production in 2026, but construction has yet to begin.

Kanga's project financing was previously controlled by Luxembourg-based AMED Funds. This is now set to change. In September 2026, Zangge Mining, the Chinese potash producer controlled by Zijin Mining, signed an agreement to buy 92% of the company for $171 million. The deal will go through a new Singapore holding company, owned 75% by Zangge and 25% by Chinese fertilizer producer Yuntianhua, leaving Zangge with an indirect 69% stake in the project.

Zangge says it intends to speed up construction preparations and bring Kanga into production "at an early date". However, the deal still needs approval from Chinese regulators and the RoC's Ministry of Mines.

Other runners and riders

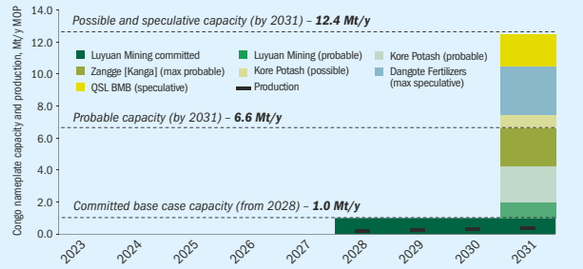
Several other RoC projects are further from completion and less is known about them. The most notable is Dangote's project at Mengo, which takes over the former MagIndustries tenement.

In June 2026, the Congolese government awarded the Mengo mining permit to Dangote Fertilizer Limited Congo. Dangote is proposing a phased development, with initial production of 1 Mt/y MOP in phase one, rising to 2 Mt/y in a second phase and then 3 Mt/y in a third phase – at an estimated investment of $3 billion.

The project is a good fit for Dangote's wider fertilizer business, with the group also planning to build an NPK plant in Congo. The project is still at the study stage, however, and the feasibility and environmental studies are yet to be completed.

Meanwhile, major Chinese brine MOP producer Qinghai Salt Lake Industry (QSL), now controlled by China Minmetals, has quietly been developing a solid potash project in the country known as 'BMB'. The project is still at the exploration stage, and little is known about it beyond a potential first-phase capacity of up to 2 Mt/y MOP.

Fig. 3: **Full realisation of potash capacity would be a significant addition to the market**



Source: CRU Potassium Chloride Report, Company Reporting

A new phase of potash activity supported by China

The Republic of the Congo is entering a new phase of potash activity. Mboukoumassi is targeting trial production as early as this year, while most other projects remain classed as 'possible' or 'speculative' in CRU's project grading system.

Chinese companies are behind much of the progress: Ganfeng has a stake in Luyuan, Zangge is acquiring Kanga, QSL is exploring at BMB, and PowerChina is the EPC contractor at Kola. As a result, after Laos and Thailand, Congo has become a key region in China's second wave of global potash investment (Figure 3).

Potash mining in the RoC has a long record of failure, from the flooding at Saint-Paul in 1977 to the collapse of MagIndustries in 2015. However, the country's large untapped carnallite and sylvinite deposits, together with substantial Chinese backing, now point to a potential revival, one that could finally put Congo on the world potash map.

With limited domestic and regional demand, almost all potash produced in the RoC will be exported, as every project developer in the region is planning. Brazil is the obvious main market, given its size and the short shipping distance. The US and China also often feature in company presentations.

The market backdrop is not encouraging. If all the 6.6 Mt/y of capacity in CRU's 'Firm and Probable' category were to come online by 2031 (Figure 3), the effect on prices would be severe, as the global potash market is already facing oversupply with the arrival of major new projects. ■



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Next-generation evaporation units in phosphoric acid plants

The ATMOS process is an advanced heat integration technology for concentrating wet-process phosphoric acid. Co-developed and patented by Yara and GEA, it combines double-effect evaporation with high-efficiency fluorine scrubbing to deliver significant improvements in energy performance and environmental control. In this article, **Azza Kioua**, Process and Sales Engineer at GEA, and **Aziz Chbeir**, Global Expert Phosphates at Yara, present findings from the validation of ATMOS at industrial and pilot scales. These show a 40% reduction in specific steam demand during phosphoric acid concentration, along with a similar reduction in cooling water consumption, and the ability to recover more fluorine as fluorosilicic acid.

