www.fertilizerinternational.com

Fertilizer INTERNATIONAL

Welcome to our iPad version of Fertilizer International Issue 515

Please either swipe through or use the contents link at the bottom of the page to navigate your way around this PDF.

To use the full interactivity of this PDF on iPad we suggest that you open it within the free app iBooks.

The nutrient needs of nuts

Innovative products and producers

Phosphoric acid process choices

Jansen potash project update

Fertilizer INTERNATIONAL

www.fertilizerinternational.com

NUMBER 515 JULY | AUGUST 2023

Cover: Harvest ready almonds waiting to be picked.
Deborah Lee Rossiter/Shutterstock.com

12

New fertilizer blending and handling projects

20

The biostimulants market blossoms

Read this issue online at:
www.fertilizerinternational.com

Published by:
BCInsight

CONTENTS

PHOSPHATES AND POTASH INSIGHT

REGULARS

Editorial

Passionately committed to sustainability

Tibaut Theys, general manager of Prayon Technologies.

PHOTO: PRAYON

Despite being an age-old industry, the phosphate sector remains vibrant and driven by a passionate commitment to leaving behind a sustainable world for future generations. **Tibaut Theys**, general manager of Prayon Technologies, explains how the industry, by implementing more efficient production processes and promoting responsible fertilizer usage, is working urgently to reduce CO_2 emissions, as well as striving to minimise its environmental footprint.

The phosphate industry is constantly evolving in response to a range of challenges and emerging trends.

Phosphate rock – as a vital resource for fertilizer production – plays a crucial role in the supply of phosphorus for global agriculture. Its availability for future generations could, however, become increasingly limited. This is due to new and emerging market uses, such as the development of lithium iron phosphate (LFP) batteries, as well as rising phosphate rock consumption for fertilizer production.

The phosphate industry, as well as having resource availability concerns, is facing a series of other pressing issues. These include the need to control carbon dioxide emissions and comply with environmental regulations. There also needs to be a fundamental change in public attitudes about the large quantities of gypsum generated by the industry.

To address these challenges, the phosphate industry has committed itself to making a series of sustainability improvements that prioritise innovation, new technologies and investment in education. Moroccan producer OCP, for example, has re-invested a lot of its earnings to create UM6P, one of Africa's best and most modern universities.

Others in the industry are creating technologies that ensure the utilisation of low-grade phosphate rock. One example is the dicalcium phosphate (DCP) 'super rock' process. Fertilizers produced from DCP deliver phosphorus to plants in a highly concentrated and water-soluble form at critical growth stages. The ability to precisely time phosphorus applications also boosts the uptake of other plant nutrients such as nitrogen. This makes DCP an almost perfect raw material.

Furthermore, the industry has made significant strides in developing removal technologies that extract impurities like aluminium, iron, magnesium, cadmium and other deleterious elements from phosphoric acid. As well as improving the quality of the final product, these latest advances also ensure compliance with new regulatory norms. This is particularly critical in regions like Europe where mandated limits on elements such as cadmium have been introduced.

The economic recovery of valuable rare earth elements (REEs) is another area of focus for the phosphate industry. Developing viable technologies to extract these from phosphate deposits – given the increasing industrial demand for REEs – represents a significant step towards resource efficiency and sustainability. Nevertheless, the low concentration of these elements means the profitability of such processes is not always guaranteed.

Changing attitudes about the gypsum stored in waste stacks has become a top priority for the industry too. The aim is to shift how gypsum is perceived so that it becomes viewed as a valuable by-product. Collaborative partnerships between phosphoric acid producers, universities, research bodies, and governments have all played a vital role. These have led to changes in the legal status of gypsum, ensuring it is classified as a by-product and not as waste.

