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Fertilizer INTERNATIONAL



Dry bulk shipping outlook
Sustainable ammonium sulphate
Optimising NPK production
Potash projects update



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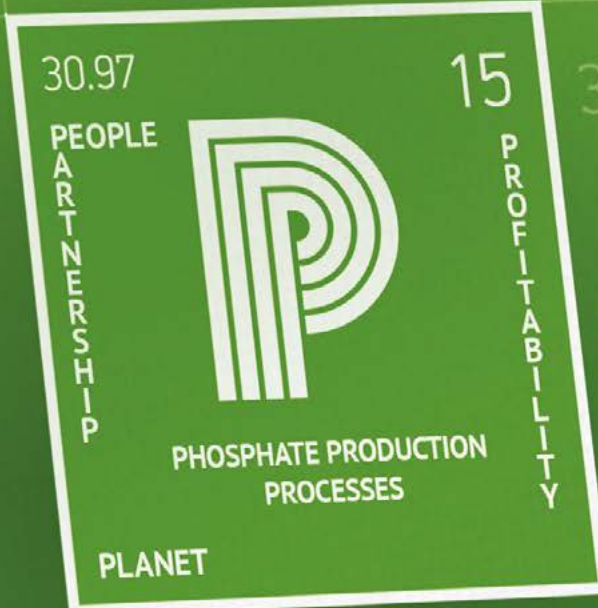
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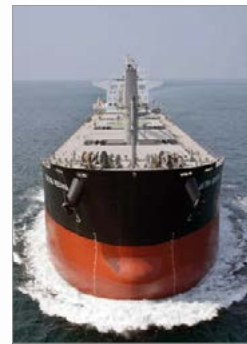
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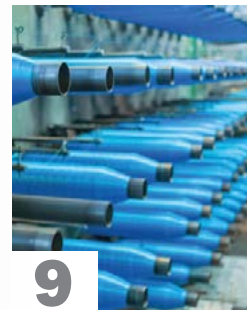
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The dry bulk market is forecast to cool, after a year of high freight rates driven by demand shocks. Should ships return to the Red Sea during 2025, then the market will weaken even more, impacting the supramax and handysize vessels typically used in fertilizer shipping, explains BIMCO analyst Filipe Gouveia.

9 Ammonium sulphate – a low-carbon sustainable pathfinder?

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The prospect of a drastic expansion in potassium sulphate production has been linked to a plethora of projects in Australia, Ethiopia, and Eritrea. Yet investor interest in supposedly promising projects has waned over the last few years. In this insight article, CRU's Alexander Chreky explains the reasons behind the high project failure rate, as well as highlighting some limited successes.

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A new home for potash



CRU's 2025 Phosphates Conference – now in its 16th year – will be held in Orlando, Florida, 31 March - 2 April next year. The 2024 event convened in Warsaw was one of the most successful to date (*Fertilizer International* 519, p4).

Building on that success, next year's event has even more to offer. That's because it will also champion the potash industry – as its new name *CRU Phosphates+Potash Expoconference* makes clear (see page 30).

So, why potash? Unbelievably, for a sector that produces close to 70 million tonnes of potassium chloride annually, there's never actually been a regular yearly event for the global potash industry.

Possibly, this has been due to the misconception that the potash sector does not innovate or invest as much, relative to other parts of the fertilizer industry. Whereas, in fact, massive potash industry investment is underway currently – directed at both new mega projects and the modernisation and expansion of existing assets.

Nutrien, for example, is shifting to large-scale autonomous mining, to cut production costs and bolster its competitive position, through its Next Generation Potash investment programme. Predictive maintenance technology is also being deployed to monitor critical assets and identify failures before they happen.

Nutrien boosted its autonomous potash production by 50% to six million tonnes in 2022, improving on this again last year by a further 40% rise in autonomous mining output.

This is only the start too. The company's president and CEO Ken Seitz wants all six of Nutrien's underground mines to become either fully autonomous or fully tele-remote in future.

Mosaic, meanwhile, finally completed its massive K3 potash expansion project at Esterhazy, Saskatchewan, last year. Esterhazy is now officially the world's largest potash complex, with an annual production capacity of 7.8 million tonnes.

The expansion has also transformed Esterhazy into one of the world's most efficient mines (*Fertilizer International* 502, p26). Mosaic added 13 automated rotary mining machines to its underground fleet as part of the \$2.9 billion mega revamp. These automated miners and Esterhazy's conveyor system are controlled remotely from a new Integrated Operations Centre (IOC) using advanced camera and sensor technology.

How long will Esterhazy keep its crown? Well, BHP recently approved \$4.9 billion for stage two of its Jansen potash project in Saskatchewan. This investment should eventually transform Jansen into the world's largest potash mine, doubling production capacity to approximately 8.5 million t/a (*Fertilizer International* 517, p8).

BHP is currently investing \$5.7 billion in Jansen's first stage. This will deliver 4.35 million t/a of potash capacity with production starting towards the end of 2026 (*Fertilizer International* 504, p8).

Mine electrification means Jansen will generate the lowest per tonne carbon emissions of any Saskatchewan potash mine. To help deliver this, Sandvik has secured major orders from BHP to supply the project with a fleet of bespoke electric MF460 borer miners and battery-electric vehicles (*Fertilizer International* 513, p38).

Potash and phosphate are both mined commodities with common extractive and process technologies. Crushing, grinding, screening, pumping, froth flotation, liquid-solid separation, dewatering, drying, evaporation and crystallisation are common to both industries.

Because of that, phosphates people are, more often than not, also potash people. That applies to engineering companies (Hatch), equipment manufacturers (Andritz, Bradley Pulverizer, Eriez, FEECO, Solex Thermal Sciences), reagent suppliers (Arkema-ArrMaz, BASF, Nouryon) and technology providers (GEA, Veolia) as well as producers (Mosaic, Nutrien, ICL, EuroChem) – and these are just snapshot examples.

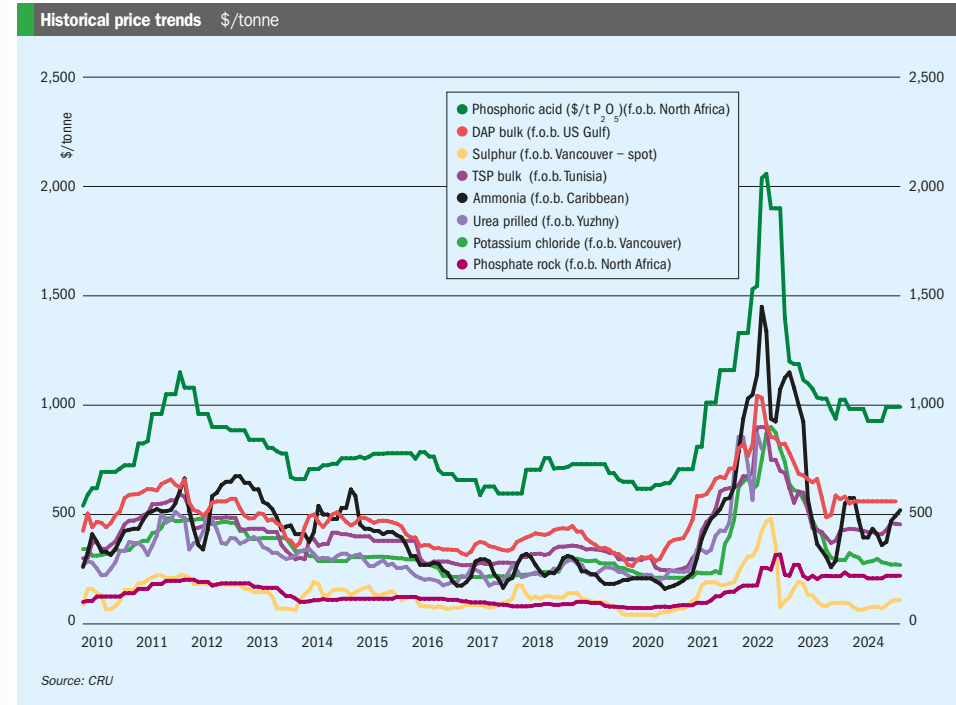
That's why it makes perfect sense to bring these two sister industries together in a single event. The massive investments currently underway in highly efficient potash mining and processing tech – and the pursuit of electrification, automation and digitalisation – also need highlighting.

Consequently, the potash industry deserves an annual gathering where its can network, hear the latest market intelligence and share new knowledge. That's why, in Orlando next spring, CRU will be building a new global community that jointly celebrates the phosphate and potash industries. We invite you to join us there – as well as spread the word that potash has a new home.

S. Ingelthorpe

Simon Ingelthorpe, Editor

Market Insight



PRICE TRENDS

Market snapshot, 17th October 2024

Urea: Prices firmed in a thin market in mid-October. Middle East values shot up \$20/t on expectations that Indian Potash Limited (IPL) would announce another tender to secure tonnes for India in December. If correct, this will follow hot on the heels of the latest Rashtriya Chemicals and Fertilizers (RCF) purchase tender for 0.56 million tonnes of urea. Sohar International Urea & Chemical Industries (SIUCI) sold a November cargo at \$390/t f.o.b. with further trader interest reported at \$385/t f.o.b. This demand was probably generated by traders positioning themselves for IPL's expected tender, given that other markets generally remained quiet.

In Algeria, AOA placed small volumes – likely destined for Latin America – at \$405/t f.o.b., while Dangote in Nigeria placed another cargo at \$352-355/t f.o.b. In a quite period, the NOLA urea price slipped back to \$325/st in mid-October. Egyptian prices, meanwhile,

were fairly solid with November priced at \$410/t f.o.b. but with nothing traded and no apparent rush to buy or sell either.

Ammonia: Benchmarks were more or less stable across the board in mid-October with supply-demand dynamics little changed. Demand from NW Europe remains quiet, although CF Industries UK is set to receive a 15,000 tonne spot cargo from Hexagon in November, with that reportedly sourced at around \$530/t f.o.b. Turkey. While regional supply does appear tight at present, steadily improving output from Trinidad and the US Gulf could alleviate recent pressures, with many players expecting Yara and Mosaic to agree a \$560/t cfr rollover in the November Tampa contract price.

East of Suez, Middle East exports remains constrained while maintenance work at Ma'aden's No 3 unit is ongoing. The producer had planned to move 125,000 tonnes in October, with 60% of that total originally lined up for India. Buyers there continue to resist higher cfr offers, with phosphate fertilizer producers

holding back on purchases until further clarity on phosphoric acid supply contracts emerges. Further east, another sale from Parna Raya into Vietnam was reported at \$510/t cfr, with the cargo in question potentially loading from Malaysia in early November – in what appears to be a swap deal with Petronas. Tonnes continue to move out of Indonesia, where Trammo picked up a formula-priced spot cargo from Mitsubishi for loading from Luwuk.

Phosphates: Prices firmed in the US in mid-October in the wake of Hurricane Milton (see page 10) as buying in India slowed and prices there stabilised. US supply is still exceptionally tight. DAP prices at NOLA have gained \$35/st since the start of October to reach their highest levels since March.

Global trade was noticeably slower with just one DAP cargo booked into India. India's DAP import price has been on a tear since May. The benchmark hit a low this year of \$510/t cfr on 9th May and has since rallied an average of \$133/t, or 26%, to \$643/t cfr, as of mid-October. India's importers are

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Market price summary \$/tonne – mid-October 2024

| Nitrogen | Ammonia | Urea | Ammonium Sulphate | Phosphates | DAP | TSP | Phos Acid |
|-----------------------|--------------|--------------------------------|----------------------|------------------|------------------|-----|-----------|
| f.o.b. Caribbean | 520 | - | f.o.b. E. Europe 249 | f.o.b. US Gulf | NOM | - | - |
| f.o.b. New Orleans | - | 363 | - | - | - | - | - |
| f.o.b. Yuzhny | Port closed | Port closed | - | f.o.b. N. Africa | 615 | 455 | 992 |
| f.o.b. Middle East | 420 | 351 | - | cfr India | 643 | - | 950 |
| Potash | KCl Standard | K ₂ SO ₄ | Sulphuric Acid | Sulphur | | | |
| f.o.b. Vancouver | 269 | - | cfr US Gulf | 129 | f.o.b. Vancouver | 109 | - |
| cfr India | 284 | - | - | - | f.o.b. Arab Gulf | 128 | - |
| f.o.b. Western Europe | - | 630 | - | - | cfr China | 150 | - |
| f.o.b. Baltic | 208 | - | - | - | cfr India | 143 | - |

Prices are on a bulk, spot basis, unless otherwise stated. Phosphoric acid is in terms of \$/t P₂O₅ for merchant-grade (54% P₂O₅) product. Sulphur prices are for dry material. n.a. = not available.

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struggling to secure cargoes as availability in the DAP market is severely limited. China, meanwhile, is expected to tighten DAP/MAP export restrictions in the fourth quarter to secure domestic supply and limit price increases for the autumn application season. There appear to be specific limits on fresh export sales from China to India, with this likely to last several months.

In Brazil, a lack of demand and low spot availability have left MAP prices little changed since mid-July. Similarly, phosphate fertilizers prices in Europe – range-bound since the start of the year – have been unchanged for the last five weeks. With Morocco's OCP managing its supply, there seems little to console those holding out for lower finished phosphate prices, especially given the deepening production difficulties in North America, lower exports from China, high demand in India, and a looming one million tonne DAP import tender from Ethiopia.

Potash: Firmly flat prices in Brazil set the tone for the potash market in mid-October. Producers are, however, expecting upward price momentum in Southeast Asia in anticipation of Pupuk Indonesia's latest tender. This tender should provide direction to the market, with offers rumoured at \$310/t cfr.

In Brazil, the MOP market was assessed unchanged at \$280-285/t cfr in mid-October. Prices there have declined steadily since May, driven mostly by ample supply, strong competition and, in recent weeks, limited demand.

The Indian potash contract was recently reassessed at \$283-285/t cfr for the remainder of its term. Consequently, Food Security Solutions (FSS) – the company

formed after Uralkali's restructuring – has agreed a new contract rate of \$283/t cfr with IPL starting from October, with the Belarusian Potash Company (BPC) expected to follow suit. China's domestic wholesale port prices, meanwhile, rallied to RMB 2,335/t fca (\$328/t) in mid-October – its first increase since July – supported by a demand influx.

Sulphur: Global sulphur markets were relatively quiet in mid-October, due to typically muted end-of-year demand – and participants also watching geopolitical developments. Chinese port prices settled to RMB 1,240-1,260/t fca (\$174-177/t), equating to around \$148/t cfr. Trading in the other Asian markets was sparse with fresh transactions remaining scarce. Delivered prices to India decreased to \$140-145/t cfr amid a lack of import demand currently.

Mediterranean supply remains tight with prices assessed at \$115-125/t cfr. The region is still recovering from a fire in the Motor Oil refinery on 17th September and water shortage issues at Tunisia's GCT. Motor Oil did, however, close a tender on 17th October for 5,000 tonnes, while GCT signed a sulphur supply contract with Total Energies on 11th October.

OUTLOOK

Urea: The short-term outlook remains firm despite the absence of any significant purchasing activity in Brazil or Europe and NOLA prices again sliding. The prospect of India stepping back into the market, without any sign of Chinese exports resuming, seems sufficient to maintain the current upward trajectory. Prices are therefore forecast slightly

higher over the next six months, based on rising import demand from India and the expectation of extremely limited exports from China over this period.

Ammonia: Prices should remain stable for the duration of October, with any further increases likely to be capped by a lack of demand. The outlook for November is more positive for buyers, with prices set to ease off once turnarounds at key export hubs are concluded.

Phosphates: Prices are likely to remain firm or higher in the near term as availability globally is currently extremely tight. Further out, delivered prices to India are expected to increase further before stabilising, with prices elsewhere broadly steady as limited availability offsets poor affordability. The Chinese government is expected to again tighten DAP/MAP export restrictions in the fourth quarter to secure domestic supply and limit price climbs during China's autumn application season.

Potash: Prices in Brazil appear to be at or near the price floor currently. In Southeast Asia, the Pupuk Indonesia tender is expected to provide further price clarity in coming weeks. Looking further ahead, soft-to-flat potash spot prices are forecast for the fourth quarter.

Sulphur: Global sulphur prices are still rising in certain regions, albeit at a slow pace. Higher prices for China's port-held stocks may have an effect on import purchases as the price gap between the two has narrowed. Sulphur affordability remains good – with phosphate price gains in recent weeks cementing this position. ■

Fertilizer Industry News

QATAR

Mega project to double urea production



Saad Sherida Al-Kaabi, the President and CEO of QatarEnergy, announcing a new ammonia-urea mega project during a press conference in September.

QatarEnergy has announced the construction of a new world-scale ammonia-urea production complex at Mesaieed Industrial City in Qatar.

The new complex – which will more than double Qatar's urea production – is expected to enter production before 2030. It will incorporate three new ammonia lines supplying four new world-scale urea production plants.

By adding 6.4 million t/a of extra urea capacity, the new complex will increase Qatar's annual urea production from about 6 million t/a currently to 12.4 million t/a. The project's first urea train is expected to enter production before the end of this decade.