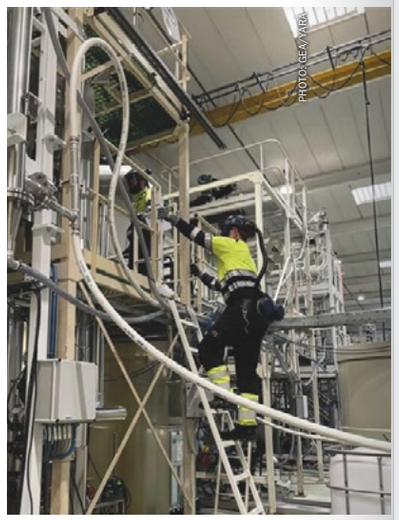
Background and objectives

Fertilizer–grade phosphoric acid is typically produced via the dihydrate (DH) route. In this process, the weak acid (26-30% P_2O_5) obtained from the reaction-filtration step is concentrated to 49-54% P_2O_5 through steam-driven evaporation.

Conventional single-effect DH units require about two tonnes of steam and six tonnes of cooling water per tonne of P_2O_5. This high thermal load conflicts with decarbonisation goals, increases fuel costs and makes it harder to comply with stricter fluoride emission limits.

In traditional evaporators, fluorine- and silica-rich vapours are also condensed without heat recovery. This leads to low energy efficiency, scaling risks, high cooling requirements and costly condensate treatment.

Beneficially, ATMOS transforms the phosphoric acid concentration step into an energy-integrated, low-emission operation that can be retrofitted at existing plants.


PHOTO: GEA/YARA

GEA pilot plant with Yara's FTIR analyser team in action.

Process concept and thermal integration

ATMOS is an innovative process solution designed to meet the evolving needs of the phosphate industry. It aims to significantly reduce energy consumption, improve process performance and limit fluorine emissions.

Traditionally, green phosphoric acid is concentrated in a single-effect evaporator. However, this requires a lot of steam and wastes energy.

Double-effect evaporators are well-known in other industries and are more energy efficient. This is because they enable the reuse of the vapours from the first effect instead of using 'live' steam.

Traditionally, in the phosphoric acid process, fluorine- and silica-laden vapours are condensed without energy recovery in a single-effect evaporator. ATMOS, in contrast, purifies these vapours with its integrated washing column – thereby making them thermally usable and significantly reducing the need for new steam by enabling a second evaporation effect. This advanced thermal integration offers savings in steam consumption of around 40%.

The ATMOS process applies double-effect evaporation. It does this by reusing the existing evaporator as the second effect and adding an upstream first-effect atmospheric evaporator with an integrated washing column (Figure 1).

In the first effect, green or partially clarified acid is concentrated to 35-40% P_2O_5 at about 100-120 °C and atmospheric pressure. The resulting vapours, which contain high levels of hydrofluoric acid (HF) and silicon tetrafluoride (SiF_4), pass through a two-stage scrubbing system:

- A primary absorber using dilute fluorosilicic acid (H_2SiF_6) to capture most of the HF and SiF_4
- An alkaline polishing stage to capture any remaining HF and SiF_4.

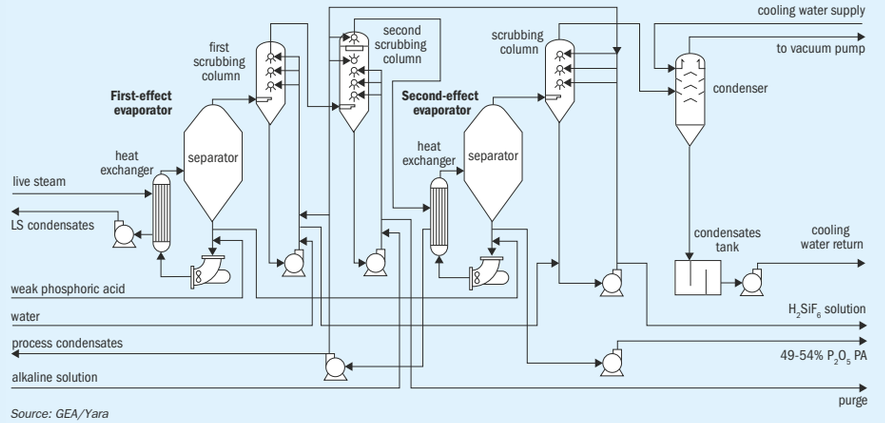
The purified vapours obtained then provide the heating medium for the second-effect evaporator. This operates under vacuum (around 0.1 bar) and at 80-90 °C to produce 49-54% P_2O_5 acid. Valuably, replacing 'live' steam with recycled vapours in this second effect cuts fresh steam demand by around 40%, depending on rock quality and the level of site integration. ATMOS incorporates three key innovations aimed at improving the performance of the phosphoric acid concentration process.