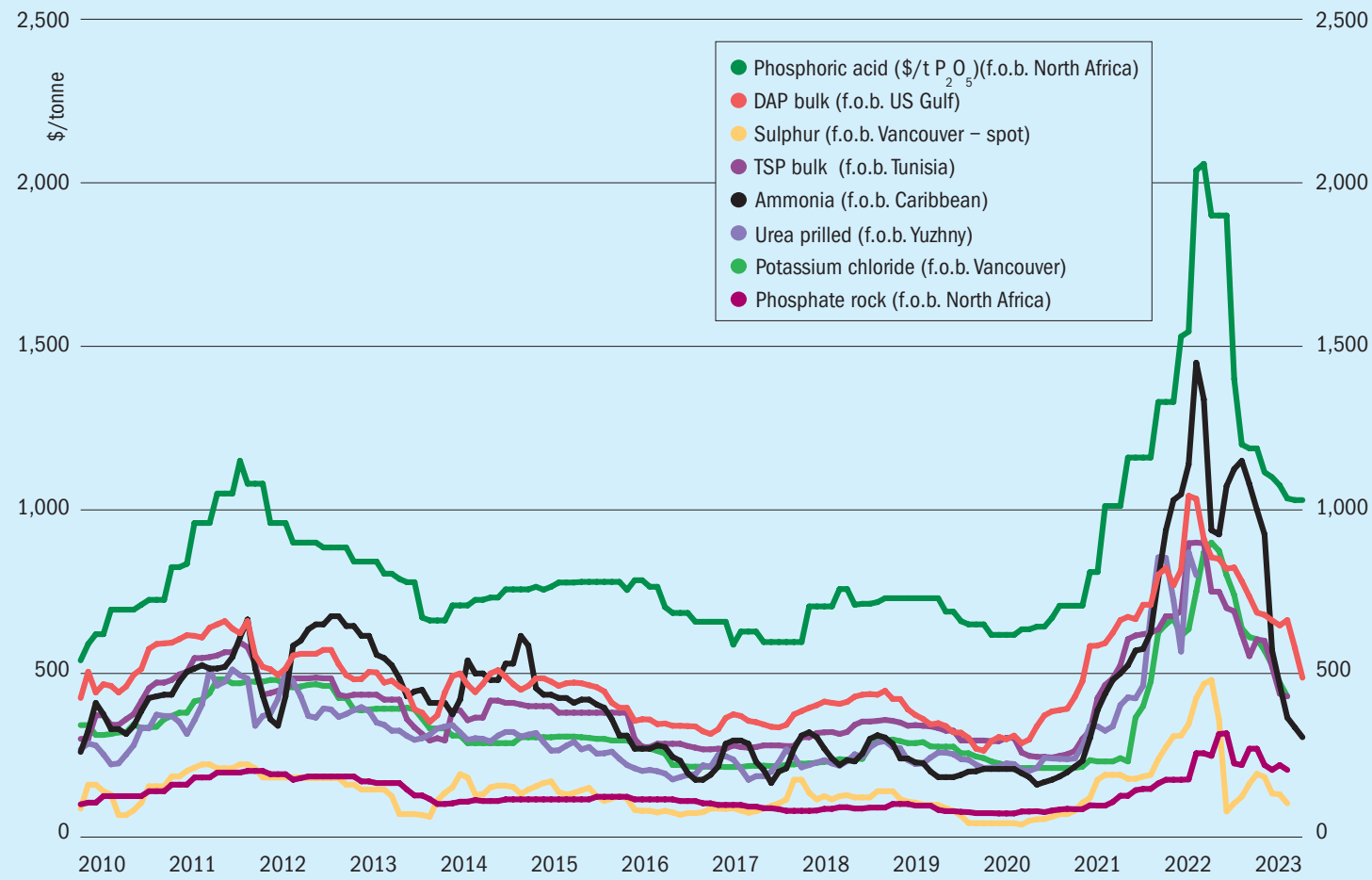
Remarkable achievements have been witnessed because of this. Gypsum generated by the phosphate industry is now being employed in a wide range of applications such as road foundations, construction blocks, cement, plaster, soil amendment, mine reclamation and so on. Nowadays, gypsum is also playing a vital role in improving the fertility of saline and acid soils. The notable success of countries like Brazil in utilising all the gypsum they produce is setting a positive example for other nations to follow.

In conclusion, the phosphate industry recognises the challenges it faces and is actively working towards sustainable solutions. Through technological advances, such as the DCP 'super rock' process, impurity removal technologies, rare earth recovery, and the utilisation of gypsum as a valuable by-product, the industry is making significant progress. By continuing to embrace innovation and collaboration, the phosphate sector will play a pivotal role in providing essential resources for global agriculture while minimising its environmental impact. It is through these collective efforts that we can build a more sustainable future for generations to come.