The new mega project was announced by Saad Sherida Al-Kaabi, Qatar's Minister of State for Energy Affairs, and the president and CEO of QatarEnergy, on 1st September during a press conference at the company's headquarters in Doha.

"We have been producing ammonia and urea in Qatar for over 50 years.

Today, we are expanding our experience and further solidifying our position by this unprecedented mega-project that will make the State of Qatar the world's largest urea producer, playing a crucial role in ensuring food security for hundreds of millions of people around the globe, day after day," Al-Kaabi said.

"Developing this project in Mesaieed Industrial City will ensure the optimum utilisation of the excellent existing infrastructure for the petrochemical and fertilizer industries, including the city's export port, which is one of the largest fertilizer and petrochemical export facilities in the MENA region. It will also establish Mesaieed as the urea production capital of the world," he added.

Affiliate company QAFCO (Qatar Fertiliser Company) currently owns and operates six world-class ammonia-urea plants in Mesaieed Industrial City. The company is the world's largest single-site exporter of urea (5.6 million t/a) with a 14 percent share of world supply approximately. ■

GERMANY

Yara opens new ammonia import terminal

Yara International has officially opened its new ammonia import terminal at Brunsbüttel, Germany, located on the North Sea and Kiel Canal.

The addition of the new terminal now provides Yara with the necessary infrastructure to import up to three million t/a of low-emission ammonia into Europe. Brunsbüttel makes an ideal hub for Germany's emerging hydrogen economy, according to Yara.

"As the world's largest shipper and distributor of ammonia, Yara Clean Ammonia

is in a pole position to secure low-emission ammonia supply to Germany, at competitive prices," said Hans Olav Raen, CEO Yara Clean Ammonia. "With its leading global ammonia position, Yara can help kick-start the German hydrogen economy, laying the ground for a net zero future."

Demand for low-emission ammonia in Germany is expected to grow significantly in future. The country's Federal Ministry for Economic Affairs and Climate Protection estimates that up to 70% of national ammonia requirements will be imported by 2030 – with potentially higher import volumes after this date.



EasyMining's planned Schkopau Ash2Phos plant, Germany.

Permit for phosphorus recovery plant

EasyMining and its water industry partner Gelsenwasser have received a permit from Germany's State Administrative Office to establish a phosphorus recovery plant in Schkopau, Germany.

The two companies welcomed this green light for their Phosphorgewinnung Schkopau GmbH (PGS) joint venture, calling this "a big and important step closer" for the first phosphorus recovery plant based on EasyMining's Ash2Phos technology (*Fertilizer International* 509, p60).

The Schkopau plant – which will extract phosphorus from sewage sludge ash – is scheduled to start production in 2027.

"The State Administrative Office positive statement presents a golden chance for us to establish a circular solution for the vital nutrient phosphorus. We eagerly look forward to initiating the phosphorus recovery process, which will not only secure a stable supply of high-quality phosphorus within Europe but also contribute to a more sustainable food supply," said Christian Kabbe, CEO of EasyMining Germany.

The project, as well as improving security of supply for phosphorus, should offer environmental protection and waste management improvements.

"The positive permit from the State Administrative Office gives us the opportunity to finally start processing waste from municipal wastewater treatment and to strengthen water and soil protection in Germany. Phosphorus recovery is key to making urban water management waste-free and reintegrating these valuable materials back into the economic cycle," said Martin Braunsreuther, Gelsenwasser's head of sales.

The Ash2Phos technology developed by EasyMining, part of the Ragn-Sells Group, extract more than 90 percent of phosphorus present in ash generated by sewage sludge incineration. The objective is to partly replace phosphorus from primary sources, especially mines in Russia and Morocco, with recycled phosphorus produced domestically.

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EUROPEAN UNION

Fertiglobe to supply renewable ammonia

Fertiglobe has been selected to supply renewable ammonia to the European Union (EU) from 2027.

The Abu Dhabi-based company was announced as the winning bidder of a pilot auction by H2Global, an initiative funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK).

Fertiglobe will now commit to supplying renewable ammonia to the EU at a delivered contract price of €1,000/t, starting with a volume of 19,500 t/a in 2027 – subject to supply availability – with volumes potentially scaling up to 397,000 t/a by 2033.

“This award marks a significant milestone for Fertiglobe in advancing sustainable ammonia production and a further critical step towards a final investment decision for Egypt Green Hydrogen, expected in H1 2025. Our selection as the winning bidder in H2Global’s pilot auction underscores our leadership in supplying low-carbon products and our commitment to shaping a more sustainable future, and I appreciate the work of our incredible team to make this award possible. We are leveraging this vital program which makes our investment in sustainable ammonia economically viable, supporting critical decarbonisation technology, while maintaining our disciplined growth strategy,” said Ahmed El-Hoshi, Fertiglobe’s CEO.

The German government has provided funding of €4.43 billion to H2Global to rapidly expand the supply of renewable hydrogen and its low-carbon derivatives such as ammonia.

H2Global’s ‘double-auction’ mechanism for buyers and sellers is designed to bridge the gap between the high prices at which hydrogen is currently being traded on the global market, and the lower economically viable prices at which it can be sold and used at EU regional level. H2Global says the auction demonstrates that renewable ammonia can be imported into the EU at attractive prices, alongside targeted support to the most competitive international projects.

Timo Bollerhey, the CEO of Hintco and co-creator of H2Global said: “This auction result is a strong indication of the

market potential of renewable hydrogen and its derivatives. The energy transition requires value for money, workable solutions – and this first pilot auction has demonstrated that financial and procurement innovations like H2Global’s mechanism not only work but are needed to create thriving markets that motivate and mobilise private finance.”

EGYPT

Stamicarbon to revamp Talkha urea plant

El Delta Company for Fertilizer and Chemical Industries has awarded Stamicarbon a contract to upgrade and expand the Talkha urea plant at El Mansoura, Dakahlia Governorate, Egypt.

A licensing and process design package (PDP) from Stamicarbon will increase the urea plant’s production capacity from 1,725 t/d to 2,250 t/d. The implementation of Stamicarbon’s Ultra Low Energy design will also reduce the plant’s steam consumption by 35% and its cooling water usage by 16%. This proprietary technology delivers energy savings by using high-pressure steam three times instead of twice.

Stamicarbon’s contract with El Delta also includes the licensing and design of a new 2,250 t/d capacity urea granulation unit based on the company’s latest fluid-bed technology.

“We are honoured to be entrusted with this significant project, which further solidifies Stamicarbon’s role as a leader in urea melt and finishing technologies in Egypt,” said Pejman Djavdan, CEO of Stamicarbon. “This expansion will significantly improve El Delta’s production from both a capacity and sustainability perspective.”

The Egyptian government is investing around \$400 million to develop and expand El Delta’s fertilizer plants. In February, thyssenkrupp Uhde’s Egyptian subsidiary signed a contract to revamp the existing ammonia production unit at Talkha.

WORLD

IFA launches fertilizer efficiency project

The International Fertilizer Association (IFA) has launched a project to boost the adoption of enhanced-efficiency fertilizers (EEFs) in partnership with Proba, a decarbonisation start-up company.

Greater use of EEFs will be incentivised by developing new quantification and verification standards – with a particular focus on nitrification and urease inhibitors. These are incorporated in fertilizers to reduce nitrogen losses, including the strong greenhouse gas (GHG) nitrous oxide, by targeting and inhibiting specific biological processes.

The project is designed to share costs and de-risk the adoption of these inhibitors across the fertilizer supply chain by working with the voluntary carbon market (VCM).

Fertilizers are essential for enhancing soil fertility and boosting crop yield, says IFA, and are therefore key to feeding the global population and supporting human health and nutrition. Yet the production and application of nitrogen fertilizers alone, as IFA acknowledges, also contribute about 1.1 billion tonnes of CO₂-equivalent GHG emissions, with approximately 60% of these occurring as agricultural nitrous oxide emissions.

Project lead Achim Dobermann, IFA’s chief scientist, said: “We are excited to begin the first stage of this important project, focused on the downstream supply chain of nitrogen-based fertilizers. We believe that a well-coordinated, science-based, and technology-focused approach led by IFA and its members is more effective and sustainable than a multitude of individual, product-specific protocols.”

IFA hopes that, by concentrating on inhibitors initially, the initiative will develop into a broader sectoral decarbonisation project that captures carbon finance.

Sijbrand Tieleman, Proba’s CEO, said: “There are too many emissions in the agri-food supply chain, with fertilizers contributing around 7% of the total. These emissions are hard to eliminate, but proven technology exists today to reduce them significantly. Inhibitors, for example, can cut GHG emissions by up to 50%, depending on regional, crop, and soil conditions.

“The challenge now is incentivising the supply chain to adopt this technology at scale. By using an insetting approach – where emissions reductions are accounted for within the supply chain itself – and leveraging carbon finance, we can support farmers in this transition. Downstream participants in the value chain, such as food companies, can report reduced Scope 3 emissions and market greener products without fear of greenwashing.”



Farmers embrace innovative products, sustainability and agtech

Globally, farmers are looking to apply new yield-increasing products, sustainable practices and innovative technology to boost profits in the face of wider business and operational pressures.

That’s according to the 2024 *Global Farmers Survey* released by McKinsey & Company on 16th October – an annual survey of agricultural attitudes now in its fifth year.

The latest survey took place between January-March 2024 and questioned around 4,400 farmers across nine countries. Its findings were previewed at IFA’s

Global Markets Conference in London in July (*Fertilizer International* 522, p4).

Farmers continue to cite input prices (48%) as the main risk to future profits, despite a general decrease in the cost of fertilizer and crop protection products over the last year.

Regionally, this year’s survey also revealed that North American and European farmers are expecting an overall 64% and 54% fall in profits, respectively, driven by high input prices, extreme weather and volatile commodity prices. In both regions, less than 15% of farmers expect their profits to instead rise. Farmers in Latin America and India, meanwhile, are much more optimistic,

anticipating higher profits of 65% and 45%, respectively, this year.

Farmers are continuing to invest in sustainable practices, McKinsey reports, albeit for different motives. In India, North America and Latin America, farmers are adopting sustainable practices to increase crop yields, while European farmers are interested in the additional revenue streams these can generate.

The leading sustainable practices are crop rotations (68%), reduced or no tillage (56%), and variable rate spraying or fertilization (40%). Generally, India and Mexico lag behind on adoption, compared with Argentina, Brazil, Europe, and North America.

The adoption of biofertilizers and biostimulants is another sustainability practice on the rise. Some 31% of the farmers are now using these globally – mainly to boost yields and improve soil quality and health.

Many farmers are also integrating new technology into their operations to bolster future profits. Adoption is, however, largely dependent upon farm size – with large farms (more than 2,500 acres)

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USA

Phosphate assets miss Hurricane Milton's might



Hurricane Milton passed well to the south of Nutrien's White Springs production plant in Florida, located around 180 miles north of Tampa. The plant was, however, damaged by Hurricane Helene in September and went offline for repairs.

Mosaic's phosphate production and port infrastructure around Tampa in central Florida has escaped the worst of Hurricane Milton and the accompanying storm surge which struck the state's Gulf coast. Instead, the hurricane made landfall on 10th October at Siesta Key in Sarasota, Florida, as a Category-3 storm.

Milton is the second-most intense Atlantic hurricane ever recorded over the Gulf of Mexico. The storm peaked as a Category-5 hurricane offshore with sustained winds at landfall of 120 mph, according to the US National Hurricane Center.

While it weakened to a Category-1 storm as it crossed Florida, Tampa still received around 18 inches of rainfall from the extreme weather event. Some three million Florida homes and business were also without power in the immediate aftermath.

"Recovery efforts post Hurricanes Milton and Helene have progressed well with all Florida production facilities having returned to normal operations except Riverview which has resumed production and is expected to return to normal rates by the end of the week," Mosaic reported in an operational update on 21st October.

This company update also confirmed that Mosaic's mining sites were starting to resume operations. South Fort Meade was expected to return to normal within days, while Four Corners was expected to revert to normal working toward the end of October.

Milton hit the state just two weeks after Hurricane Helene made landfall near

Perry, Florida, on 26th September. More than 200 people lost their lives, the majority through flooding in North Carolina.

Although Mosaic's 687,000 t/a capacity (P₂O₅) Riverview phosphates plant went offline following Helene, the company's other facilities sustained only limited damage and Tampa port was also able to reopen after a few days, Mosaic confirmed on 30th September.

Mosaic has pledged to provide "an update on production losses [from Helene and Milton] as recovery efforts progress". Hurricane Helene's impact could have lost the company 150,000-200,000 tonnes of total product from its phosphate operations, market contacts suggested to CRU.

The industry was bracing itself for the arrival of Milton in Florida, a state which accounts for around 85% of Mosaic's finished fertilizer production, given that US DAP/MAP supply has been very tight for months.

Nutrien's White Springs production plant, around 180 miles north of Tampa, received some damage from Hurricane Helene and was still out of action, as of 11th October, while Nutrien assessed the damage and required repairs. Milton, in contrast, passed well to the south of White Springs, which has a production capacity of 482,900 t/a (P₂O₅).

Mosaic's Bartow (858,000 t/year P₂O₅) and its New Wales plants (1.3 million t/a P₂O₅), along with Riverview, were originally in the direct path of Milton and therefore vulnerable to damage. As a con-

sequence, Mosaic's share price declined by 7% to \$25.40 over a five day period (3-8 October) preceding the storm.

Some price volatility was also reported. At New Orleans (NOLA), DAP for October traded at \$570/st f.o.b. on 8th October, and then a loaded DAP barge transacted at \$582.50/st on 9th October. A loaded MAP barge changed hands at \$625/st f.o.b. on 7th October, while on 8th October multiple first-half October MAP barges traded at \$630/st f.o.b., with loaded MAP barges offered at \$635-640/st f.o.b. Finally, a loaded DAP barge traded at \$579/st f.o.b. NOLA around midday on 10th October.

Yara continued shipping up to 25,500 tonnes of ammonia from Trinidad to Tampa for Mosaic in the aftermath of Milton, with the vessel Yara Freya due at the west Florida port on or around 14th October. Mosaic has received around 180,000 tonnes of ammonia at Tampa so far this year, including the latest Yara cargo, sourced from a variety of traders and supply partners.

The imported ammonia is consumed at Mosaic's Riverview phosphates production site. Riverview also consumes domestic ammonia barged across the US Gulf from CF's Donaldsonville, Louisiana, production plant and – periodically – from Mosaic's own Faustina ammonia production unit in the state.

News insight courtesy of Fertilizer Week



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45% more likely to adopt agricultural technology (agtech) compared to small farms (less than 100 acres). This is largely because farming at scale is necessary to generate a positive return on investment (ROI) from agtech.

"Farmers are facing a critical moment, with the economy and a range of macro factors putting immense pressure on the industry. From extreme weather events to volatile commodities prices and supply chain disruptions, these challenges are driving up costs. Our survey shows that farmers who want to boost their profits in the coming years need to invest in their operations, whether through sustainable farming methods or adopting agtech to streamline processes and reduce labor-intensive tasks," said Vasanth Ganesan, partner at McKinsey.

In general, farmers are re-evaluating their operations to maximize profitability in response to "a volatile economic landscape, amid extreme weather concerns and high commodity prices", concludes McKinsey. While many are adopting new products and sustainable practices, these must generate a significant ROI to justify farmers overhauling their operations.

UAE

OCI exits Fertigllobe

OCI completed the sale of its entire 50% +1 share stake in Fertigllobe to the Abu Dhabi National Oil Company (ADNOC) in mid-October, the sell off having met all necessary legal and regulatory conditions. ADNOC now owns 86.2% of Fertigllobe, with the remaining 13.8% stake floating on the Abu Dhabi Securities Exchange (ADX).

The completion of this transaction is a major milestone in the expansion of ADNOC's low-carbon fuels business – and its strategy to become a top five global chemicals player.

ADNOC has signalled that it will now transfer its stakes in existing and future low-carbon ammonia projects to Fertigllobe – at cost – when these are at completion. This includes the transfer of two ammonia projects in Abu Dhabi with a combined capacity of around two million t/a. These two additions will more than double Fertigllobe's current merchant ammonia capacity of 1.6 million t/a, as well as increase its combined net sales

capacity for ammonia and urea to 8.6 million t/a. The company is currently the world's largest seaborne nitrogen exporter.

Dr Sultan Ahmed Al Jaber, ADNOC's managing director and CEO, said: "Fertigllobe is a world-class company, and it will be the vehicle through which ADNOC advances its low-carbon ammonia business, supporting our efforts to enable a just, orderly, and equitable global energy transition. We see significant growth opportunities for Fertigllobe and I am confident that under the continued and dedicated leadership of Ahmed El-Hoshy, the company will deliver greater value for its shareholders."

ADNOC highlighted the benefits to Fertigllobe of the acquisition. These included access to its key energy customers globally and ADNOC's extensive experience in carbon capture and sequestration (CCS) for low-carbon ammonia production, as well as its leadership in maritime energy logistics.

Ahmed El-Hoshy will continue in his role as Fertigllobe's CEO, while stepping down from his role as CEO of OCI Global.