The first innovation optimises the operating conditions of the first effect to directly process weak acid. Suitable construction materials are needed for the intermediate acid stream and the solids generated. As the first effect takes place at high working temperatures, corrosion-resistant materials must be correctly selected to avoid any issues.

The second innovation maximises acid recovery and minimises emissions via extensive vapour treatment, including multiple droplet separation and scrubbing stages. The main challenge associated with this configuration is controlling scaling and maintaining the overall water balance of the process.

Finally, **the third innovation improves energy efficiency** by recovering heat from the vapours and reusing it as process steam for the subsequent stage. While this concept significantly reduces steam consumption, it requires careful management of scaling on the shell side of the second-effect heat exchanger. The two evaporation effects also need to operate reliably together.

Fig. 1: **Flowsheet for the ATMOS process**

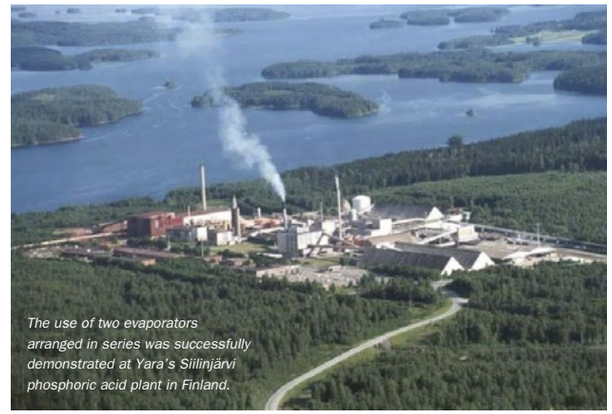


Source: GEA/Yara

Pilot and semi-industrial validation

The use of the two evaporators configured in series was successfully demonstrated at Yara's Siilinjärvi phosphoric acid plant in Finland. The main goal of this semi-industrial plant test was to obtain results under real operating conditions, and help develop GEA's new ATMOS pilot unit by predicting the behaviour of the intermediate acid generated.

In the Siilinjärvi plant test, the process conditions of the first-effect evaporator differed slightly from ATMOS conditions. But


PHOTO: GEA/YARA

The use of two evaporators arranged in series was successfully demonstrated at Yara's Siilinjärvi phosphoric acid plant in Finland.

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the system showed stable hydraulics, level control and temperature profiles under realistic variations in feed composition and throughput.

A pilot test with the ATMOS demo plant was also conducted at GEA's Lab Test Center between September and October 2024. The main objective of this test was to verify the feasibility of recycling fluorinated vapours generated by the concentration of green phosphoric acid at semi-industrial scale.

While the washing of these vapours is usually done with water, this is not totally efficient. An alkaline solution was therefore used in a polishing scrubbing stage, in addition to the primary scrubber, to improve process efficiency and eliminate most fluorinated compounds from the vapours.

Heat-transfer coefficients (K/K_0) in the acid heat exchanger (evaporator) and in the condenser remained stable throughout the trial, indicating effective scaling control (Figures 2 and 3). Condensate analyses also confirmed that dissolved silicon stayed well below amorphous SiO_2 solubility limits, demonstrating low fouling risk and proving that fluorine-rich vapours can be reused as a clean thermal medium when gas-liquid contact and pH are properly controlled.

At the end of the pilot test, the first and second scrubbing columns were dismantled to see if there were any traces of scaling, especially from SiO_2. Traces of white solid were observed at the suction of the first recirculation pump of the first scrubber (Photos 1 and 2). This material was difficult to break up and laboratory analysis confirmed it was solid SiO_2.

Nothing was found, however, in the second scrubbing column. All the parts of the recirculation pump, the piping and the spray nozzles were very clean (Photos 3 and 4).

Inspection of the condenser inlet also revealed no traces of scaling (Photos 5 and 6). These observations confirmed the success of the pilot campaign and the stability of heat-transfer coefficients over time.