Looking ahead, pioneering research and development is exploring new frontiers and developing the technological solutions of tomorrow. This dedication to innovation is crucial for maintaining the phosphate industry's relevance – by ensuring it can adapt to the ever-changing dynamics of the global market and meet the future sustainability challenges facing us all. ■

Market Insight

Historical price trends $/tonne



Source: BCInsight

Market Insight courtesy of Argus Media

PRICE TRENDS

Urea: There was a general price upswing for both urea and ammonium nitrate in mid-June, while ammonium sulphate and urea ammonium nitrate (UAN) prices remained weak. Urea prices were pushed up in most regions as traders sought to secure cargoes across the globe – resulting in granular urea deals from the Baltic ($260-280/t f.o.b.), Egypt ($312-335/t f.o.b.), Middle East ($253-280/t f.o.b.) and China ($308-310/t f.o.b.). Import markets, in contrast, were less active and price direction was correspondingly mixed. Prilled and granular urea prices fell to $300-315/t cfr southeast Asia, for example, while Brazil trade stalled when offers moved above $290/t cfr.

Key market drivers: Nervousness about the impact of rising northern hemisphere energy prices in the autumn prompted buyers in several countries to seek urea prices for August-September loading. Seasonal demand, in the form of widespread last minute purchases, continued to drive trading activity in late June and helped support prices, particularly in North Africa and China.

Ammonia: Spot activity was limited in late June due to two factors. Firstly, participants were assessing how the resumption of EU ammonia imports duties would hit supplies from affected countries. Secondly, the impact of falling domestic ammonia prices in China on the east Asian supply/demand balance was also being watched. In the background, NW Europe's ammonia producers faced tough decisions on the economics of producing vs importing due to continuing European natural gas market volatility.

Key market drivers: Although European gas prices eased in late June – with TTF month-ahead prices falling from their mid-June spike – the ammonia output of NW European plants may still be curtailed if import prices remain $100/t below regional production costs. In a spot sale from Malaysia, Petronas is reported to have sold 3,000-4,000 tonnes of ammonia at $325-335/t f.o.b. for prompt delivery to Vietnam. Indian fertilizer producer Fact has also issued a tender to buy 7,500 tonnes of ammonia for 11-17th August delivery at Cochin.

Phosphates: There was a burst of sales in major markets west of Suez as June ended. This saw DAP firming at Nola and MAP spot sales emerging in Brazil. In the US, DAP barges climbed to $435-455/st f.o.b. Nola, up from $435-440/st f.o.b. in mid-June. In Brazil, Russian MAP was trading at $430/t cfr for both end-June and July loading, down from $430-440/t cfr in mid-June. East of Suez, DAP cfr India slipped to $453-455/t cfr, down from $469-470/t cfr. China DAP f.o.b. prices were stable on a lack of sales and limited offers.

Key market drivers: China's May DAP exports more than tripled year-on-year to 516,200 tonnes, driven by higher shipments to India and Thailand.

Market price summary $/tonne – Late June 2023

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phos Acid
f.o.b. Caribbean	270-340	225-310**	f.o.b. E. Europe 120-160	f.o.b. US Gulf	473-506	-	-
f.o.b. Yuzhny	Port closed	Port closed	-	f.o.b. N. Africa	445-510	370-420	960-1,100
f.o.b. Middle East	210-260	240-316**	-	cfr India	459-480	-	970-990*
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**		**Sulphur**		
f.o.b. Vancouver	287-387	-	cfr US Gulf	50-85	f.o.b. Vancouver	76-90	-
f.o.b. Middle East	300-345	-	-	-	f.o.b. Arab Gulf	80-90	-
f.o.b. Western Europe	-	650-750	-	-	cfr N. Africa	84-110	-
f.o.b. Baltic	280-380	-	-	-	cfr India	100-115+	-

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

Potash: ICL has become the second producer to sign an MOP contract with China at $307/t cfr. This follows Canpotex's settlement with India at the same price earlier in June. Under the contract, ICL will supply 800,000 tonnes of standard-grade MOP to its Chinese customers in 2023 with the option to supply an additional 350,000 tonnes this year. In the west, Brazil is preparing for the upcoming safra season, with the purchase of around 250,000 tonnes of granular MOP at $330-340/t cfr for June-August shipment. Low trading activity elsewhere has pushed down MOP prices in Europe and southeast Asia.