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Dr Burkhard Lohr, the chair of the executive board of K+S Aktiengesellschaft, will retire at the end of May next year, after more than 12 years in the role, having decided not to extend his current mandate.

His replacement, Dr Christian H Meyer, the company's current CFO, will take over from Dr Lohr, effective 1st June 2025. The supervisory board of K+S made the decision on 23rd October.

Dr Andreas Kreimeyer, chair of K+S's supervisory board said: "Since 2017, Burkhard Lohr has demonstrated exemplary entrepreneurial foresight and decisiveness in his role as the company's leader. His strategic focus on the core business, the sale of the American salt business, and the reorganization of the company have successfully steered the company through significant challenges over the past few years.

"K+S has once again established a solid financial basis and is now debt-free. Upon assuming his position, he promptly devised a long-term, sustainable solution for the disposal of K+S wastewater and terminated the injection.

"He has consistently emphasized the importance of personal engagement and constructive dialogue with the company's stakeholders. By engaging with political representatives at the federal, state, and site community levels, he has highlighted the systemic importance of the domestic raw materials industry and its role in value creation, particularly in the context of current geopolitical challenges.

"The implementation of Werra 2060 project and the continuous ramp-up of production in Canada have set the course



Dr Christian Meyer will take over as the chair of K+S at the start of June next year.

for the company's sustainable growth in the coming years. The company has been committed to the ambitious course of energy transformation towards greenhouse gas neutrality.

"On behalf of the entire supervisory board, I would like to thank Burkhard Lohr for his outstanding achievements over the past more than 12 years in his role."

Dr Kreimeyer continued: "As CFO, Christian Meyer is highly familiar with K+S. He has known the company many years. In him, we have an excellent manager who, in addition to his extensive experience in the financial sector, also stands for consistent corporate leadership and steering as well as cost discipline. We are firmly convinced that, as chairman of the board of executive directors, he will successfully continue to drive the transformation of the company forward."

Ahmed El-Hoshy is continuing as Fertigllobe's CEO, while stepping down as the CEO of OCI Global. Mr El-Hoshy spent 15 years growing OCI's US and European business in ammonia and methanol, as well as generating shareholder value by executing several recent divestments.

El-Hoshy has been CEO of Fertigllobe since 2021, playing a critical role in preparing the company for its initial public offering (IPO) and helping to consolidate ADNOC's ownership of the company (see page 11). Fertigllobe's wider executive leadership also remains in place, including Haroon Rahmathulla in his position as COO and Andrew Tait as CFO.

Sachin Nijhawan has become the new CEO of thyssenkrupp nucera US, working alongside Juergen Grasinger who has been named COO. In his new role, Mr Nijhawan will seek to advance the company's international growth strategy and expand its global leadership in the manufacturing and supply of hydrogen production technology. He will work out of thyssenkrupp's Houston office and be responsible for US operations and business activities.

Commenting on the appointment, Werner Ponikwa, thyssenkrupp nucera CEO, said: "Sachin brings to our US team the right blend of expertise and commercial relationships to advance our international growth strategy and continue our market leadership in the large and growing hydrogen market."

Mr Grasinger, in an expanded COO role, will meet the needs of thyssenkrupp's blue-chip customers and large-scale clean energy projects by ensuring continuity across all operations. Ponikwa added: "Together, Sachin and Juergen have the full support and resources of thyssenkrupp nucera and its advisory board, and we are excited for the path forward as we jointly collaborate to unlock the huge market potential for driving towards decarbonisation and climate neutrality." ■

PHOTO: K+S

Dry bulk market expected to cool

The dry bulk market is forecast to cool, after a year of high freight rates driven by demand shocks. Should ships return to the Red Sea during 2025, then the market will weaken even more. This development, explains BIMCO shipping analyst Filipe Gouveia, would particularly affect the supramax and handysize vessels typically used in fertilizer shipping.

Loading an Ultramax ship in Vancouver, Canada, with potash destined for Brazil.

Freight rates surged in 2024

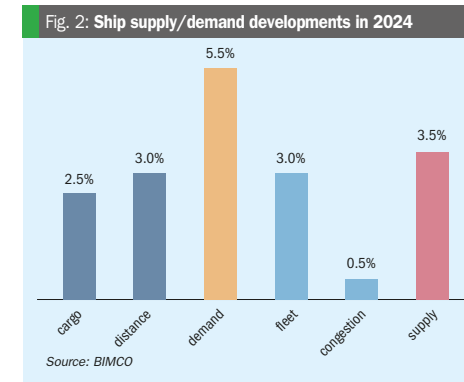
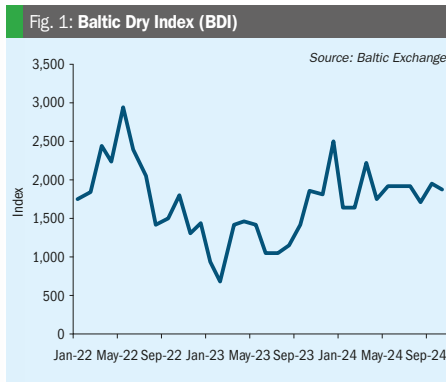
During the first three quarters of 2024, the Baltic Dry Index (BDI) was 58% higher on average than during the same period in 2023 (Figure 1). This freight rate increase was supported by a tighter ship supply/demand balance, particularly in capesize, the fleet segment with the largest vessels. We estimate that overall ship demand will grow by 5-6% in 2024, outpacing supply growth of 2.5-3.5% (Figure 2).

A rise in sailing distances is one factor. These are set to increase by 2.5-3.5% in 2024 (Figure 2), causing a spike in demand because of ships spending longer at sea. Throughout most of 2024, bulk ships were affected by transit limitations in the Panama Canal and higher risks in the Red Sea due to Houthi attacks on ships. The consequent increase in the number of transits around the Cape of Good Hope raised both sailing distances and transit times.

An increase in iron ore, grain and bauxite loadings in the South Atlantic added to longer average sailing distances. Shipments originating from this region – which largely head to Asia – sail for above average distances.

Overall cargo volumes are also expected to grow by 2-3% this year (Figure 2), driven by iron ore and grains.

China has significantly increased its iron ore imports this year, despite a decline in steel production and higher



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10-12
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31 MARCH - 2 APRIL
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iron ore mining domestically. This decline was particularly marked for recycled steel production. Therefore, which does not consume iron ore as a raw material. Nonetheless, with iron ore supply growing faster than demand, a build-up of inventories in China still occurred.

China's domestic steel demand has been under pressure since 2021 due to the crisis in its property sector, a major end market. While exports have provided an additional outlet for Chinese domestic steel this year, export volumes have not been enough to keep production stable.

Global grain shipments, meanwhile, benefited from stronger harvests in exporting countries such as Argentina and the United States. Furthermore, despite lower production in Brazil – the world's largest grain exporter – during 2024, exports from the country were supported by high inventories from the previous year.

On the supply side, the dry bulk fleet is expected to grow by 3% on average in 2024 (Figure 2). January-September ship deliveries were down 5% year-on-year due to a relatively small orderbook. However, high freight rates incentivised the continuing operation of older ships, causing ship recycling to fall to its lowest level since 2008. Easing congestion is also freeing up ship capacity, with this being equivalent to as much as 1% of supply.

Weaker supply/demand balance in 2025

BIMCO is working with two scenarios for its 2025 outlook, a base case and an alternative case, these depending on how long current shipping disruption will last. In our base scenario, ships are assumed to return to Red Sea and Suez Canal routings throughout 2025, whereas in our alternative scenario it is assumed that this will be delayed until 2026.

The ship supply/demand balance is, however, still expected to weaken in both scenarios. A 2-3% increase in supply and a 0.5-1.5% decrease in demand is forecast in our base scenario and a 0.5-1.5% increase in demand in our alternative scenario (Figure 3). Both scenarios could lead to weaker freight rates, particularly in the base scenario.

Sailing distances in our 2025 base case will fall by 1.5-2.5%, while these will remain stable in our alternative scenario (Figure 3). Rerouting away from the Red Sea, due to the longer sailing distances,

has contributed an estimated 2% increase in demand. We therefore expect demand to contract by the same percentage when this no longer applies. The continued return of ships to the Panama Canal will also negatively impact demand next year. However, this will be counterbalanced by an expected increase in sailing distances resulting from stronger South Atlantic cargo.

Cargo volumes are forecast to grow by only 1% in 2025. Import demand for the three largest globally shipped commodities, coal, iron and grains, is expected to moderate. Minor bulk cargoes are, however, expected to grow at a faster rate than this.

Iron ore shipments are expected to only grow by up to 1%, with domestic demand in China remaining muted. The Chinese government has announced stimulus measures to boost economic growth and support the property market, but we do not expect these to boost iron ore shipments significantly above 2023 levels. Iron ore inventories in China remain near to historical highs, while new real estate projects are 54% below the ten-year average. Production of recycled steel may also rebound from current low levels in 2025, especially as new capacity is added during the year.

We estimate a 1-2% decline in coal shipments, a commodity that accounts for 25% of all dry bulk cargo. Import demand for thermal coal is expected to cool as renewable energy capacity continues to grow rapidly in China and in the developed countries. Hydroelectric power could also rebound in India and China – the world's two largest coal importers in 2025 – due

to a recovery in water levels over the summer. Additionally, growing domestic coal mining in both markets will continue to threaten imports.

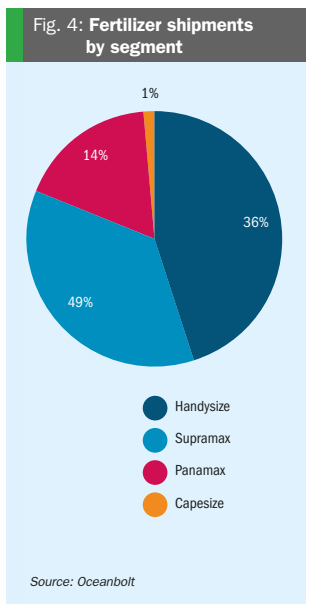
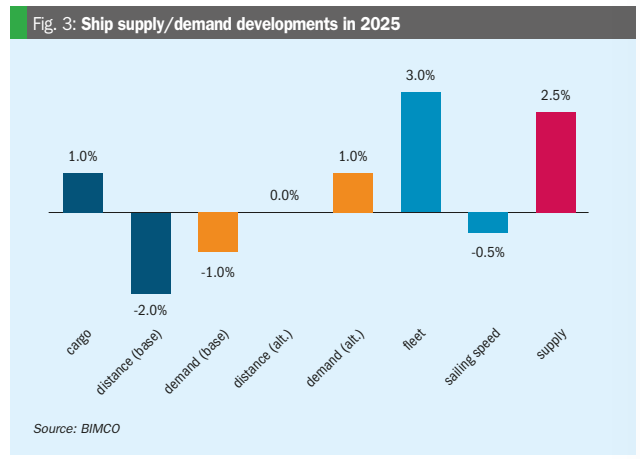
Minor bulk cargoes are forecast to grow 3-4% in 2025. The gradual easing of interest rates in the advanced economies together with the energy transition are expected to support demand. Shipments of bauxite, steel and some ores and metals are expected to strengthen, while shipments of commodities such as wood products are likely to continue to struggle, linked to weak Chinese domestic consumption.

Average monthly growth in the dry bulk fleet is estimated at 3% in 2025, providing a boost to supply, while ship recycling may increase marginally on a cooling market. Sailing speeds, meanwhile, may fall by up to 1% with weaker freight rates encouraging slower sailings to save on bunker costs.

Fertilizer shipping segments are expanding

Over the two years 2024 and 2025, the supramax and handysize fleets are estimated to grow by 8%. That is considerably faster than the 6% growth in the fleet overall. These two segments include the smaller ships in the dry bulk fleet that typically transport fertilizers (Figure 4).

So far in 2024, the Baltic indices for the supramax and handysize segments have risen by 37% and 33%, respectively, signalling higher freight rates year-on-year. Both segments have seen growing cargo



demand with rates significantly benefiting from disruptions in the Red Sea and Panama Canal.

Looking ahead, supramax and handysize freight rates may fall in 2025, even if cargo demand for these segments continues growing. That's because the supply/demand balance is expected to weaken next year, the main factors being high fleet growth and the recovery in transits through the Panama Canal. Freight rates will fall even further if ships return to the Red Sea.

Panamax vessels, a segment with bigger ships, are also used on a smaller number of trade routes. They are more commonly used for shipments from Russia, China, Canada, Jordan and the UAE to India, Brazil, China and Morocco.

In 2023 and 2024, strengthening shipments for coal, which accounts for more than half the cargo carried by these ships, supported panamax freight rates. Conversely, a poorer outlook for coal shipments in 2025, together with a growing fleet, could lead to weaker freight rates in this segment next year.

China's priorities could alter outlook

Several other factors – besides the situation in the Red Sea – could still alter the outlook for 2025. Economic activity and policy making in China, the destination of 39% of bulk shipments, could greatly affect shipping market performance. So far in 2024, the Chinese government has been determined to reach its 5% GDP growth target and improve domestic demand. But bulk imports next year could be lower or higher than forecast, depending on the success of the announced stimulus measures, as well as on how much of this stimulus package is directed at physical infrastructure and real estate.

Government policy priorities could also significantly alter import demand. China plans to increase recycled steel to 15% of total steel production by the end of 2025, for example. While recycled steel production weakened in 2024, due to declining profitability, iron ore imports could fall if the recycled steel target was prioritised by China's government next year.

Coal shipments could also be greatly affected by changes to Chinese government policy. A focus on mine safety caused China's coal production volumes to drop in 2024, for example, after several years of policy promoting domestic coal mining. Chinese coal imports could therefore either increase or weaken in 2025 – depending on whether mining safety or a mining ramp-up is prioritised. Additionally, the increase in renewable energy capacity in China has negatively affected coal shipments. But such capacity additions could be set to slow, if the government does not respond quickly enough to emerging bottlenecks in the electricity grid.

Lastly, an increase in attacks on ships in the Black Sea, as seen in October 2024, could disrupt global grain supply. While the world is less dependent on Ukrainian grain now, a new blockade on the country could still lead to a drop in global shipments.

Summing up

In conclusion, the dry bulk market shipping rates, after a strong 2024, will likely weaken in 2025. The smaller supramax and handysize segments which typically transport fertilizers could be particularly affected, especially if ships are able to return to the Red Sea. Several other factors could still reshape market conditions, however, with Chinese government policy being particularly influential.

Author's note

Bulk market outlook as of end-October 2024.

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Ammonium sulphate – a low-carbon sustainable pathfinder?

Emerging evidence suggests that by-products used as fertilizers, particularly ammonium sulphate, may emerge as winners from the EU's implementation of the carbon border adjustment mechanism (CBAM). In this article, **Franck Boher** of Upgraid investigates whether by-products can help reshape sustainable fertilizer production in Europe.

Nylon thread factory. This ubiquitous textile and polymer is produced across the globe from the precursor caprolactam, generating large volumes of ammonium sulphate as a by-product.

False choices

Recent events suggest that many fertilizer producers in Europe are struggling to maintain a delicate balancing act between EU sustainability requirements and the imperatives of worldwide competitiveness. Over the last 12 months alone, Yara's Montoire and Timac Agro's Tonnay NPK plants have closed in France, for example.

But does more sustainable always equate to more expensive and less viable. Instead, what if this is a false dichotomy and there are actually strong synergies between sustainability and competitiveness – with the two even going hand-in-hand?

EU regulations offer some hope

EU authorities have a two-pronged agenda. On the one hand, they are seeking to protect and grow industrial investment and employment in Europe, while simultaneously encouraging industrial players to adopt more sustainable and circular business models.

Across Europe, to meet these policy objectives, industrial projects designed to boost both sustainability and competitiveness have received substantial financial stimuli and subsidies over the last 10 years. Astute companies and individuals, who know how to navigate and take advantages of incentive programmes, can drastically reduce their business investment costs and speed up their returns on investment. To fully benefit from these potentially lucrative policy incentives, the skill is matching the right technology with the right funding source and the right project partners.

Even more significantly, EU regulators are gradually shifting policies to new goals such as:

- The protection of end consumers, e.g. chemicals regulation (REACH) and the fertilising products regulation (EU 2019/1009)
- Creating a level playing field between countries inside and outside the EU via the carbon border adjustment mechanism (CBAM).

Other EU policy measures are attempting to gain competitive advantages for the region's industrial players. The way in which life cycle assessment (LCA) and analysis of business circularity, for example, are becoming key requirements for financial incentives at member state level provides some evidence of this.