Fig. 2: **Evolution of the heat-transfer coefficient (K/K_0) of the evaporator as a function of time**

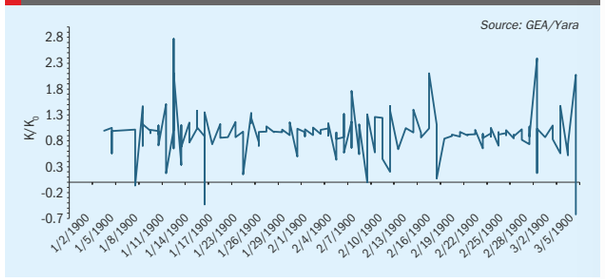
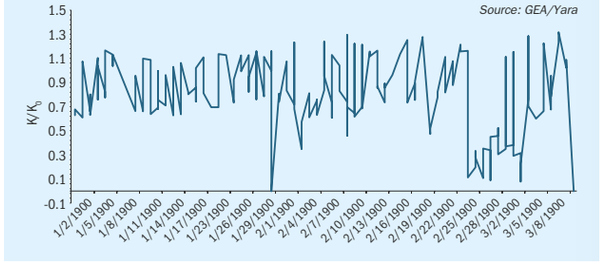


Fig. 3: **Evolution of the heat-transfer coefficient (K/K_0) of the condenser as a function of time**



Performance gains and environmental impact

ATMOS reduces specific steam consumption in the dihydrate concentration step from about 2.0 to 1.2 tonnes of steam per tonne of P_2O_5, representing a 40% cut in thermal energy demand. A similar proportional decrease in cooling water demand also eases the load on cooling systems, enabling higher throughput and helping to relieve capacity bottlenecks.

The multi-stage scrubbing system used in the ATMOS process improves fluorosilicic acid recovery by up to 20% compared to single-stage water scrubbing. This reduces gaseous fluorine emissions and lessens the need to neutralise the condensates from scrubbing. Lower off-gas fluorine levels, with higher conversion to fluorosilicic acid, help operators comply with stricter stack and water discharge limits.

ATMOS can also support climate change targets by improving energy efficiency and reducing indirect CO_2 emissions, depending on the site's energy supply mix. Overall, the combined steam savings, lower cooling duty and better recovery of fluorosilicic acid reduce operating costs and improve the life-cycle footprint of phosphate fertilizers.

What stands out most about ATMOS is its ability to recover heat and therefore minimise steam consumption during phosphoric acid concentration. Its advanced thermal integration enables:

- Up to 40% savings in steam consumption
- Up to 40% reductions in cooling water demand.

The major benefits of the ATMOS process are:

- **The potential for low-carbon electricity generation**: by reducing primary steam demand, ATMOS frees up thermal capacity that can be redirected to steam turbines or other plants, supporting on-site decarbonised power production or steam utilisation.
- **Strong economic impact for coal-fired sites**: every tonne of steam saved directly lowers energy costs and emissions from fossil fuel combustion, offering substantial savings and sustainability gains.
- **Reduced fluorine emissions**: phosphoric acid evaporation leads to the stripping and the condensation of fluorine compounds. Importantly, from an environmental perspective, ATMOS significantly reduces the levels of fluoride compounds present in the condensates generated.

PHOTO: GEA/YARA



Photo 1: Scaling observed in the suction piping of the recirculation pump of the first scrubbing column.

PHOTO: GEA/YARA

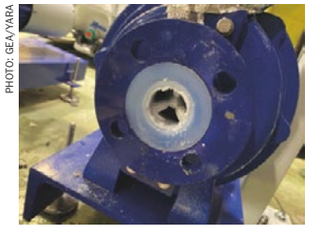


Photo 2: Scaling observed in the recirculation pump of the first scrubbing column.

PHOTO: GEA/YARA

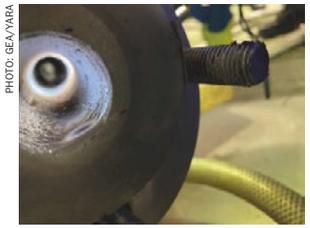


Photo 3: No scaling was observed in the piping of the recirculation pump of the second scrubbing column.

PHOTO: GEA/YARA

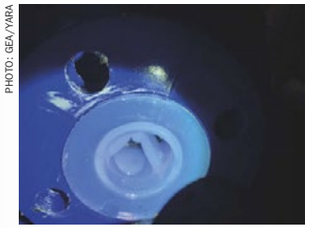


Photo 4: No scaling was observed in the recirculation pump of the second scrubbing column.