Key market drivers: Indian imports ground to a halt in late June. Importer Fact cancelled a 30,000 tonne MOP order as it awaited the outcome of the new contract settlement. A corn and soybean price rally is supporting MOP demand for the US summer fill programme. US corn and soybean futures have risen by 18 percent in the past month. This rally has been driven by risks to the US harvest from a lack of rain and crop conditions.

NPKs: The market has continued to soften, most noticeably in Asia, with suppliers accepting the lower price levels necessary to generate sales. Prices of key NPK grades dropped further in China and also edged down in Southeast Asia. India was, once again, the main theatre for large-scale business. Importer RCF bought 35,000 tonnes of 15-15-15 from a trader at $343.50/t cfr (duty unpaid). Although European NPK trade has been picking up, this has mainly been in truckloads with buyers limiting themselves to hand-to-mouth volumes on the expectation of further price decreases.

Key market drivers: Indian fertilizer importer and producer Fact has downsized its 35,000-45,000 tonne tender request for 15-15-15 to a fixed 35,000 tonne volume and postponed the tender's closing date to 27th June. Overall, India is continuing to restock NPs and NPKs with significant year-on-year import and production increases in May. EU import duties on ammonia and urea again came into effect on 17th June after a six-month suspension.

Sulphur: Prices softened further in key trading regions in late June amid low demand and ongoing contract negotiations. Bids in a range of $62-68/t f.o.b., for example, were reported for the most recent Qatar 35,000 tonne spot sales tender for July lifting. Initial Middle East contract negotiations with traders for supply from the UAE in the third-quarter are said to have been concluded at $65/t f.o.b., a drop of $52/t on the high end in the second-quarter.

Key market drivers: Lower bids in the low-to-mid $60s/t f.o.b. in the Middle East against the latest sulphur spot tender. In China, offers fell below $85/t cfr to south China and below $90/t cfr river. First contracts with traders for third quarter sulphur supply from the UAE emerging at $65/t fob.

OUTLOOK

Urea: Although farm-level demand is set to fall to its weakest point annually over the next few weeks, bouts of short-covering and the risk of rising energy prices could reverse this trend. On the supply side, several production plants are due to return from planned shutdowns and unplanned outages.

Ammonia: Supply in southeast Asia looks tight for the coming weeks. Further declines in Chinese domestic prices could, however, alter the region's supply/demand balance in August. While prices in Europe look stable currently, further gas price spikes pose a potential upside risk.

Phosphates: Improving crop affordability ratios are stoking demand in the US and Brazil. The Nola benchmark is set to maintain its premium due to lower inventory levels. The discount on MAP cfr Brazil, relative to major markets in the east, should reduce as the import season takes off. Brazil's imports remain at record levels and warehouses are well-stocked. Looking ahead, there is an expectation that the India DAP cfr price will slip below the Brazil MAP cfr level, given Indian inventory levels and DAP imports above four million tonnes so far.

Potash: More demand for the safra season should emerge in Brazil in the coming weeks, helping to stabilise prices. Elsewhere, market players are still searching for a price floor in some regions, although some price stability is emerging in southeast Asia.

NPKs: Prices are set to slide further, as suppliers try to convince buyers to take significant volumes instead of purchasing smaller lots back-to-back.

Sulphur: Spot market price expectations have eroded further, with initial third-quarter supply contracts at lower levels and increasing oversupply globally. DAP and MAP producers are also failing to lend market support, as these major fertilizer market buyers of sulphur are producing at low operating rates. This is leaving sulphur tonnes available, particularly west of Suez.

Fertilizer Industry News

UNITED KINGDOM

New Yorkshire fertilizer plant

Yara International is to build a major new speciality fertilizer and biostimulant production plant near York.