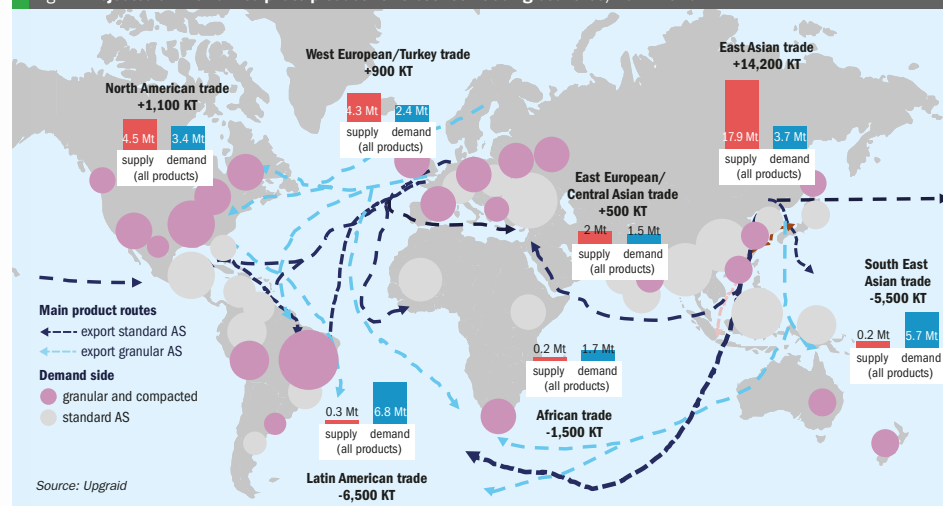
In this article, we highlight how the ammonium sulphate market provides an excellent case study on how by-products used as fertilizers could emerge as winners from the implementation of these new EU regulations.

Ammonium sulphate – not a primary product

There is a sizeable and growing fertilizer market for ammonium sulphate internationally. Around 32 million tonnes are produced worldwide each year, according to International Fertilizer Association (IFA) statistics, with supply growing at 3-4 percent per annum. While this volume is far exceeded

PHOTO: SHUTTERSTOCK/INDUPHOTOS

Fig. 1: Projected ammonium sulphate product flows between trading countries, 2022-2025



by annual urea production globally (190 million tonnes) it is broadly comparable to the market size of other nitrogen fertilizers such as ammonium nitrate (AN, 48 million tonnes) and calcium ammonium nitrate (CAN, 15 million tonnes).

The main supply and demand centres and trade flows for granular, compacted and standard ammonium sulphate are shown in Figure 1. This illustrates how integral AS supply chains are to the global fertilizer market.

Ammonium sulphate is also in a unique position as, unlike other fertilizer commodities, it is typically not a primary product. Instead, more than 90 percent of the market is generated outside of the fertilizer sector as an industrial by-product. Consequently, AS is subject to very different market dynamics and price setting mechanisms in comparison to other fertilizers.

The boost to ammonium sulphate from CBAM?

Ammonium sulphate falls into the reporting scope of CBAM due to the carbon footprint of the ammonia (direct carbon value) and electricity (indirect carbon value) used in its production. Similar to other nitrogen fertilizers, the EU has published default values for ammonium sulphate for use in CBAM reporting. These defaults apply

in cases where international suppliers are not able to directly verify the carbon footprint of the imported ammonium sulphate source. Values vary substantially from one nitrogen fertilizer to another, when calculated on a per unit of nitrogen basis (Table 1).

Current default values suggest that ammonium sulphate is subject to around 50 percent less carbon tax (per unit of nitrogen) than nitrates, with the caveat that this applies to the CBAM's transition phase ending in 2026. Nonetheless, this already provides a sizeable competitive edge over certain nitrogen fertilizers – and is not the only competitive advantage offered by ammonium sulphate either.

Building a competitive edge

Primary (i.e. on-purpose) ammonium sulphate production is marginal, supplying less than 10 percent of global output while, conversely, 90 percent of world output originates as a by-product sourced from a range of different industrial processes.

In fact, ammonium sulphate is generated as a by-product by more than eight diverse chemical industry value chains – these ranging from polymer manufacture to electricity production, and from the production of amino acids to the making of electric vehicle (EV) batteries. These very different industries all have one thing in common though: they all

Table 1: CBAM default values for ammonium sulphate (Amsul 21N) versus other nitrogen fertilizers

| CN code | Product | Direct default value (kg CO ₂ per kg of fertilizer) | Indirect default value | Carbon tax coefficient per unit of nitrogen |
|-----------------|---------------------|--|------------------------|---|
| 28142000 | Ammonia | 2.68 | - | - |
| 31021010 | Urea - 46N | 1.78 | 0.12 | 0.041 |
| 31022100 | Amsul* - 21N | 0.86 | 0.09 | 0.045 |
| 31023010 | Ammonitrate 33.5N | 2.32 | 0.07 | 0.071 |
| 31024010 | CAN - 27N | 1.77 | 0.06 | 0.068 |

Source: European Commission, DG TAXUD

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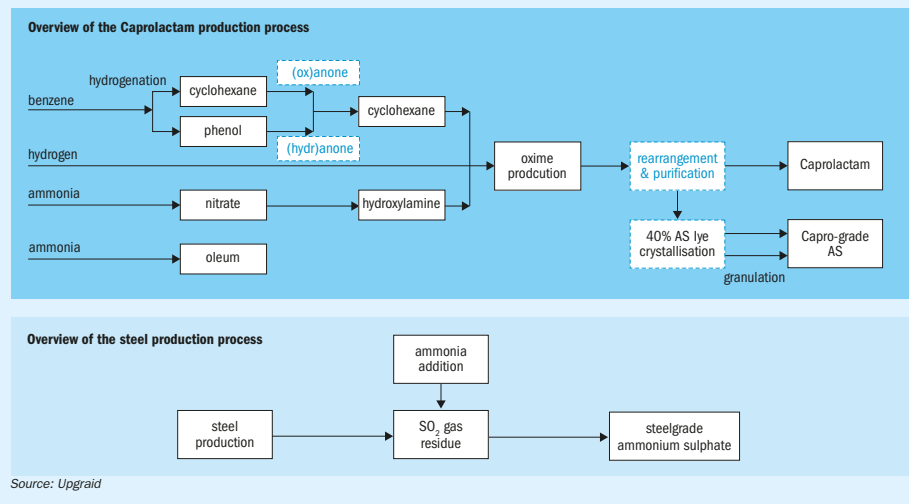
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Fig. 2: Overview of caprolactam (top) and steel production (bottom). Both processes generate ammonium sulphate (AS) as a by-product. But the late addition of ammonia in the steel process, purely for the purpose of making ammonium sulphate, suggests that steel-grade AS may pay twice as much carbon tax as the equivalent caprolactam-grade under the EU carbon border adjustment mechanism (CBAM).



split their carbon footprint between the primary core product and the by-product (ammonium sulphate).

Currently, until the end of the CBAM transition phase in 2026, upstream industries actually have a degree of flexibility in how they allocate the portions of their ammonia carbon footprint between their core product and by-product, provided they document the chosen option. Unsurprisingly, the wide range of chemical industry value chains that generate by-product ammonium sulphate have made different choices which, in the end, will result in different amounts of carbon tax paid per tonne of AS produced.

This is a fact that fertilizer buyers, such as distributors and agricultural cooperatives, should be aware of when weighing up their sourcing options for ammonium sulphate in future. Answers on the carbon tax question are generally provided by pinpointing two things: firstly, the point of entry for ammonia into the process; and, secondly, whether the purpose of adding ammonia is for manufacturing the primary product or the by-product.

In general, the earlier ammonia is incorporated into the process for manufacturing the main product, the more

likely it is that the already low carbon tax of ammonium sulphate can be reduced further (see Figure 2), as long as the industrial producer is properly documenting this.

In caprolactam manufacture (Figure 2, top), ammonia is a starting material added upstream as part of the main synthesis process. Consequently, the generation of caprolactam-grade ammonium sulphate, as a by-product, is more carbon-neutral because the carbon footprint of ammonia is already accounted for in the core product.

For steel-grade ammonium sulphate, in contrast, ammonia is incorporated downstream for the sole purpose of producing ammonium sulphate (Figure 2, bottom). This gas scrubbing process – and other AS production processes that treat sulphate residues with ammonia – is responsible for the entire carbon footprint of ammonia and, as a result, will pay higher carbon tax under CBAM, unless a switch is made to using blue or green ammonia instead.

Table 2: Four fertilizer finishing technologies: comparison of production and investment costs and the market premiums of the finished products obtained.

| | granulation | dry compaction | Wet compaction (Agriloop) | bulk-blending |
|---------------------------------------|-------------|----------------|---------------------------|---------------|
| Cost per tonne produced (€/t) | 35-50 | 22-30 | 18-22 | 16-20 |
| Initial investment (base index: 100)* | 100 | 70 | 25 | 20 |
| marketing and quality premium (€/t)** | +60 | +20 | +40 | 0 |

* Relative cost of installing one tonne of production capacity. Granulation = 100

** Market price of the finished fertilizers produced

Source: European Commission, DG TAXUD

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GREEN POLYMERS ARRIVE – BUT AT A PREMIUM

In the polymer industry, major European players like BASF, Lanxess, Fibrant, Domo Chemicals and Ube are developing low-carbon nylon and its precursor low-carbon caprolactam as part of their innovation pipelines.

The introduction of EcoLactam® – an ultra-low footprint nylon – by Fibrant, the world's largest caprolactam and ammonium sulphate producer with production plants in The Netherlands (Geleen) and China (Fuzhou and Nanjing), is one example. The carbon footprint of EcoLactam® is up to 70 percent lower than standard nylon, according to Fibrant.

The demand for low-carbon nylon is being set by the clothing industry. High profile companies in the sports and outdoor apparel/footwear sector, in particular, have generally been first movers on sustainability and made very public pledges on carbon reduction. In any case, the carbon footprint of European caprolactam and nylon is already

on a downwards trajectory having fallen by at least 20 percent over the last five years or so.

For many shoe and clothing makers, sustainability is an important part of their appeal to environmentally-aware consumers. In this context, a switch-over to 'green' nylon provides these companies with a marketing edge – and therefore a potential competitive advantage that can justify its price premium. Despite this, a carbon tax is still seen as a necessary pre-condition for scaling up European production of low-carbon nylon.

While large-scale production will take time, a clear dividend for the fertilizer industry and its sustainability agenda is that low-carbon nylon manufacturing for the apparel sector could provide a growing source of low-carbon ammonium sulphate fertilizer as by-product – with clothing shoppers not farmers having to pay the premium for this. ■

In the scenario shown in Figure 2, steel-grade AS may end up paying pay twice as much carbon tax (€30-40/t) as caprolactam-grade AS.

To sum up, one fact is certain: splitting the carbon tax between a core product and a by-product should make ammonium sulphate even more attractive versus other nitrogen fertilizer options.

By-products – lowering production costs?

Fertilizer production in Europe has an industrial footprint that dates back more than a 100 years – starting with the founding of BASF, DSM, ICI, Rhône-Poulenc and other national industry champions. Unfortunately, this long and proud chemical industry heritage also has its disadvantages. Fertilizer production assets – which once symbolised Europe's chemical engineering innovation and excellence – are now ageing and will require major investment if they are to adapt to the requirements of EU climate and energy policies. This includes the 'greening' of manufacturing processes and product portfolios by

switching to low-carbon (green and blue) ammonia (see box). In the meantime, newer plants are springing up outside of the EU which are designed from the ground-up with sustainability and energy efficiency in mind.

Increasingly, for the European fertilizer industry, ticking both boxes for sustainability and competitiveness has become a prerequisite for survival. How then to achieve this?

When it comes to the granulation of compound fertilizers, for example, the question boils down to a simple cost equation: is Europe able to produce sustainably at €25 per tonne what it currently produces at €50/t or higher when gas costs surge?

Energy costs can vary from 25 percent to more than 60 percent of total fertilizer production costs, depending on the process used. Fertilizer finishing technologies, for example, generally rely on energy-intensive equipment and/or drying processes (Table 2). The evaporation and removal of water, in particular, consumes a high amount of electricity or steam.

Upgrad believes that shifting the European fertilizer production model away from energy-intensive granulation and compaction plants to energy-efficient processes that evaporate less water and are more scalable would certainly help make the industry more competitive again. By-product fertilizers such as ammonium sulphate could again be part of the solution here.

Ammonium sulphate has a crystalline structure that requires only minimal water evaporation to produce granules. Indeed, the compaction of ammonium sulphate stands out as a scalable and cost-competitive industrial model capable of producing granulated fertilizers with a minimal carbon footprint, as shown by the Agriloop wet compaction process in Table 2. The advantages include:

- A 40 percent reduction in energy consumption per tonne of product produced
- Achieves 65 percent primary throughput versus around 40 percent for drum granulation and dry compaction
- A 60 percent cut in CO₂ emissions per tonne of product produced
- Cuts water consumption per tonne of product produced by a factor of four
- Valorising chemical and agro-industry by-products and transforming these into high quality granulated fertilizers
- Is scalable from 6-96 tonnes per hour
- Can granulate NPK, NKS and NPS fertilizers.

Summing up

In a nutshell, the European fertilizer industry – and, more broadly, the other value chains in the region's ageing and commoditised chemical sector – are now at a crossroads where they will need to derive maximum value from their product portfolios if they are to survive. Now, more than ever, the use of by-products as fertilizers should be a particular focus.

Ammonium sulphate, for example, combines regulatory advantages, exemplifies the circular economy and offers a cost-optimised production model. This by-product stands out as a viable way of reconciling competitiveness and sustainability. It also has great potential as a stepping stone and transition product until green ammonia becomes affordable and widely adopted along the value chains of the chemical and fertilizer industries. ■

Sulphur – inventory, availability and pricing

Significant changes to the level and location of sulphur inventory over the last two years have caused swings in short-term supply availability. Inventory plays a necessary role in balancing the sulphur market but exactly when, where, how, and why inventory enters the market can trigger a diverse range of price responses. In this insight article, CRU's **Peter Harrison** looks at how inventory change influences sulphur availability and pricing.

The sulphur market is in a constant state of structural imbalance as supply and demand movements are driven by different economic drivers. This creates a frequent flip-flop between surplus and deficit, with inventory being necessary to manage this volatility in availability.

How does the sulphur market balance?

Most sulphur supply originates as a by-product of oil and gas production with the volume of sulphur produced being independent of the demand for the product. Sulphur demand is driven by a diverse range of industries with the dominant sectors focused on fertilizer, metals and industrial markets. There is an underlying link between sulphur supply/demand and overall economic activity, but the exact influence of this on each sector is not identical.

Given the inherent disconnect between supply and demand, the sulphur market is in a constant state of flux between surplus and deficit (see Fig. 1). According to CRU data (see Fig. 2), since 1990, the sulphur market has been in a deficit for 15 years and in surplus for 20 years, with an average balance of 0.37 Mt. The range of supply imbalance has been between a peak surplus of 4 Mt and a deficit of 2 Mt with the annual market balance, as share of market size, averaging 1%. The state of physical surplus and deficit necessitates that inventory be built and drawn down to allow supply to meet demand.

Where and why is inventory built?

Historically, sulphur inventory has been built at production sites with remote geographical locations and insufficient access to logistics. The largest accumulation of sulphur in long-term storage is in Alberta, Canada, at oil sands operations. There has also been stock accumulated in Kazakhstan, at the Kashagan operation, and in Saudi Arabia at the Berri gas plant. Canada's stocks have been built over many years but the accumulation of volumes at Kashagan and Berri has been a more recent trend. There are also other locations with inventory throughout the Middle East and Central Asia.

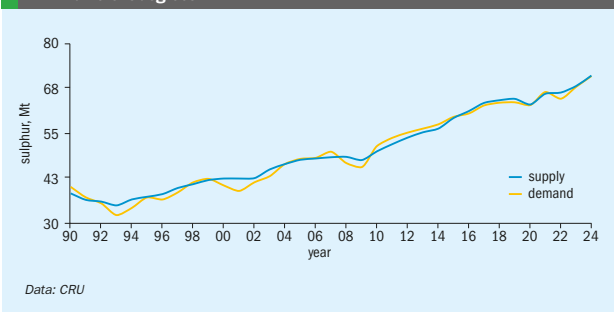
Prior to 2020, most of the inventory management happened at production sites with increased sales in times of deficit and increased stock build in times of surplus. However, China has begun to

play a more active role in inventory management. China has operated a system of port inventory for many years, but this stock would typically not exceed 1.5 Mt, equivalent to 10-15 % of annual imports. However, since 2020 China has twice accumulated over 3.0 Mt of inventory, equivalent to 30-35% of annual imports (see Fig. 3).

How has the behaviour of stockholders changed?