PHOTO: GEA/YARA



Photo 5: Inlet piping of the condenser with no scaling, as shown by micro-camera imaging.

PHOTO: GEA/YARA

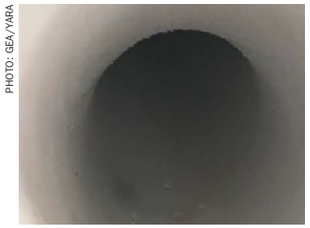


Photo 6: Inlet piping of the condenser with no scaling, as shown by micro-camera imaging.

Fluorine recovery and condensate quality

As well as reducing steam consumption, the implementation of ATMOS at phosphoric acid plants can also improve the recovery of fluorine as fluorosilicic acid. With growing environmental scrutiny and stricter regulatory limits on fluorine, the condensation of fluorine-containing vapours is becoming an increasing concern – especially as the treatment and/or disposal of the resulting condensates can be costly.

The configuration of the ATMOS process offers a number of advantages in fluorine recovery. These include:

- The addition of only one extra scrubbing column
- Improved condensate quality enabling water reuse
- Elimination of scaling issues in the cooling water circuit downstream of the condenser
- Lower levels of fluorine compounds in condensates compared with conventional treatment systems.

ATMOS implements two key process modifications to achieve this.

First, the evaporators are operated in series. The first unit produces dilute acid (35-40% P_2O_5) at atmospheric pressure, while the second operates under standard conditions (i.e., under vacuum) to produce concentrated phosphoric acid (49-54% P_2O_5).

Second, a dual-stage washing system purifies the vapours. The initial washing stage uses a dilute H_2SiF_6 solution while the second washing stage uses an alkaline solution.

This system ensures efficient heat recovery without major scaling. Both washing steps operate at 100 °C and atmospheric pressure, and use preheated wash solutions to prevent condensation inside the columns.

Retrofit strategy and implementation

ATMOS can be installed as a modification to existing plants (i.e., as a retrofit) or incorporated in new (greenfield) phosphoric acid plants.

In retrofits, a new first-effect atmospheric evaporator and two washing columns are added upstream, while the existing evaporator is used as the second effect in the process. The washing columns can be configured to target fluorosilicic acid recovery and meet site emission limits for fluorine, thereby balancing investment with environmental performance.

ATMOS retrofits have a compact layout and – because the newly installed equipment operates at atmospheric pressure – are relatively simple mechanically. This makes them an attractive and affordable CAPEX option for brownfield projects.

The main retrofit requirement is a planned shutdown. This is necessary to reroute the vapour and condensate lines at the plant and connect the existing evaporator as the second effect. Ideally, this work should be timed to coincide with the plant turnaround schedule.

The selection of corrosion-resistant materials for the first-effect evaporator and washing system is critical due to the high temperature and acidic operating conditions and the presence of fluorine. Although alkali consumption in the polishing scrubber varies, according to the primary absorber performance and the target level for residual fluorine, it can be minimised through proper process control.

Incorporating ATMOS in greenfield phosphoric acid plants provides industrial manufacturers with the opportunity to build new, environmentally-responsible production units or increase their production capacity.

Overall, ATMOS offers a mature and economically-attractive solution for modernising the phosphoric acid concentration process – thanks to substantial reductions in steam use, cooling demand and fluorine emissions. ■

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Purified phosphoric acid with sulphur-decoupled technology



SOURCE: TRAVERTINE

Fig. 1: Travertine's demonstration plant, Rochester, New York.

US-headquartered Travertine is combining advanced separation and electrochemistry techniques to meet the growing market for purified phosphoric acid. By removing traditional sulphur feedstocks and either upcycling phosphogypsum waste or digesting phosphate rock, the Travertine Process™ delivers a much-needed, lower-cost process to the industry. **Dr Laura Lammers**, Travertine's founder and CEO, introduces this innovative technology and highlights its key advantages.

Yet another global sulphur crisis has shaken the fossil fuel-dependent, capital-intensive phosphate industry – and, along with it, phosphate fertilizer producers and markets. As The Fertilizer Institute (TFI) wrote earlier this year: "Without sulfur, there is no sulfuric acid. Without sulfuric acid, there is no phosphate fertilizer."