The new plant will double production capacity for the company's YaraVita product range and is expected to be operational by the end of 2025. It will also provide Yara with the option to expand production capacity further in future, if required.

Virtually all the plant's output will be exported to overseas markets.

The new plant will be located close to the company's existing Pocklington site in Yorkshire in the UK. Pocklington is Yara's UK head office and its global centre for the development and production of the YaraVita range of foliar and micronutrient fertilizers.

The new production plant will increase Yara's footprint in the speciality fertilizer segment, one of the fastest growing markets for agricultural inputs. Speciality products are designed to increase crop yields and improve crop quality.

"Sales of YaraVita specialty crop nutrition products and biostimulants have grown fivefold in the last 20 years. These products are formulated to meet the specific needs of crops throughout the growing season and to help them increase their resilience to climate change," Yara said in a statement.

It added: "Specialty nutrients provided by foliar fertilizers – applied to the leaf or fruit – are just as vital for crop growth and quality as nutrients applied to the soil via traditional mineral fertilizers. Biostimulants for plants are just like taking vitamins for humans. This helps the plants adapt better to climate change and improve nutrient use efficiency,"

The efficacy of YaraVita products has been demonstrated through their use in around 3,000 crop trials. Their application generally resulted in higher crops yields, these typically increasing by 3-8 percent and, in some instances, by as much as 30 percent. Farmers benefit from the resulting yield and crop quality improvements through higher profitability and a greater return on investment.

The global market for speciality fertilizers is projected to grow at nearly seven percent per annum (p.a.) between 2022 and 2027, according to MarketsandMarkets. The biostimulants market is growing even faster – at more than 12 percent p.a. from 2018 to 2030 – DunhamTrimmer estimates.


PHOTO: YARA

Testing new fertilizer technologies at Yara's Pocklington site in the UK.

"Our specialty crop nutrition products help farmers increase yields and quality without increasing land use. That not only benefits farmers but is also good for the planet," said Mónica Andrés Enríquez, Yara's EVP for Europe.

"It's no wonder that this market is growing exponentially. Amid today's food security and climate change challenges, it's more important than ever to feed the world with nutritious food while also protecting the planet," she added.

"Specialty crop nutrition products are complementary to traditional mineral fertilizers and are crucial for achieving balanced crop nutrition. Although only needed in small amounts, they can make a big difference for farmers and are critical to ensure a lower carbon footprint for food production by increasing yield per unit of land," said Rejane Souza, Yara's SVP for global innovation.

Yara has operated in the UK since 1843 under a series of different company names – including Fisons, Norsk Hydro and Hydro Agri – following various mergers and acquisitions.

The Pocklington site has been active since 1967 and currently produces YaraVita products for distribution and sale in over 60 countries. Yara's uses the UK site as a centre for production, product development, soil/plant analysis and agronomic advice. ■

EUROPE

European ammonia production struggles to compete

Europe's domestically-produced ammonia remains uncompetitive with ammonia imports, Argus reported at the start of May, even as European gas prices fell to their lowest level in two years.

In early May, the front-month contracts for natural gas at the Dutch TTF, Europe's most traded gas hub, closed below €35/MWh for the first time since July 2021. This contract price has fallen by more than half since the start of the year, standing at around €32/MWh at the end of June, some 90 percent below its all-time high of €319/MWh in August last year.

While these drastic European gas price falls have led to major reductions in domestic ammonia production costs, ammonia import prices have fallen even further, reports Argus, meaning it is still more economical to import ammonia into Europe than to produce it domestically.

European fertilizer production economics have yo-yoed over the last two years. While domestic ammonia production did briefly become competitive with imports earlier this year – having been largely uneconomical during the second-half of 2022 (*Fertilizer International* 510, p8) – ammonia imports again become cheaper than domestic production from mid-March onwards.

This situation, by favouring imports into Europe, has once again led to regional production curtailments during 2023's second-quarter. Yara, Europe's largest ammonia producer, announced it had curtailed 2.8 million t/a of ammonia capacity – equivalent to 58 percent of its European total – as of the end of April. Consequently, around 3.8 million t/a of Yara's finished fertilizer production was also curtailed as a result.