The upswing in the level of inventory held in China is partly the cause and partly a symptom of a wider shift in stockholder activity. Throughout 2020, stocks steeply increased in response to falling prices, concerns over logistics and speculative buyer behaviour. The fall and subsequent rebound in stock levels followed the upswing and retreat

Fig. 1: Global sulphur supply/demand is guided by economic activity but to different degrees



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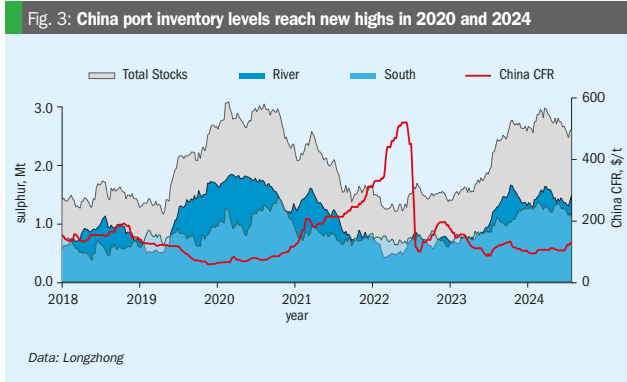
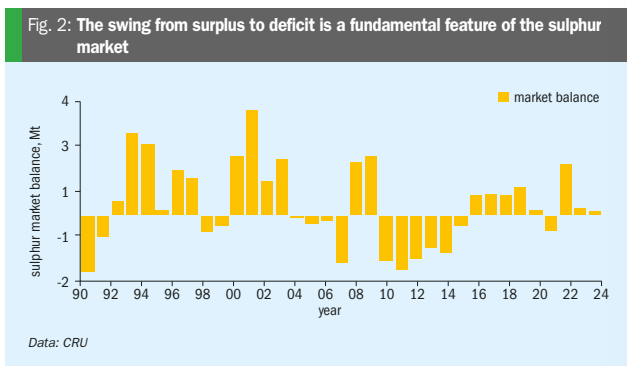
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in sulphur pricing, but also continued to incorporate an element of speculative purchasing behaviour.

Since April 2024, stocks have fallen with inventory currently assessed at 2.68 Mt, the same level as the beginning of the year. The decline has been mainly driven by drawdown at river ports, typically belonging to traders, whose inventory has fallen by 0.2 Mt, and the southern stocks (phosphate producers' stock) have dropped by 0.1 Mt.

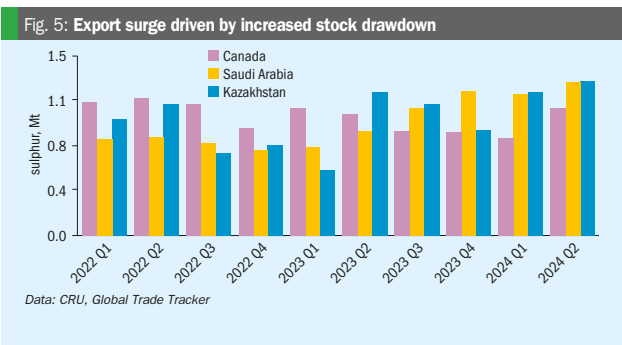
The increase or decrease in stocks has responded inversely to the trajectory of sulphur prices. The last time a programme of consistent stock drawdown occurred was from 2020 to 2022 when stocks declined from a high of 3.0 Mt to 1.3 Mt (see Fig. 4). In total, port inventory dropped by 1.7 Mt in around two years. This time frame coincided with a significant jump in China CFR prices from an average of \$76/ t in 2020 Q3 to \$492/ t in 2022 Q2. After the stock peak, prices reversed their upward trajectory and were depressed throughout 2023, which triggered stock build-up up to April 2024. Strong demand from China has pushed sulphur prices up since July, and port inventory levels have started to fall again.

Since late 2022, there has been a shift in the overall market dynamic as the market has entered a period of global surplus and lower prices. However, this period has also coincided with an increase in voluntary stock drawdown in Kazakhstan and Saudi Arabia (see Fig. 5). It is typical for a global net-surplus to be composed of both supply locations which are building inventory and others in the process of drawing down stocks. However, this is typically still price driven. Canada's stock drawdown behaviour has followed the price trend, with periods of high prices driving increased drawdown and low prices slowing additional sales. By contrast, higher Kazakhstan and Saudi Arabia exports since 2023 Q2 have coincided with a period of lower pricing. The objective in both locations has been to decrease the volume of supply held in inventory. In Saudi Arabia, this has been due to the current stock location nearing capacity and therefore the strategic benefit of managing logistics outages has diminished. Saudi Arabia has added around 0.15 Mt /quarter to its export programme from stock drawdown. In Kazakhstan, meanwhile, the trigger of stock decline has been regulatory risk. Stock at Kashagan was



accumulated in the early years of operation, when export logistics were yet to be completed. Kazakhstan has a long-held aversion to the long-term storage of sul-

phur with regulatory pressure triggering the sale of 9.5 Mt of sulphur inventory from 2005-2015. The most recent pressure on Kashagan's sulphur inventory came in the



form of the announcement of a significant fine from the Kazakh government due to the accumulation of 1.7 Mt of stock at the site.

This has triggered a concerted effort from the operators of Kashagan to start a programme to remove the accumulated inventory. The programme of stock removal has increased exports from Kazakhstan by around 0.25 Mt /quarter with the total inventory expected to be depleted by mid-2025.

How will stock change influence the market in 2025?

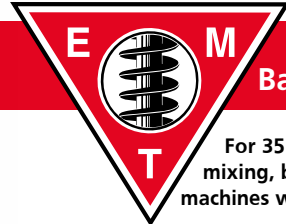
The presence of high inventory in China and the programme of proactive stock drawdown in Saudi Arabia and Kazakhstan will continue to place a negative pressure on prices. However, the current rally in sulphur prices, driven by resurgent demand, illustrates the difference between short-term sentiment and overall trend. The other point

shown by the recent price increases is that proactive stock drawdown and price surges can coincide with each other. The determinant of this relationship is the overall market balance trend. The global sulphur market has entered a period of resurgent demand growth and slowing supply increases, with the global balance expected to move into deficit in 2025. The result is that proactive stock drawdown will be a necessary feature of the market and will not put downwards pressure on prices, as was the case in 2024 H1. The status of China's inventory will continue to hang over the market as the current 2.6 Mt level is equivalent to 2-4 months of imports. Especially as these volumes give Chinese consumers and traders more choice over if, when and how much they enter the international traded market.

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Yara's Golden Batch tool – digitally optimising NPK production

The 'golden batch' refers to stable periods at production plants that consistently generate high quality NPK products at high output. Yara's Golden Batch digital tool digitises and stores past data from optimal production runs, making these easy to retrieve and implement again in future. Yara's **Marianne Ytterbø** provides an overview of this novel digital tool, explains how it was developed, and highlights key benefits.

Introduction and overview

The Golden Batch is a digital tool built and developed by Yara for NPK fertiliser plants. The basic idea of the tool is to digitise historical records of 'good production' held by operators in binders and notebooks. The tool provides access to data on previous successful production runs in a user-friendly way and, by making these searchable, allows operators to follow up on this knowledge during current production. It also continuously monitors the plant, ensuring the best production periods are always captured and stored for the future.

Central to the tool's development has been an objective definition of 'good production'. Having a clear definition plays a dual purpose as it allows:

- Firstly, the identification of golden batches in historical datasets, and
- Secondly, the identification of superior production periods during current plant operations – providing scope for further 'real time' production optimisation.

This approach, by avoiding subjective assessments of NPK production runs, helps improve production standardisation, troubleshooting capabilities and the training of new personnel.



An operator at Yara's Uusikaupunki NPK plant, Finland, monitors production and consults the Golden Batch tool (screen top left) before making adjustments to improve the production process.

Unsurprisingly, adopting such a novel and transformative tool has not been without its challenges. In particular, operator training and implementation at NPK production plants has demanded substantial time and effort – but, nevertheless, these actions have been imperative for unlocking the full potential of the tool.

Presently, the Golden Batch tool has been successfully implemented at eight Yara NPK plants. Overall, this has resulted in high user adoption, as a

clearly observable trend, albeit with challenges at some plants. Also, at the initial plant where the tool was deployed, a post-project review revealed a significant increase in the production rate after implementation.

Importantly, the Golden Batch is not a static solution. Instead, it is a dynamic tool designed for continuous improvement. The app will continue to evolve in future – in response to user needs, innovative ideas, and constructive feedback.

PHOTO: YARA

Yara's Digital Production department

Yara identified the potential for generating significant value from digital transformation at its production plants in 2018, and established a department called Digital Production to unlock this potential. This new department built up the company's in-house digital competencies by recruiting developers and data scientists.

The core principle of the department is 'value first'. In practice, this means adopting a methodology where problems, and the potential value to Yara of overcoming these, are comprehensively understood before work starts on developing solutions. To put it simply, the department focuses on the 'why' before delving into the 'how' – always gaining a thorough understanding of why a particular issue merits resolution before considering how to rectify it.

Identifying priority production issues at Yara plants requires an analysis of the potential value of the proposed solution coupled with an estimate of the amount of effort required to unlock this value. Consideration is also given to whether proposed solutions can be effectively scaled and replicated across multiple plants.

To analyse and answer these questions, personnel at the Digital Production department work alongside plant experts as part of cross-functional and multidisciplinary teams.

Description and origins of the tool

The core functions of the Golden Batch tool are to:

- Continuously monitor the production process
- Identify and preserve exemplary production runs – known as 'golden batches' in a comprehensive database.

These golden batches serve as reference points, providing operators with access to the best production settings at their fingertips.

The Golden Batch tool is based on an idea that originated at Yara's NPK fertiliser plant in Uusikaupunki, Finland, and was subsequently developed in a collaboration between the plant's staff and Yara's Digital Production team. The aim was to provide NPK plant operators with easier access to the best production settings.

The Golden Batch tool – by offering intensive, focused, and regular access to

information on the best reference batches – has enabled operators to achieve higher production rates during NPK production runs. Furthermore, the tool allows operators to achieve stable production more quickly – after start up or NPK grade changes – by providing a clear visual overview of production target values.

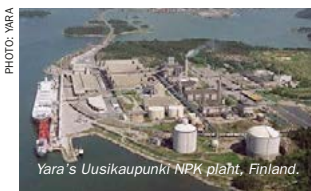


PHOTO: YARA

Tool development at Uusikaupunki

A promising production solution identified early on by the Digital Department was (as already mentioned) based on an idea from the NPK production team at Uusikaupunki.

When production was running well, plant operators at Uusikaupunki captured control system screenshots and subsequently maintained these in binders for future reference (see photo). Their motivation was to preserve these successful plant settings and use this information for fine-tuning future production runs.

The Uusikaupunki plant produces many NPK product grades, with each individual grade requiring a different way of optimising the process to ensure good production runs. In addition, the plant's running behaviour will also be influenced by day-to-day variations in operating conditions. These can include differences in the types of raw materials being consumed, fluctuations in ambient temperature, and the level of clogging in production equipment.

All these variables can make it difficult for the operators to keep track of and properly adjust the production process and optimise this for each combination



Operator at Uusikaupunki checking a reference binder. This holds paper records for 'golden batch' production runs achieved in the past.

PHOTO: YARA

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of NPK grade and plant operating conditions. However, using the reference binders, operators at Uusikaupunki could now browse back and find a suitable screenshot as a starting point for adjusting the current process.

The original concept for the Golden Batch tool had two aspects: firstly, to digitise these reference binders and, secondly, ensure that exemplary reference batches – new golden batches – were automatically detected in future so they could be preserved for subsequent use.

Golden batch definition

The starting point for collaboration with the Uusikaupunki plant was formulating a definition of 'good production' by analysing historical process data. The initial focus was on identifying periods characterised by a high production rate. However, data analysis revealed that high production rate alone was an insufficient as a criterion, because 'good production' also required operational stability, this being characterised by low process variance over an extended duration. Taking stability into account was necessary to ensure that any reference batches saved for future use could be sustained over a lengthy time period.

For example, while it is possible to ramp up NPK production to an extremely high rate, this is not necessarily stable as it can potentially lead to undesirable outcomes subsequently, such as the clogging of crucial production equipment. The incorporation of long-term consequences as part of the definition was therefore crucial, because solely maximising production rates – without due regard for future consequences at the plant – could result in adverse effects and operational difficulties.

Various stability criteria were evaluated before coming up with a suitable and comprehensive definition of stable production. The purpose of this exercise was to identify a set of criteria that, from the historical dataset, could:

- Identify stable production periods for the majority of NPK product grades
- While simultaneously excluding periods marked by instability.

The criteria examined included variance of the production rate itself, along with other pertinent 'tags' such as the electric currents of important motors

and recycle rates. (Note: a tag is a control system object that contains a variable, time stamp and data quality information.)

During the examination of historical data plots, a decision was made to accommodate brief periods of instability – as shown by short, intermittent spikes in the data – where these were within a much longer stable period.

The eventual outcome was a robust methodology and definition for detecting periods of high and stable production. But this was not all. NPK plant operators are also required to monitor and control other important production parameters. In particular:

- The plant needs to generate high quality NPK end products that meet quality standards and avoids excessive amounts 'off-spec' material
- Emissions from the production process need be kept low to meet environmental regulations.

At Uusikaupunki, product that does not meet the Yara quality standard is stored in separate silos and recycled back into the process as raw material. Operators need to prevent these silos from overflowing.

Therefore, due to their importance, both emissions and product quality were incorporated into the definition of good production by introducing a concept known as 'comparable production rate'. This penalises emissions and the production of undersize products while rewarding the consumption of off-spec products in the production process.

From this, the following finalised definition of a golden batch was agreed. This combines the definition of high and stable production with the concept of comparable production rate:

"A golden batch is identified as a six-hour period characterised by stable production and exceeding 80 percent of the highest production rate achieved for that product grade in the past. In instances where multiple stable periods occur during a production campaign, the golden batch is determined based on the period with the highest comparable production rate."

This systematic approach provided a reliable means of identifying and preserving periods of good production from the past as reference points for future operations.

Operating conditions and product quality

As mentioned previously, optimal plant settings depend on both the product grade and on the operating conditions.

Operating an NPK plant is something of an art, requiring knowledge of how to adjust the plant in response to numerous conditions affecting the production process. To reduce complexity, it was agreed with plant experts that the Golden Batch tool should include selected operating conditions if these:

- Affect how the plant runs
- And/or affect the production rate that can be obtained
- But are outside the operator's control.

For example, an increase in the outside temperature may require a reduction in production rate at the plant because of limited cooling capacity. Outside temperature, therefore, while affecting plant capacity and production output, is an operating condition outside of the control of operators who have no influence on the weather.

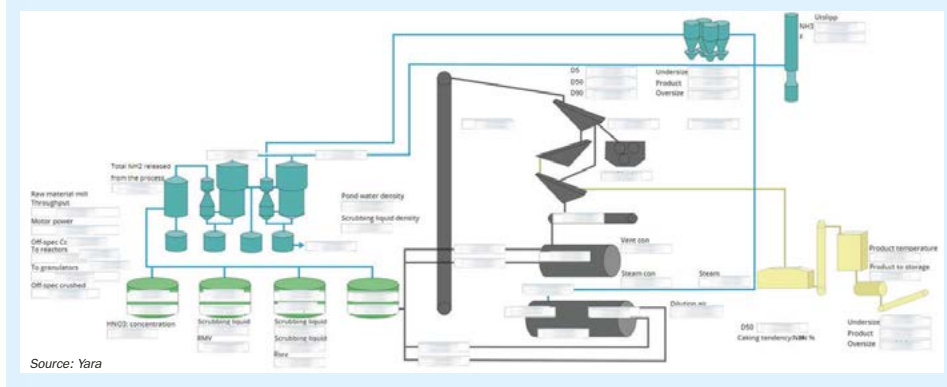
Allowing for operating conditions is important as, in the past, production references were solely based on the maximum rate achieved previously for each NPK grade. This was unrealistic and could be demoralising for operators when such rates were clearly unachievable under current operating conditions. Golden batch references, in contrast, avoid this issue by ensuring the saved database includes NPK references for all combinations of the selected operating conditions.

Production quality is also a high priority for Yara. Consequently, all NPK products are analysed and checked against quality specifications. This includes measurements of chemical content and physical properties, such as granule shape, dusting tendency, and compressibility. Most quality measurements are carried out at least once every 8 hours or determined using online instruments.

As discussed above, one variable, the quantity of undersize granules, is used in the calculation of the comparable production rate. This ensures that quality considerations are incorporated into the identification of golden batches.

As well as this, additional quality criteria are taken into account using 'quality stars'. For each golden batch, quality star ratings are awarded based on performance of the product batch against a range of variables.

Fig. 1: The Golden Batch tool user interface. Process variables are shown in the form of flow sheet designed to represent the plant and based on the control system screens.



Golden Batch tool user interface

As already explained, Yara was able to establish and categorise golden batches as production references, according to operating conditions and their assigned quality star ratings. Once this was done, a user-friendly interface was developed to allow operators to access this information. Four key operator steps and tool functions were identified:

1. **Search for golden batches matching their current operating conditions.** A simple search page was constructed, enabling operators to input details on the product they intend to produce and the current plant conditions. Certain conditions, determined by tag values, are also detected automatically, such as outside air temperature.
2. **Evaluate the golden batches available.** The tool then displays the relevant golden batches to the operator so that they can evaluate them and select the best reference to use for the upcoming production run. For each golden batch, a match percentage is calculated, indicating how well its operating conditions reflect current plant operating conditions. This allows operators to easily evaluate each of the golden batches – based on the percentage score for operating conditions, the production rate achieved and the product quality registered.
3. **Select the golden batch to use as a reference for the current production.** Operators can then select the best reference based on their experience and their evaluation of current plant conditions.