The same can be said of battery energy storage technology, where surging demand for lithium iron phosphate (LFP) and lithium sulphur (Li-S) is facing difficult headwinds from sulphur, sulphuric acid and purified phosphoric acid (PPA) market disruptions.

As a result, phosphate producers are looking to new industry partners for survival. Those partners include my company, Travertine, which has developed an integrated phosphate process to help the industry regain its footing.

The Travertine Process: a new approach

Rather than burning sulphur tied to specific oil and gas refinery feedstocks, the award-winning Travertine Process™ uses electricity to recycle phosphogypsum. This is converted back into sulphuric acid for digestion of phosphate rock. The same process also yields calcium hydroxide for clinker production or calcium carbonate for ready-mix concrete.

Purified phosphoric acid (PPA) is then produced by integrating the resulting water balance with advanced separation technology. PPA is suitable for precise, efficient application as a liquid phosphate fertilizer via fertigation and, more recently, for the cathodes of LFP and lithium manganese iron phosphate (LMFP) batteries, in response to soaring demand for electric vehicles (EVs) and other segments.

Decoupling from traditional sulphur feedstocks via the recycling of phosphogypsum solves a monumental industrial waste problem. It also sets the industry up for success – by offering long-term price stability that's buffered from geopolitical supply chain shocks.

Travertine and the Travertine Process were born almost five years ago, originating from research at UC Berkeley. Now, with a 2,000 m² laboratory and pilot plant in Boulder, Colorado, and a 180 tonne per annum (t/a) sulphuric acid demonstration plant outside of Rochester, New York (Figure 1), our team's scientists and engineers stand ready to deliver innovation to the phosphates industry.

Although other processes for phosphogypsum valorisation have been proposed by technology licensing companies, Travertine's electrochemical plant is the first known to operate at demonstration scale, running for over 3,000 hours with commercial-scale electrochemical cells. We're at an exciting commercialisation and scaling threshold with various industry partners around the world.

Salt splitting – the missing link in sulphur-decoupled phosphate production

Pre-treatment of phosphogypsum to reduce radium, total organic carbon, phosphate and fluoride allows mineralisation of the phosphogypsum to a calcium product that meets building materials specifications. An example of one such phosphogypsum feedstock valorisation is shown here (Table 1).

Results at pilot and demonstration plant scale show >99% gypsum conversion, >95% sulphate recovery, continuous high-purity sulphuric acid regeneration and a calcium carbonate product. Sulphur losses across the integrated phosphoric acid process (total unrecovered sulphur) are around 4-6% of the circulating sulphur inventory. This corresponds to an overall sulphur demand reduction of approximately 94-96%, relative to conventional wet-process phosphoric acid (WPA) production.

Makeup sulphur for the small remaining balance can be supplied through alternative sulphate sources, including previously accumulated phosphogypsum stack material, externally sourced gypsum, or soluble sulphate streams, such as sodium sulphate. This flexibility enables partial or complete decoupling from traditional sulphur supply chains and creates a pathway for utilising existing sulphate-containing materials as process inputs (Figure 2).

Nested within the overall Travertine Process, our electrochemical salt splitting unit is the missing link in sulphur-decoupled phosphates production. Towards this end, we are developing the first commercially available high-current Bipolar Membrane Electrodialysis (HC-BMED) stack. This three-compartment unit converts waste sulphate salts into valuable acid and base products using only direct current (DC) power.

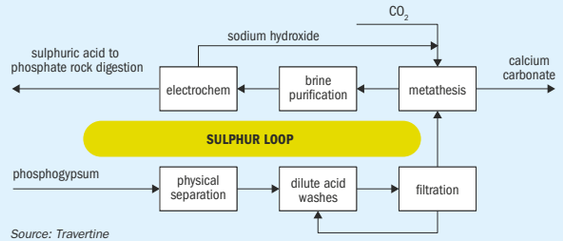
The HC-BMED stack uses a 60°C operating temperature – an industry-first – to minimise resistive losses and cooling system requirements. It also operates

Table 1: **Phosphogypsum (PG) valorisation results**

Composition	Untreated Phosphogypsum, wt-%	Treated Phosphogypsum, wt-%	Calcium Carbonate, wt-%
CaO	30.8	38.1	51.6
SO_4	51.5	65.7	1.3
P_2O_5	1.17	0.11	0.1
F	0.96	0.01	0.02
Cl	< 2	0.02	0.004
Fe	< 0.1	0.02	0.018
Mg	0.06	0.02	0.009
Al	0.06	0.02	0.004
TOC	0.4	0.1	0.4
Ra-226 (pCi/g)	35.7	9.1	10.4