4. **Follow up using the golden batch reference.** Process variables are shown by the interface in the form of flow sheet (Figure 1) designed to represent the plant and based on the control system screens (see main photos). This allows operators to easily recognise the production process and quickly see the values of the relevant tags. Having selected the best golden batch reference, operators are directed to the flow sheet where the golden batch values for selected plant tags are displayed. These represent the average values of these tags during the period when the golden batch was produced. Operators can utilise these as benchmarks for the ongoing production, the aim being to align the current plant values with the golden batch values for the relevant tags.

New golden batches

The tool continuously monitors the production process and looks for new golden batches. The discovery of a new golden batch requires all necessary criteria to have been exceeded. The comparable production rate for the period also needs to be higher than it has been in the past for the same operating conditions. Checking for this happens in two steps:

1. **Suitability as a candidate:** does this production period meet all golden batch criteria?
2. **Comparing the candidate batch with historical data:** is it better than a golden batch already saved in the database?

Golden batch candidates are called 'golden windows'. The tool automatically checks for these by periodically monitoring production and assessing whether this has been 'golden' in recent hours (i.e., it meets all golden batch criteria), as illustrated in Figure 2.

Potentially, all golden windows could be golden batches. However, only the best golden window from each campaign can be a golden batch. Furthermore, only the top three golden windows end up being designated golden batches and made available to users for future reference. In this context, a group is a specific combination of operating conditions – such as high ambient temperature and low clogging, for example.

Evaluation and results

To assess performance, data analysis was carried out after the Golden Batch tool had been live and operational for one year. This assessed plant performance improvements, the uptake and usage of the tool by operators, and operator feedback.

The tracking carried out at Uusikaupunki indicated notably high levels of tool usage. Qualitative feedback on the tool from the plant's operators was, in general, highly positive. Operator comments included:

- "Easy to find the best batch and information without having to dig in production logbooks. It only takes a little time to get used to it."

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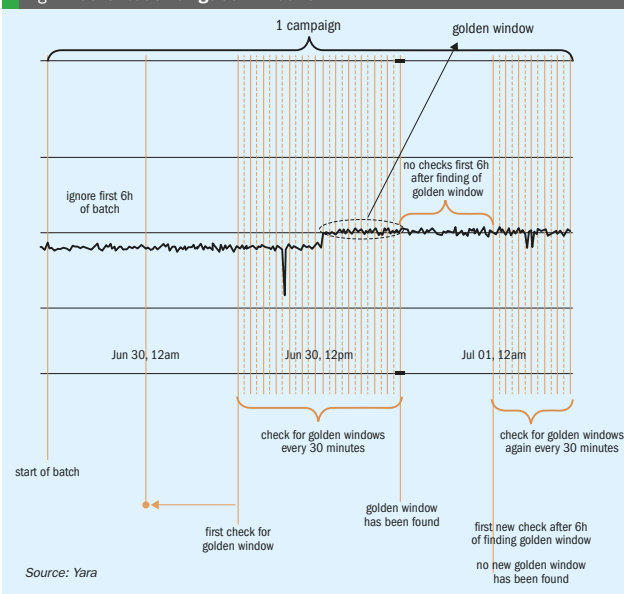
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Fig. 2: Identification of 'golden windows'.



Source: Yara

- “More, and more accurate, information than currently available in the production logbook.”
- “You gain courage to run at a high production rate when you know you have gone there before.”

Production logs confirmed that the tool was being actively used in a timely and effective manner. As might be expected, operators often used the tool to search for and select reference batches when they were transitioning between different NPK product grades.

A comparison of average production rates indicated a 2.5 percent increase at Uusikaupunki after the Golden Batch tool became operational. This was not universally true, however, as a product-by-product analysis revealed an increase in output for some products partly offset by a decrease for others.

An analysis of losses, as documented in Yara’s reporting system, revealed a decrease in losses after the implementation of the Golden Batch tool. An enhancement in overall equipment efficiency was also noted. Importantly, these improvements were achieved without compromising NPK product quality.

Challenges and lessons learned

The journey to develop and scale up the Golden Batch tool encountered various technical, operational, and strategic challenges along the way. Overcoming these also offered valuable lessons, as shared below:

- **Data quality and consistency.** Individual NPK plants have very different levels of instrumentation. Therefore, when key data is not logged digitally, operators will need to refer to other, non-digital sources instead to find good settings, such as personal logbooks and personal production experiences.
- **Complexity of the production process.** Some production challenges are hard to accurately measure because NPK fertilizer production is an inherently complex process. Unstable granulation is one notable example. There are many factors that determine how well granules form during production. Not all of these are measured and, consequently, the tool may not be able to support all production settings.
- **User training and adoption.** Training operators to effectively use the Golden Batch tool requires time, a resource typically limited at production

plants. Nonetheless, ensuring comprehensive end-user training and support remains paramount. Experience from the roll out has confirmed that a well-structured training programme, coupled with accessible user manuals and ongoing assistance, contributes to a smoother transition to this new way of working.

Future developments

The Golden Batch tool has been rolled out to eight Yara plants with expansion to additional sites currently underway. As well as helping operational teams increase plant production rates, the tool is also contributing to other continuous improvement activities, such as troubleshooting high emissions, for example. Also, when production issues occur, examination of records for golden batches where these are absent can provide insights into how production can be conducted to avoid these.

The benefits of the Golden Batch tool are independent of the production process. This makes its roll out to plants producing other fertilizer products, not just NPKs, a future option. After all, saving and having access to data for good production periods is relevant for all production plants.

A substantial amount of valuable data, both on tool usage and how NPK plants are operating in comparison to the golden batch settings, has now been collected. An analysis of this data is currently underway to identify which of the golden batch criteria fail more frequently. This is expected to provide insights into potential production bottlenecks at different plants. A separate analysis of how production plants perform over time for different NPK grades is also in progress. The results of this will help in product portfolio planning.

The Golden Batch tool should also support Yara’s other priority areas in future. These include reducing production emissions and energy consumption, as well as ensuring NPK plants have the flexibility to accept different quality raw materials. This can be done by adding emissions and utilities monitoring to the tool, for example. Connecting the tool to data sources for raw material inputs should also enable production settings and production quality to be mapped against the quality of the raw materials being consumed.



Marianne Ytterbø, Yara’s Product Manager at Digital Production (right), was responsible for developing the Golden Batch digital tool and its production roll out.

Conclusions

With the deployment of the Golden Batch tool, best operational practice at fertilizer plants is stored and made easily retrievable, to be used as references for current production. This aids operators in pushing up production rates as well as helping troubleshoot process issues.

This article provides an overview of the journey from ideation to realisation, highlighting the collaboration between Yara’s Digital Production team and engineers at the company’s NPK fertilizer plant in Uusikaupunki, Finland.

As the tool is rolled out to eight plants and its use expands, continuous improvements are being implemented, based on the feedback and experiences of operators. Each new deployment prompts plant-specific refinements, alongside general updates to the user interface and the introduction of new functionality.

Future planned developments include using the data collected by the tool for continuous plant improvement activities and adding capabilities for monitoring

emissions and energy consumption. The feasibility (and desirability) of securely integrating the Golden Batch tool as part of the control system – so it is directly available to operators – is also being investigated.

Importantly, the tool is not specific to just NPK production. This raises the possibility of a roll out to other types of fertilizer production plants as a future option.

About the author and the article

Marianne Ytterbø is Yara’s Product Manager at Digital Production for the Golden Batch application. This article is based on the paper presented at the International Fertiliser Society (IFS) Conference, Cambridge, UK, 7th December 2023, and subsequently published by the Society.

Reference

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Polyhalite – what next?

We look at the future of polyhalite mining and its use as a fertilizer following Anglo American's announcement that investment in its UK-Based Woodsmith mine will fall to zero in 2026 under current plans.

At its Woodsmith mine in the UK, Anglo American is continuing with tunnel boring activities at a reduced pace. Around 29 kilometres, out of a total length of 37 kilometres, has been successfully tunnelled, as of the end of June.

Earlier this year, mining giant Anglo American announced it was cutting investment in its Woodsmith polyhalite mine in the UK, with this declining to \$200 million next year and then to zero in 2026 as it deleverages and looks for an investor/strategic partner to take an ownership stake.

While Woodsmith is being slowed, PolyNatura, a polyhalite project in New Mexico owned by Canada private equity company Cartesian Capital, is being fast tracked (see project profile on page 45).

Globally, ICL remains the only company commercially mining polyhalite currently, extracting this mineral from its Boulby mine in the UK and turning it into a one million tonne market globally. The company has expanded its polyhalite product range and is also researching its potential use in cutting nitrogen losses to the atmosphere.

GoudenKorrel, meanwhile, a new Polish entrant with its own proprietary grinding and granulation process, is heavily marketing a range of four polyhalite-based products using material sourced from the UK.

Anglo American's crop nutrient ambitions

Mining major Anglo American is currently developing the UK-based Woodsmith mine project. This will access the world's largest known deposit of polyhalite, a natural mineral fertilizer containing potassium, sulphur, magnesium and calcium – four of the six major and minor nutrients that every plant needs to grow.

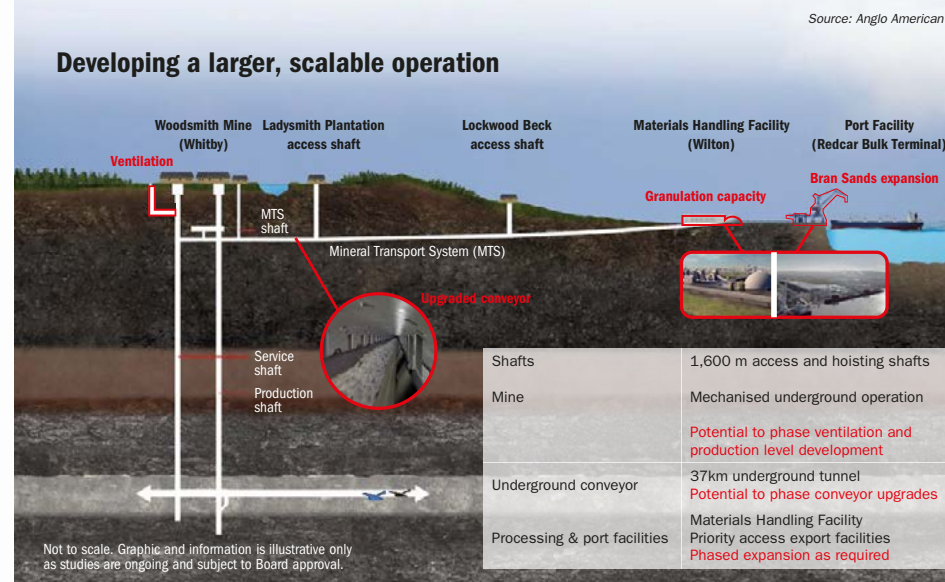
The Woodsmith mine is located around five kilometres south of Whitby, a small fishing port in North Yorkshire on England's North Sea coast. Anglo American gained control of the project in March

2020 through the cash purchase of Sirius Minerals for \$496 million (£405 million) (*Fertilizer International* 495, p10).

Woodsmith will extract polyhalite from the deeply buried underground ore deposit – containing 290 million tonnes of permitted reserves – via two 1.6-kilometre-deep shafts (Figure 1). Unusually, the ore extracted at the mine will then be transported to the port of Teesside through a 37-kilometre-long underground tunnel on a conveyor belt system. This mineral transport system (MTS) is designed to minimise the project's surface environmental impact.

On arrival at Teesside, polyhalite ore will be granulated at a materials handling facility at Wilton to produce a premium-quality, low-carbon fertilizer certified for organic use. This product, known as POLY4, will be exported from Redcar Bulk Terminal, the company's dedicated port facility.

Fig. 1: Anglo American announced changes to the core infrastructure (red text) at its Woodsmith mine project in February 2023. Investment is, however, set to be paused in 2026 following an announcement in May this year.



The fortunes of the Woodsmith mine project under Anglo American ownership over the last 2-3 years can be summed up as a tale of two resets:

- Firstly, a reset in February 2023 to make the project scalable to 13 million t/a capacity, up from 10 million t/a previously, with the announcement of annual investment of \$1 billion annually to deliver first polyhalite production by 2027
- Then a second reset in May 2024, triggered by a takeover bid from BHP, which effectively paused the project by cutting planned investment to zero by 2026 – while the company deleverages its balance sheet and looks for a strategic partner to take an ownership stake of up to 49 percent.

Anglo American is no stranger to the fertilizer sector, having owned Cleveland Potash Ltd (CPL), the operator of the Boulby potash mine in the UK, before selling this "non core business" to current owner ICL Fertilizers in 2002. The company also once owned niobium and phosphates businesses in Goiás and São Paulo states, Brazil, before agreeing to sell these to China Molybdenum Co (CMOC) for \$1.5 billion in 2016.

Strategy update unveiled

2023 landmark was a year for Anglo American's fertilizer market ambitions – with the mining major committing itself to investing in the region of \$4 billion to complete the Woodsmith project. The new investment plans were unveiled as part of a strategy update for the large-scale polyhalite mine released at the end of February that year (*Fertilizer International* 514, p44).

This confirmed initial production of polyhalite by 2027, requiring an annual capital investment of around \$1.0 billion. The mine's ultimate annual output was also increased to 13 million tonnes, up from 10 million tonnes previously.

Anglo American approved \$0.8 billion of investment for the Woodsmith mine in 2023, with most of this expenditure going to shaft sinking and tunnel boring activities. This came on top of \$522 million of capital expenditure in 2022 and nearly £390 million in 2021 (*Fertilizer International* 508, p62).

Under the updated strategy, investment and construction activities were directed at core project infrastructure (Figure 1), in particular:

- The mine's two 1.6-kilometre-deep shafts that sink down to the mechanised underground polyhalite mining operation
- The 37-kilometre-long underground mineral transport tunnel (MTS) needed to carry material from the mine to the materials handling facility (granulation plant) at Wilton on Teesside
- Three smaller intermediate access shafts to the MTS needed for maintenance and ventilation.

Delivering these project elements was seen as part of the mine's critical path to production. Additional project activities on Teesside – the construction of the materials handling facility at Wilton and the Redcar Bulk Terminal – although not part of this critical production path, were also singled out as key elements of Woodsmith's core infrastructure.

Going bigger for the long term?

Anglo American's CEO Duncan Wanblad spoke in detail about the company's new strategy for the Woodsmith mine during an annual results presentation in February

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2023 – explaining how the company had reset the project during 2022.

"Firstly, ...we have made significant changes to the scope, design, and approach to execution, ensuring that we bring the project up to Anglo American's high safety and technical standards, and employing modern mining methods, to set the project and the operation up to deliver its full potential. We have changed the execution strategy to an EPCM [engineering, procurement and construction management] model... and engaged a specialist contractor to execute the deep shaft sinks.

"Secondly, on the project timelines and scope, we are making changes to allow for an expanded scope ...which we want to set up correctly from the beginning. Nobody wants to turn around in ten years' time and wish we had made everything more scalable.

We are going bigger because we believe in the asset, we believe in the product and we believe in the market.

"The annual spend will vary from year-to-year but is likely to be around the \$1 billion mark. We expect to hit polyhalite by 2027, from which point we will be in a position to bring some volume to market.

"We expect Woodsmith to have the capacity to produce up to five million t/a by 2030, with the ability to expand to 13 t/a as the market develops."

The CEO's vocal backing for core infrastructure upgrades (Figure 1) appeared to provide the Woodsmith mine with certainty and placed the project on a clear trajectory to production within four years. Yet before the year's end it became clear that Anglo American, having scaled up the project and adopted higher mining standards, was looking for a strategic partner to share the growing investment burden.

Outside investors sought

News emerged that Anglo American was looking to sell a minority stake of up to 49 percent in its Woodsmith mine project following a report in *The Times* on 27th December 2023 (*Fertilizer International* 518, p9).

Work was underway to identify potential investors before starting a formal sales process, *The Times* said, noting that Anglo American itself had already injected \$2.5bn into the project to date. At the time, CEO Duncan Wanblad told city analysts that the

company was "moving at pace to find a partner" to share project costs.

There was speculation that the company was targeting infrastructure investors and sovereign wealth funds as well as chasing further binding offtake agreements from the fertilizer industry for its POLY4 product.

Wanblad said Anglo American needed "the right partner at the right price for this particular asset". Currently, the company is looking to secure new investors for the project by early 2025, with an external stake of up to 49 percent on offer, allowing Anglo to maintain project control.

Costs have risen rapidly since the project's inception. This is partly because Anglo American has needed to redesign what was originally a junior mining project. *The Times* reported on 9th November 2023 that project costs had tripled since 2017, describing the Woodsmith mine as a "money pit" for the company

In 2017, Sirius Minerals, the project's previous owner, originally estimated that the Woodsmith mine would cost \$2.9 billion to build. But Tom McCulley, the head of Anglo American Crop Nutrients, confirmed that analyst estimates from earlier this year that Woodsmith could now cost around \$9 billion to complete were not "too far off".

BHP bid prompts restructuring plan

Anglo American announced it would be concentrating on a narrow portfolio of just copper, iron ore and crop nutrients in future, as part of a "radically simplified" and "future-enabling" reorganisation plan unveiled on 14th May this year. The announcement followed an internal review of the business which began last year.

The plan involves offloading previously core assets, with Anglo American exiting from steelmaking coal and nickel and selling its Anglo American Platinum and De Beers business units, by divestment or demerger.

The company's CEO Duncan Wanblad described these proposals as the most radical changes to Anglo American in decades.

"We set out our clear strategic priorities earlier this year – operational excellence,

portfolio simplification, and growth. Our decision to focus Anglo American's portfolio in our world-class resource asset base in copper and premium iron ore – while retaining our crop nutrients optionality at Woodsmith – marks a major new phase in executing our strategy," he said.

Anglo American's decision to drastically and voluntarily restructure itself was made in response to an unsolicited takeover bid from BHP, the world's largest mining company by market capitalisation.

BHP made three consecutive, ever higher bids for Anglo American on the 30th April, 7th May and 20th May this year – all of which were successfully fended off. These bids valued the company at £31.1 billion (US\$38.8 bn, €36.3 bn), £34 billion (US\$42.6 bn, €39.5 bn) and finally £38.6 billion (\$49.1 bn, €45.4 bn), respectively.

In June, Anglo American started the formal process of selling its metallurgical coal assets and exploring options for its nickel operations, after rejecting BHP's third and final offer.

Coking coal will be the first segment offered for sale, followed by demerger of the Amplats platinum group metals business and then De Beers diamonds, CEO Duncan Wanblad said, quoted by Reuters.

Keeping faith in polyhalite?

In practice, Anglo American's "optionality" on crop nutrients means drastic cuts to the \$1 billion of planned annual investment in the Woodsmith mine, to \$200 million next year and then to zero in 2026, effectively turning off capital expenditure over a two-year period.

This expenditure slowdown was necessary to "support balance sheet deleveraging [debt reduction], while critical technical studies are completed in 2025, to then support syndication", Anglo American said.

Alexander Schmitt, the Chief Marketing Officer of Anglo American Crop Nutrients, elaborated on the company's plans for the Woodsmith mine project on 20th May, while speaking to invited guests at the company Singapore office.

A detailed review of critical works at the Woodsmith mine has been necessary to de-risk the project schedule, preserve those areas going into care and maintenance, and keep the project in readiness for later ramp-up."

"The latest announcement means that the development of the project will be slowed down and the start of the production has been pushed out," Schmitt said, adding that first production will be pushed out by "at least two years" beyond the previous 2027 start date.

"Some construction activities we will expect to continue. We are currently reviewing how to do that. We intend as well to focus on completing technical studies and assessing syndication partnering options, the process of bringing one or more additional investors into our crop nutrition business on board, before ramping up the construction again as soon as possible in the future," Schmitt continued.

"I want to be absolutely clear... The slowdown should not be interpreted as Anglo American losing faith in this product. The message I want you to take away from last week's announcement is we at Anglo American are creating a simplified organisation with an exciting future around the three core pillars: copper, iron ore and polyhalite."

Progress update and future plans

Further details of Anglo American's polyhalite plans also emerged in a progress update published as part of the company's half year results at the end of July.

"On 14 May 2024, [it was] announced that in order to support deleveraging of its balance sheet, [Anglo American] will be slowing the pace of development of the Woodsmith project in the near-term. Crop Nutrients is identified as one of the three key pillars of the ... more focused portfolio, and as such the focus will shift to preserving the long-term value of this high quality asset, and enabling the project's future development," the update said.

The wind down in capex over the next two years was also confirmed alongside the expected opex:

"Forecast capital expenditure for 2024 remains c.\$0.9 billion, focused on core infrastructure, with \$500 million spent during the half (30 June 2023: \$307 million). Capital expenditure for 2025 and 2026 is c.\$0.2 billion and nil, respectively. Operating expenditure for 2025 and 2026 is expected to be c.\$0.2 billion and c.\$0.1 billion, respectively."

Additionally, the slowdown in construction – and the associated lengthening of the project schedule – prompted an impairment charge (a decrease in asset value) of

\$1.6 billion. The update also revealed that parts of the Woodsmith mine are being mothballed.

The sinking of the production shaft – currently at a depth of 712 metres – has now been paused and will enter care and maintenance. Sinking of the service shaft, meanwhile, will continue downwards from a depth 745 metres through the Sherwood sandstone strata, subject to the allocation of capital. The Sherwood sandstone is a key shaft zone because of its expected hardness and the potential for water fissures.

Tunnel boring activities for the MTS system, meanwhile, will continue at a reduced pace. Around 29 kilometres out of a total length of 37 kilometres had been successfully tunnelled, as of the end of June.

A detailed review has also been carried out to identify critical works at the mine. This has been necessary to de-risk the project schedule, preserve those areas going into care and maintenance, and keep the project in readiness for later ramp-up.

Critical technical studies are also currently underway in readiness for any future construction restart. The project's configuration is being rescope to fit the revised funding and syndication plan, with a focus on scalable mining methods and the optimisation of infrastructure. The mine's final design capacity – around 13 million t/a currently – remains subject to further studies and approval.

ICL innovates

ICL owns and operates the world's only polyhalite mine at Boulby in the UK. The company markets and sells this natural, multi-nutrient fertilizer as Polysulphate under its PLUS range. Production of this polyhalite product reached one million tonnes in 2023, a new annual record (*Fertilizer International* 520, p15)

Polysulphate has a low carbon footprint, provides four plant nutrients – sulphur, potassium, magnesium, and calcium – and is certified for organic use in many



Application of ICL's new NPKplus product (16-8-16) at a citrus orchard, Yichang City, Hubei Province, China.

VAN IPEREN INTERNATIONAL

GreenSwitch SOP enters the market



The first bulk shipment of GreenSwitch® Potassium Sulphate (SOP) left Sweden for The Netherlands in mid-September.

Laboratory tests confirm that GreenSwitch® SOP meets the rigorous specifications for water-soluble fertilizers – including pH, high potassium content and solubility.

The first bulk consignment of GreenSwitch® Potassium Sulphate (SOP) left Cinis Fertilizer's factory in Sweden on 18th September for delivery via ship to customer Van Iperen International in The Netherlands (see photo).

"This first delivery is an exciting step forward," said Erik van den Bergh, Van Iperen's managing director. "The soon-to-arrive first batch of GreenSwitch® SOP signifies a crucial step in our mission to distribute premium quality circular fertilizers that benefit growers and contribute to more sustainable agriculture practices."

The delivery follows first production by Cinis Fertilizer at its inaugural 100,000 t/a capacity SOP plant at Örnsköldsvik, Köpmanholmen, Sweden, on 4th June. The plant will also produce 65,000 t/a of sodium chloride as a co-product (*Fertilizer International* 521, p38).

The Örnsköldsvik plant is powered by fossil-free and renewable energy and produces SOP from sodium sulphate (Na_2SO_4) using patented technology. Cinis has contracts in place for upcycling sodium sulphate from industrial residues – including those from electric car battery manufacturing and ashes from pulp mills.

This first-of-its-kind production method – based on the glaserite process – uses half as much energy as conventional SOP production, according to Cinis. The company quotes an energy consumption of 50,000 MWh for its production process versus 100,000 MWh for conventional manufacture, based on a 100,000 tonnes of SOP production.

The result, says Cinis, is a fertilizer with a low carbon footprint making a "unique and circular contribution" to sustainable agriculture. The SOP obtained

at Örnsköldsvik will be sold and marketed by Van Iperen International as GreenSwitch® Potassium Sulphate, a pure and fully water-soluble SOP product, with significantly reduced CO_2 emissions, that is suitable for foliar and fertigation applications.

Van Iperen has already begun packaging and distributing GreenSwitch® SOP to its customers, having previously received deliveries from Sweden by trucks. The company is now scaling up its packing and distribution operations following the arrival of the boat shipment. The first packaged product deliveries were subsequently sent out to customers globally in October.

Laboratory analyses have already been carried out to determine product quality and suitability. These validation tests confirm that the rigorous specifications for water-soluble fertilizers – including pH, solubility and high potassium content – have been met. ■

PADCOM

Manitoba's first potash mine enters production

Manitoba's first potash project entered production in July. The pioneering solution mining project is being developed by the Potash and Agri Development Corporation of Manitoba (PADCOM) in the hamlet of Harrowby, about 16 kilometres west of Russell, Manitoba. It began pilot production in June 2023.

The Manitoba government granted PADCOM permission to begin potash extraction and production in June 2022. The company has invested \$12 million in the mining venture to date.

Daymon Guillas, PADCOM's president, confirmed to CBC News that commercial production had started over the summer and that white Manitoba potash would soon enter the market.

PADCOM is using an innovative 'polythermic' selective solution mining process. When fully operational, its mine will extract and produce 100,000 t/a of potash – with the potential to scale this to 250,000 t/a – from the Russell Harrowby ore deposit in the province. The solution mine is expected to have a life of more than 100 years.

PADCOM emphasises the sustainability of its mining operations.

"This operation will use a more environmentally friendly mining process," said Daymon Guillas, PADCOM's president. "The physical footprint is small, and the process will use green energy."

According to the company, solution mining using advanced technology developed by Beechy Potash Products Corp (BPPC) offers the following benefits:

- Lower operating costs and reduced water and energy consumption

- compared to a typical conventional solution mining
- Less surface impact due to the small plant size and the avoidance of salt tailings
- Overall, the mine's technology and operations will generate almost zero emissions.

It also produces a white not pink potash product.

"If you're not using solution mining, you're bringing up the salt to the surface as well, so one of our key mantras is to keep as much salt underground as we can," PADCOM's CEO Brian Clifford told CBC News. "When you're looking at the other mines around here when you're driving, you can see millions and millions of tonnes of salt on the surface. That is not a part of our mining operation."

PADCOM was set up to pursue rural economic development opportunities in Western Manitoba, with the specific aim of developing the Russell Harrowby potash deposit. It was formed in partnership with



PADCOM president Daymon Guillas announcing the start of pilot production at its Manitoba potash solution mine in June last year.

Gambler First Nation, a local indigenous community, who have a 20 per cent equity stake in the project.

According to Daymon Guillas, 11 per cent of the mine's net profits will be given to Gambler First Nation, Waywayseecappo

First Nation, Birdtail Sioux First Nation, Treaty 2 Territory, Treaty 1 Territory and the Manitoba Métis Federation (MMF) as social royalties. A further four per cent of profits will also go into an economic development fund for the area. ■

HIGHFIELD RESOURCES

New \$220 million funding deal for Muga

Highfield Resources announced \$220 million of equity funding on 23rd September, enough to bring the first phase of its flagship Muga potash in Spain into production.

The new investment package comes from Hong Kong and Shanghai listed Yankuang Energy and other strategic investors, including Beijing Energy and trader Singapore Taizhong.

"This is to fully fund the Muga project," Olivier Vadillo, head of marketing and investor relations, told *Mining Journal*. "This is very much a transformative strategic partnership that we're building here, to create what will be a global project in very distinct but complementary geographical location."

"On completion of this deal, we believe we will have the assets, the team and the capital to unlock and create significant value for Highfield," added Ignacio Salazar, the company's CEO, in a market announcement.

Muga's concession covers a 46 km² area of the Ebro basin, straddling Aragón and Navarra provinces in Northern Spain. Initially, the project will have an annual production capacity of around half a million



Highfield's proposed Muga potash project in northern Spain.

tonnes for muriate of potash (MOP), with the potential to double this capacity as part of Highfield's second phase plans. Access to international markets is provided through the Port of Pasajes, San Sebastian, 150 kilometres to the west of the proposed mine.

The underground mining project is targeting a sylvinitic ore zone starting at a depth of 350 metres. The ore, which is inter-bedded with halite, will be extracted by conventional underground 'room and pillar' mining using continuous miners, road headers and conveyors.

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A processing plant, to be constructed at Sangüesa, will then upgrade mined ore using a two-stage crushing process, attrition scrubbing, hydrocyclone desliming and froth flotation. Additional proposals include a 1.3 million tonne capacity crystallisation plant capable of producing 135,000 tonnes of granular potash and 260,000 tonnes of industrial salt (NaCl) as by-products from the treatment of tailings (*Fertilizer International* 472, p64).

Muga is fully permitted and construction-ready with the following fundamentals:

- Ore reserves in excess of 10 million tonnes (K₂O)
- Conventional 'room and pillar' mining
- Construction-ready project with an eventual planned annual production capacity of one million tonnes
- Mine Life of 30 years

- Estimated capex of around \$800 million and opex of \$118/t
- Net present value (NPV) of €1.82 billion and a 24% internal rate of return (IRR).

"Muga will be very much a European project feeding the European markets," marketing head Vadillo told *Mining Journal*. "We're only about an hour's drive, from the French border, and there's a huge amount of demand in the south of France as well, a lot of buyers that we know very, very well."

The \$890 million (£834 million) project is being financed by a mix of:

- **New equity funding:** \$220 million (€267 million) from Yankuang Energy, Beijing Energy, Taizhong and other strategic investors
- **Debt:** €321 million (\$342 million) of secured project financing from BNP Paribas, Caja Rural de Navarra, ING, HSBC, Natixis and Société Generale

- **Equipment operating lease:** €25 million (\$27 million) of financing via Macquarie
- **Short-term funding:** €14 million (\$15 million).

As part of the new finance deal with Asian investors, Highfield will also acquire the capital of the Southey potash project in Saskatchewan, Canada, as well as develop this project. This 2.8 million t/a solution mining project – which dates from 2011 – has the necessary environmental approvals and published a project feasibility study (PFS) in 2016. It is currently owned by Yancoal Canada, a subsidiary of Yankuang Energy.

Critically, Highfield's buy-in to the Southey project and the equity package for the Muga project are inter-conditional. The equity deal is due to be completed in early 2025, with Highfield seeking to raise as much \$15 million in the interim to support project activities. ■

PHOTO: SO4



Brine evaporation ponds, Western Australia

New SOP capacity – reality bites

The prospect of a drastic expansion in potassium sulphate production has been linked to a plethora of projects in Australia, Ethiopia, and Eritrea. These have sought to take advantage of market tightness and high price premiums. Yet investor interest in supposedly promising projects has waned over the last few years. In this insight article, CRU's **Alexander Chreky** explains the reasons behind the high project failure rate, as well as highlighting some limited successes.

CARTESIAN CAPITAL GROUP

PolyNatura revives polyhalite project hopes

The owner of PolyNatura Corp, global private equity firm Cartesian Capital, is advancing the Ochoa polyhalite project in New Mexico, in cooperation with Fistera Energy, an investment company that specialises in greenfield sustainability projects. The Ochoa project (*Fertilizer International* 480, p60) is located some 60 miles east of Carlsbad, New Mexico, less than 20 miles west of the Texas/New Mexico state line.

The large-scale deposit is said to be the sole polyhalite resource in the Americas with 630 million tons of Measured & Indicated resources at an average grade of 82.6%. This resource will support a mine life of at least 50 years, based on annual production of 1.8 million tons from 161 million tons of Proven & Probable reserves with an average product grade of 87.1%.

PolyNatura's polyhalite deposit is located within the Permian-age Delaware Basin at a depth of around 1,500 feet (460 metres) underground in a flat-lying seam of 5.4 feet average thickness. The mineral will be extracted by a conventional 'room-and-pillar' technique using electrical continuous miners.

Preparing the New Mexico polyhalite ore for market only requires dry crushing and sizing – a relatively simple, low-cost method that consumes minimal water compared to



This folded gyrock, like polyhalite, occurs in the Permian-age Delaware Basin, New Mexico.

chemical processing. This minerals processing step will also use granulation and concentration circuits to increase polyhalite grade and boost project economics. The concentration circuit will incorporate short wavelength infrared (SWIR) equipment to analyse and sort the crushed ore.

The current plan is to truck the final product 22 miles east of the processing plant to a rail loadout facility equipped with 60,000-ton product storage domes. Polyhalite will be loaded from here onto the

Texas & New Mexico Railroad which, in turn, links to the Union Pacific Railroad. Rail freight provides access to Gulf and Pacific ports for onward shipment to international destinations.

The company is targeting the US, Mexico and other Latin American countries such as Brazil and Colombia as key markets. Full commercialisation of the project is scheduled for 2027-2028 following pre-construction, procurement and construction phases. ■

Introduction

Potassium sulphate (sulphate of potash, SOP) is valued as a low-chloride potassium and sulphur source for chloride-sensitive cash crops such as tobacco, fruit, and vegetables. While SOP accounts for a little under 10 percent of global potash demand, far behind the much more widely traded and produced potassium chloride (muriate of potash, MOP), it commands a significant price premium over MOP, principally due to its value as a low-chloride potassium fertilizer.

SOP is manufactured either through secondary processes which react MOP with a sulphate source, most commonly sulphuric acid in the Mannheim process,

or via primary production routes that extract and process natural brines. Global SOP production capacity is around 12.6 million tonnes, estimates CRU, with primary capacity accounting for around 30 percent of this total.