Source: Travertine

Fig. 2: **Schematic flowsheet of Travertine's core closed-loop sulphur process**



Source: Travertine

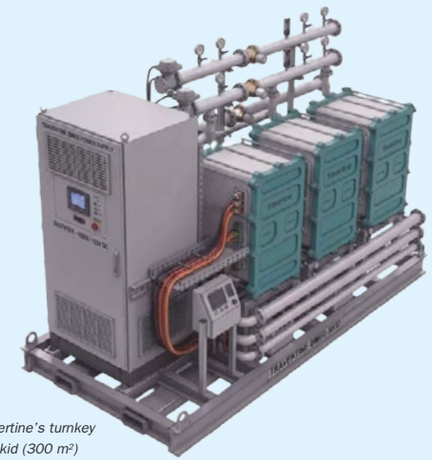


IMAGE: TRAVERTINE

Fig. 3: Travertine's turnkey HC-BMED skid (300 m²)

PURIFIED PHOSPHORIC ACID TECHNOLOGY PK

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at a current density of up to 2,500 A/m² to minimise capital costs and footprint. Additionally, by running at an electrical potential of less than two volts per cell, it delivers industry-low energy consumption and minimises plant operational cost. The stack assemblies are supplied in compact 100 m² units or as turnkey 300 m² skids for easy, modular expansion (Figure 3).

Mitigating trade-offs and optimising the phosphoric acid purification process

With a cost-effective phosphogypsum solution in hand, we turned our attention to the development of a phosphoric acid purification process. We integrated the latest advances in phosphate rock digestion, recrystallisation and filtration (DRF) with industry-proven nanofiltration (NF) and ion exchange (IX) separation technology for acid purification. We then constructed our pilot plant at the Boulder laboratory to match the scale utilised by current phosphate technology and equipment providers. Here, the team processed a number of sedimentary and igneous phosphate rock feedstocks from global producers to optimise the integrated process.

In the Travertine PPA Process, the DRF circuit for phosphate rock is integrated with electrochemical sulphuric acid production and gypsum valorisation. Phosphoric acid from the DRF circuit is fed into a bulk purification circuit, where the majority of impurities are removed. The partially purified phosphoric acid then enters a polishing and concentration circuit to create the final PPA product (Figure 4).

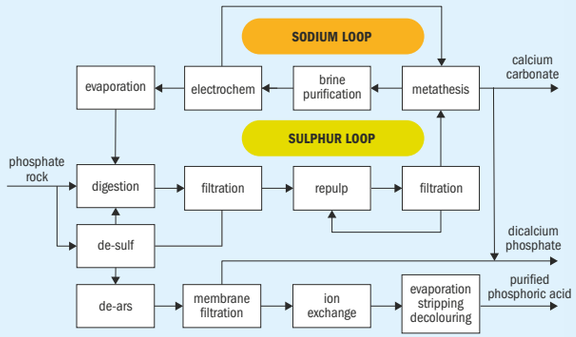
A number of customers across North America have approved samples of the final PPA product for their specific applications.

Conventional purified acid production utilises solvent extraction with MIBK or TBP-IP solvents, and suffers from a trade-off between product purity, phosphate recovery (P_2O_5), waste generation and process complexity. The raffinate obtained is chemical waste that requires deep-well injection, which is highly restricted.

Instead of solvent extraction, our process relies on membrane filtration and ion exchange – technologies that have already been deployed successfully in the phosphates industry as individual units for specific projects.

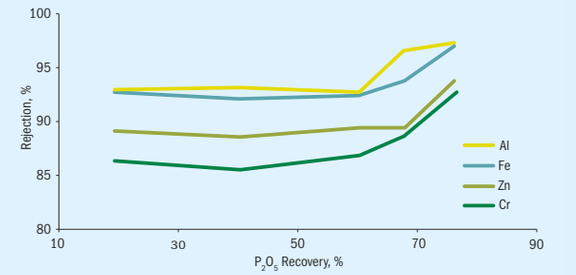
Bulk purification is performed using membrane filtration. Here, clarified phosphoric acid is first pumped through an ultrafiltration (UF) system to remove fine particles. NF membranes are then used to reject sulphates and associated cations.

Fig. 4: **Schematic flowsheet of the Travertine PPA Process**



Source: Travertine

Fig. 5: **Nanofiltration bulk impurity rejection as a function of P_2O_5 recovery**



Source: Travertine

Large-scale industrial UF/NF systems for phosphoric acid streams have been running for decades in the phosphates industry. The performance of Travertine's nanofiltration system for clarified phosphoric acid treatment is shown in Figure 5.

Techno-economic analysis of Travertine's process shows that the value of the calcium co-product offsets a substantial portion of sulphate recovery costs, while increased P_2O_5 recovery and elimination of sulphur consumption reduce operating expenses. Analysis also shows there is a 24% higher gross operating margin at a 100,000 t/a capacity PPA plant compared to conventional PPA production, assuming a sulphur input cost of $110/t.

A North American phosphate renaissance amidst global woes

With large phosphate operations in Florida, North Carolina and Idaho, the United States was the premier phosphate supplier in the world for 50 years. However, the US became a net phosphate importer in the late 1990s and slipped from the number one producer spot globally in the early 2000s.

The US phosphate industry has not built a new plant since 1975 and has contracted sharply over the last 30-40 years – from 22 phosphate facilities in 1990 to 10 today, and from 18

PHOTO: TRAVERTINE



Travertine's committed and talented team.

phosphate fertilizer companies to four. Remaining production plants are capital-intensive to maintain and require large amounts of capital to be set aside for remediation.

To revitalise the industry, Travertine is developing various projects in close collaboration with industry partners.

Our Louisiana project will produce 30,000 t/a of PPA for liquid fertilizers and other applications. Named Project Yellowstone, it is designed to be easily scalable to 100,000 t/a capacity. During pilot testwork, we processed sedimentary rock all the way through to purified phosphoric acid, which was then leveraged by a customer in American liquid fertilizer formulations.

Along similar lines, the US Department of Agriculture (USDA) recently relaunched its federal FIELDS funding programme. This will finance the next generation of independent, domestic fertilizer manufacturing plants and bring these into operation.

Elsewhere in North America, we recently completed pilot testwork for the Canadian Project Greystone venture. While the US produces phosphate rock on a large scale – 20 million tonnes in 2025 – Canada currently produces negligible amounts, relying heavily on US imports. Earlier this year, we announced a joint venture framework agreement with Canadian developer Arianne Phosphate to deploy the Travertine Process at its Lac à Paul phosphate project in Quebec.

The project's mine is designed to produce approximately 1.5 million tonnes of phosphate rock concentrate (38.6-41.5% P_2O_5) annually. This will supply a 350,000 t/a capacity purified phosphoric acid plant and a 200,000 t/a capacity phosphoric acid plant (both 100% P_2O_5 basis). During the testwork, we took Arianne's igneous rock all the way through the Travertine Process to purified phosphoric acid, which was then qualified by a customer active in the production of Canadian lithium iron phosphate cathode materials.

PHOTO: ARIANNE PHOSPHATE



Core samples of igneous phosphate ore from Arianne Phosphate's Lac à Paul project.

Meeting the moment with cost-effective solutions that prevail

In a changing world, the sulphur crisis, the accumulation of phosphogypsum waste and increasing purity requirements are all challenges facing the global phosphate industry. With the current sulphur price floor at least two to three times higher than before, a step change in the wet phosphate production process is imperative, in our view, to secure affordable phosphate supply.

The Travertine Process eliminates the two main cost drivers – sulphur feedstock and phosphogypsum waste – that affect the economic supply of phosphate fertilizer and the viability of the phosphate industry in its current form. By decoupling phosphate production from the global sulphur supply chain, Travertine's wet process achieves phosphate production costs at least 30% lower than those of the conventional wet process.

Reliable, cost-effective, alternative pathways for sulphuric acid and purified phosphoric acid are at our fingertips. Development of these solutions pre-dated the current Middle East conflict and global sulphur crisis, although both of those drivers have been accelerants for industry change. The moment of opportunity has arrived and the time to act is now. ■

About the author

Dr Laura Lammers is the founder and CEO of Travertine. The company was founded in 2022 to commercialise a new electrochemical technology for sulphate upcycling. Dr Lammers was previously a faculty scientist at Lawrence Berkeley National Laboratory and a professor at the University of California, Berkeley, where her lab pioneered the techniques that underpin Travertine's process.

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