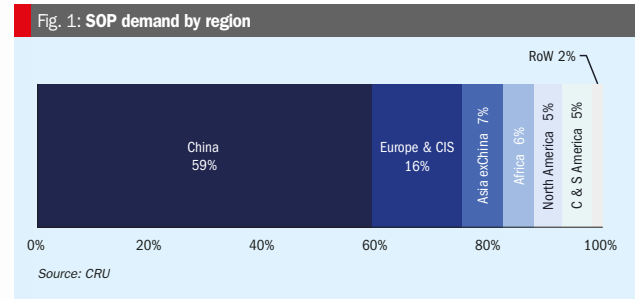
But there's a problem in the world of SOP: a lack of new capacity outside of the self-contained Chinese market, the world's largest demand centre (Figure 1). Price signals provide the main evidence for this – with the SOP price premium over MOP reaching record levels. NW Europe SOP has maintained an average premium of \$265/t over MOP during the last quarter (Q3) and shows no signs of falling any time soon.

Not that there's been a lack of trying. In recent times, a flurry of primary SOP projects, most notably in Ethiopia, Eritrea and Australia, have been vying to enter the market. Collectively, these projects have the potential to add more than two million tonnes per annum (t/a) to global SOP capacity by the end of the decade, a 16 percent increase on current levels. Yet, in 2024, very few of these junior mining ventures remain as serious contenders likely to enter commercial production by 2030.

East African potash hopes remain distant

Eritrea and Ethiopia once had high hopes for SOP production, given the abundant reserves in the Danakil region. Despite their early promise, however, all major SOP projects in the region have failed to materialise. Factors such as a lack of infrastructure, conflict, corruption, and sanctions have seen leading East African projects (Figure 2) either indefinitely delayed or prompted owners to divest their assets to Chinese developers and others.

The Danakil depression hosts extensive potash resources, with abundant and high-grade sulphate mineralisation present at accessible depths. The Ethiopian-Eritrean border bisects the northern part



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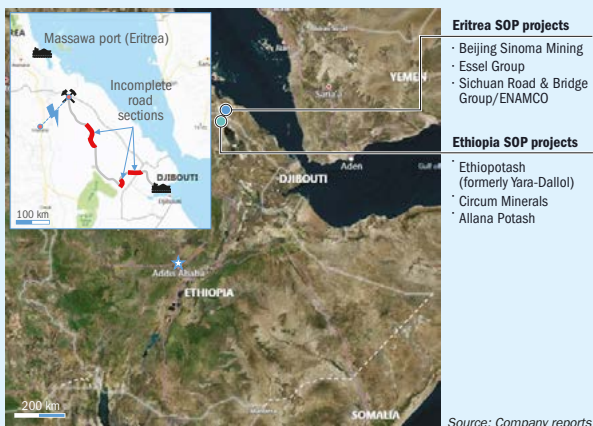
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Fig. 2: Ethiopian and Eritrean potash projects



of the resource with mineral licences held on both sides.

In Eritrea, leading SOP developer Sichuan Road & Bridge Group/ENAMCO, alongside other less advanced projects from Beijing Sinoma Mining and Essel Group, were planning to deliver SOP capacity totalling 500,000 t/a. In Ethiopia, meanwhile, Circum Minerals and Ethiopotash (formerly Yara Dallo) have pursued projects with a combined capacity of nearly one million t/a in their first phases. Also located in Ethiopia is an inactive mining project previously developed by Allana Potash and ICL.

Yet the various attempts to develop East Africa's abundant SOP resources have seen project hopes dashed and commercial interest in these thwarted.

In 2015, potash incumbent ICL acquired Allana Potash Corp and its MOP+SOP Danakhil project – with this initially appearing to be a major turning point for the Ethiopia's agricultural and industrial sectors. The Israeli potash producer was set to invest more than \$1 billion in the project, according to media reports at the time, with three new fertilizer blending units planned.

However, in a dramatic reversal, ICL abandoned the Danakhil project less than 18 months after its purchase

due to a legal dispute with the authorities. The company ended up taking the Ethiopian government to the Permanent Court of Arbitration in the Hague, seeking compensation for an alleged illegal tax assessment.

It transpired that the Ethiopian government had attempted to claim \$50 million in unpaid tax after ICL sought to transfer mining licences to its subsidiary Allana Potash Afar. This huge tax bill was unfounded, in ICL's view, and consequently the company terminated its interest in Ethiopia, having no doubt decided that the country was too high risk for major capital investment.

Then, in November 2020, other SOP projects in the region stalled after fighting broke out in Ethiopia's Tigray province. This forced developers to pause activities, evacuate employees, and reconsider their project plans.

Norwegian fertilizer producer Yara was the first major company to exit, selling its Dallo project stake to Ethiopotash in July 2022. There have been no major project updates since this sale more than two years ago.

Australian junior Danakali was the next to bolt, selling its stake in its joint venture Colluli group to China's Sichuan Road and Bridge Group in late March 2023, saying that sanctions had made fundraising for

the Eritrean-based project very difficult. The Danakil project in Ethiopia, owned by Circum Minerals, is likely also dormant awaiting the injection of new capital, given that it has not reported any significant updates since 2018.

Overall, the frosty relations between Ethiopia and Eritrea make any sort of cooperation over exploitation of the Danakil potash reserve unlikely in the near term. A lack of governance and poor regional infrastructure will also continue to hamper these projects going forward.

A final consideration is that Ethiopia – despite its rapidly growing fertilizer consumption – does not consume significant quantities of potash currently, either for direct application or as part of compound/blended NPKs. This is partly linked to the fact that potassium is considered non-deficient in most Ethiopian soils, with the country choosing to import huge volumes of NPS fertilizers instead. Local farmer preferences are important as strong domestic demand for potash could have helped to derisk some of these projects, while the absence of such demand may hamper development of the region's potash resources in future.

Australian projects fall at final hurdle

Until recently, Australia was being touted as new SOP production hub for the Asia-Pacific region. As SOP prices hit record highs in 2022, the country boasted nearly twenty potassium sulphate projects at various stages of development. Of these, around seven have progressed the furthest (Figure 3) with two seeming to have serious prospects of sustained commercial production after reaching the commissioning stage.

However, in what has become a familiar story, commissioning difficulties, cashflow problems and indebtedness have combined to hobble Australia's emergence as an SOP production centre. Instead, most developers have now either paused or been forced to abandon their SOP projects, with some pivoting towards other commodities.

The pathfinder Lake Way and Beyondie SOP projects, while both crossing the finishing line and entering production during 2021, ultimately failed to sustain this commercially.

The Lake Way project was commissioned by its original owner Salt Lake Potash in April 2021 and later began commercial

Fig. 3: Australian potash projects



production in June that year. However, Salt Lake Potash went into receivership in October 2021, with accrued debts of AUD 127 million, having struggled to fully commission the plant and generate the anticipated output and returns.

Lake Way has since been revived under new ownership, after its purchase by the Czech private equity firm Sev.en Global Investments in late 2022 for an undisclosed amount. While details are sparse, Sev.en announced its first production of SOP at Lake Way in July this year, with plans to scale-up commercial operations to 200,000 t/a and become a significant domestic and global supplier (*Fertilizer International* 522, p9).

Following closely on the heels of Lake Way, Kalium Lakes started SOP production at its Beyondie project in October 2021, subsequently delivering an inaugural product shipment to CSBP Fertilisers in August 2022. Kalium had plans to ramp up SOP production capacity at Beyondie to 170,000 t/a. But commissioning issues affected the plant's ability to deliver a stable and consistent SOP output. The result was missed production targets and financial difficulties that ultimately led to the company entering receivership in August 2023.

In a disappointing finale, the receivers ended up auctioning off the project's assets to pay off creditors after attempts to find a buyer failed. All is not lost, however, as Reward Minerals recently announced it will acquire Beyondie's production plant assets for a knockdown price of AUD 2.13 million. The purchase includes the fully constructed processing plant, site offices and maintenance infrastructure.

The reputation of BCI Minerals as **25** last man standing in the world of Australian SOP projects might be due to its focus on sodium chloride production as the primary output (5.3 million t/a) from its Mardie project rather than SOP (140,000 t/a).

Like other Australian projects, BCI Minerals plans to use large-scale evaporation and concentration ponds to generate the highly concentrated brine needed for SOP production. Unlike these other projects, however, Mardie will produce SOP from seawater instead of hypersaline lake water. The only other

commercial SOP producer currently using this method globally is CNOOC Shandong Ocean Chemicals at its 20,000 t/a capacity plant in Shandong, China.

Mardie is a fully funded, under construction project, having received AUD 650 million from the Australian government alongside finance from private investors. Key environmental approvals were granted in July this year, with first SOP production scheduled for 2027.

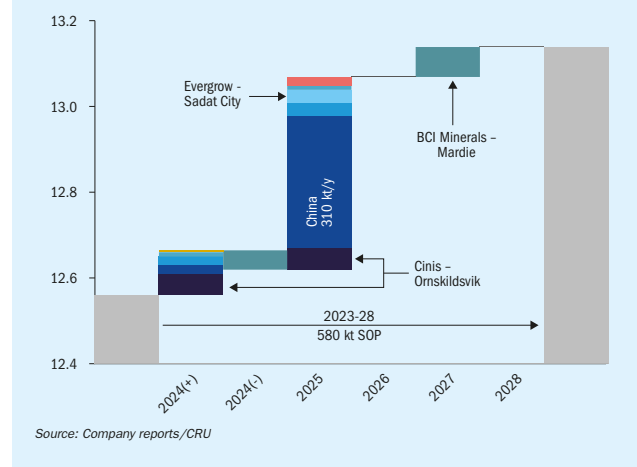
Other Australian SOP ventures remain in the study phase and, with the less favourable investing environment for these currently, many developers have pivoted to other ventures.

Reward Minerals has surrendered other leases to focus on its flagship Carnarvon potash project and recently acquired Beyondie project assets. The developer is also hoping to market its "breakthrough potash processing technology" to third-party companies around the world.

Agrimin, meanwhile, is still pursuing funding for its Lake Mackay project – which it claims is the world's largest undeveloped salt lake potash resource – having completed various feasibility studies.

Australian Potash, previously associated with the Lake Wells SOP project, announced it would refocus on other minerals such as gold and nickel after exiting administration in February 2024, citing the lack of investor enthusiasm for SOP projects.

Fig. 4: Annual SOP capacity additions, 2023-2028



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Similarly, Trigg Minerals has relinquished its Lake Rason and Lake Yeo tenements in Western Australia to focus on its "core Lake Throssell SOP asset", as well as announcing a shift to developing gold and base metals instead. The company also signalled it was pursuing "an alternative pre-processing approach" to that used by previous SOP operators.

Parkway Minerals was developing the Karinga Lakes SOP project as a joint venture with Verdant Minerals. But its lapsed website domain raises questions about the extent of current project activity.

Finally, Centrex Metal's Oxley SOP and NOP project looks likely to remain in the feasibility phase for the time being while the company focuses efforts on its Ardmore phosphate mine expansion.

A limited capacity pipeline

Globally, outside of the remaining Australian projects, there are only a few potential new additions to SOP capacity over the next five years. Indeed, only 290,000 t/a of additional SOP production capacity is expected to be brought to market over this period – setting aside new additions to secondary production capacity in China, a self-contained market.

Some new ex China SOP capacity will come via the secondary production route and the rapid construction of small-scale Mannheim units. These include Indorama's 20,000 t/a capacity Kokand SOP plant in Uzbekistan and Evergrow's planned 30,000 t/a SOP expansion in Egypt.

Realistically, only two SOP projects are large enough to export either regional or globally: BCI Minerals' Mardie salt project in Western Australia (see above)

and Cinis Fertilizer's new SOP plant at Ornskoldsvik, northern Sweden.

Cinis Fertilizers: a potential SOP game-changer?

Cinis Fertilizer's commissioned the Ornskoldsvik potassium sulphate and sodium chloride production plant in early June 2024. Unusually, the unit employs the little-used glaserite process to make SOP.

Unlike the Mannheim production route, which uses sulphuric acid in high-temperature furnaces, the glaserite process used by Cinis manufactures SOP by combining potassium chloride and sodium sulphate under lower temperature conditions. Additionally, the process yields sodium chloride as by-product rather than hydrochloric acid produced via the Mannheim route – the latter typically being more difficult to offload.

The Ornskoldsvik plant has nameplate capacities of 100,000 t/a for SOP and 65,000 t/a for its sodium chloride by-product. The company holds offtakes with Van Iperen International for the SOP and with K+S for the salt, with the latter company also supplying the MOP feedstock for the process.

The Ornskoldsvik plant is the first to be delivered from an ambitious SOP project pipeline. Cinis ultimately plans to operate a total of 1.5 million t/a of SOP capacity via the construction of a series of plants across the Nordic region and North America by the end of the decade. This would represent slightly more than

10 percent of global potassium sulphate capacity, equivalent to more than half of current global demand outside China.

A key question is why Cinis has opted to use the glaserite process and – given the environmental and cost benefits claimed by the company – why this production method has not been more widely adopted across the SOP industry instead of the more commonly used Mannheim route. The answer to this largely centres on the availability and cost of the sodium sulphate feedstock consumed by the glaserite process versus that of the sulphur/sulphuric acid consumed in Mannheim production.

Globally, other than remaining Australian projects, there are only a few potential new additions to SOP capacity over the next five years."

Feedstock requirements

Cinis has longstanding plans to use locally available, low-cost sodium sulphate sourced from the waste streams of wood pulp mills and battery manufacturing plants. The company assumes a sodium sulphate cost of SEK 0-500 /t (around \$0-50 /t), based on its 2022 IPO prospectus. In September, Cinis signed its first waste-derived sodium sulphate supply agreement with Swedish environmental company. Prior to this, the company has been purchasing merchant sodium sulphate as an interim measure.

At face value, the traded sodium sulphate price is not substantially different to that of sulphur or sulphuric acid. Since the start of the year, sodium sulphate (f.o.b. Spain) has averaged \$110 /t, for example, with the sulphur price (cfr North Africa) only around \$15 /t lower on average. Cinis will, however, be paying for



Erection and installation of the SOP crystallisation plant at Lake Way, Western Australia.

freight on top of this. While vessel size limitations at its port (5,000 dwt) will add to freight costs, total import costs for Ornskoldsvik are still likely to be well below \$200 /t.

However, a major caveat is that the sodium sulphate requirements of the glaserite process are four times higher than the sulphur requirements of the Mannheim process. One tonne of SOP obtained via the glaserite process needs 0.79 tonnes of sodium sulphate, for example, whereas a Mannheim unit only consumes around 0.2 tonnes sulphur to produce the same amount of SOP.

Although additional energy costs are associated with sulphur burning in the Mannheim process, the highly exothermic reaction that takes place allows Mannheim units to benefit from energy co-generation. They can also trade excess sulphuric acid to generate sales income.

Moreover, sulphur and sulphuric acid are far more widely traded than sodium sulphate. Total global sulphur exports were around six times larger than those of sodium sulphate between 2019 and 2023, CRU estimates. China also appears to dominate sodium sulphate exports, with Spain being the only other significant exporter.

Consequently, the use of merchant sodium sulphate in SOP production, in comparison to sulphur, faces supply availability limitations and potentially significantly higher raw material procurement costs. It is therefore not surprising that glaserite plants have previously been located at or adjacent to sodium sulphate production centres.

Procurement plans

Almost certainly, this makes procuring locally available, lower-cost sodium sulphate an immediate priority for Cinis. This has been achieved via its new supply contact with Ragn-Sells. Negotiations to secure waste sodium sulphate from wood pulp mills, meanwhile, are continuing.

However, sourcing sodium sulphate from other waste streams could be more promising. Notably, the disposal of sodium sulphate has become something of a headache for prospective European battery cathode manufacturers. Indeed, a nearly finished BASF cathode plant at Harjavalta in Finland had its environmental permits revoked in February 2024 largely because of concerns over sodium sulphate waste disposal.

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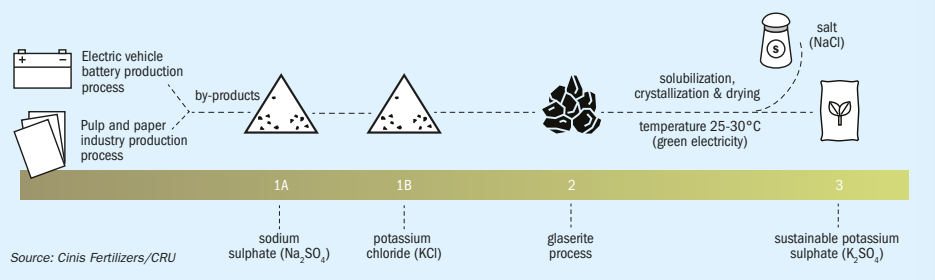
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Fig 5: Cinis Fertilizer's glaserite production process



Source: Cinis Fertilizers/CRU



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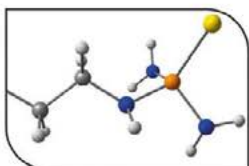
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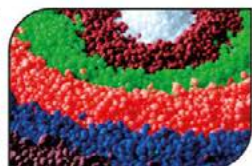
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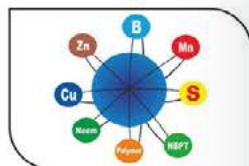
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