The Norwegian fertilizer giant made the decision to take its 600,000 t/a capacity Ferrara ammonia plant in Italy offline, just three weeks after bringing it back online following a nine-month shutdown. The company also scheduled a planned maintenance shutdown at its 383,000 t/a

capacity Tertre ammonia plant in Belgium in the second quarter.

In comments accompanying its latest financial results, Yara said it will "use its global sourcing and production system to import ammonia to Europe and supply global customers where possible". Yara has the ability to import ammonia into the region, and therefore limit its production costs when gas prices are high, because its European production plants are located close to ports facilities.

The 2.8 million t/a of ammonia capacity idled by Yara at the end of April equates to an annual cut in gas consumption of just under 2.5 billion m^3, calculates Argus. Across Europe, this would translate into a gas demand cut of just over 10 billion m^3/a, suggested Argus, if the 42 percent operating rate at Yara's plants were mirrored by the EU's entire ammonia production capacity of 19.6 million t/a .

There is only a weak chance of a revival in ammonia demand during the third-quarter of 2023, according to Argus.

"Seasonally low third-quarter demand makes it unlikely that there will be an uptick later this summer. The significant fall in ammonia production costs in recent months has only spurred a small amount of additional demand in Europe, India and China," Argus said.

Argus, in its recent ammonia outlook, was instead forecasting an oversupplied market this summer, once the 1.3 million t/a capacity Gulf Coast Ammonia plant in Texas begins production in July.

While global fertilizer demand is normally at its lowest in the third-quarter, ammonia buying should pick up around September, said Argus, in readiness for the autumn application season.

UNITED STATES

Extra $400 million for fertilizer production expansion

The United States Department of Agriculture (USDA) has announced a massive funding increase for its Fertilizer Production Expansion Program (FPEP).

"Due to the strong demand for funding, the Commodity Credit Corporation is providing up to $400 million in additional FPEP funding to finance even more projects that will promote competition in agricultural markets," USDA said in a statement on 23rd June.

USDA had previously allocated $500 million in funding for the FPEP. The programme's first two funding rounds generated immense interest and were heavily oversubscribed, receiving applications valued at approximately $3 billion from 350 businesses.

"The rapid increase in the cost of critical inputs like fertilizer is only the latest example of why we must invest in strong, domestic agricultural supply chains," said Tom Vilsck, USDA Secretary. "The FPEP not only increases fertilizer production and improves competition, but also creates new opportunities for American businesses and is one of the many ways that the Biden-Harris Administration is making long-term investments to strengthen our supply chains."

USDA also announced in June the award of $30 million in grants under round one of the FPEP. These grants will help US farmers in Florida, Iowa, Louisiana, Minnesota, Montana, Texas and Wisconsin access extra supplies of domestically-produced fertilizers.

The seven winners were selected from 21 round one projects shortlisted by USDA in January. Examples include:

- **Black's Valley Ag Supply Inc** will build a new dry fertilizer production plant and storage unit in Durand, Wisconsin. The production plant will increase the company's annual fertilizer production by 33 percent.
- **Farmer's Union Oil Company** will expand a fertilizer processing plant in rural Montana. This project will increase the supply of local and affordable fertilizers within a four-county region, while creating several local jobs.
- **Progressive Ag Cooperative** will construct a dry fertilizer plant that serves cooperative members from northern Iowa and southern Minnesota.

Additionally, USDA invited public comments on 66 projects eligible for grants under the FPEP's second round. The department will only fund projects if they adhere to federal policies that protect the environment and historic properties. USDA expects to announce the round two FPEP finalists in the coming months, once this public consultation has been concluded.

Stamicarbon secures green ammonia plant contract

Stamicarbon has signed a license agreement with a US customer to develop a basic engineering design package for a 450 tonne per day green ammonia plant.

The plant will produce green ammonia as a feedstock for nitrogen fertilizers. It will incorporate Stami Green Ammonia technology and is expected to start up in 2026.

The name of the customer has not been disclosed but is said to be a prominent North American fertilizer producer.

The Stami Green Ammonia process produces low-carbon ammonia by generating hydrogen from water electrolysis using renewable energy, instead of via conventional steam methane reforming. This is then combined with nitrogen derived from the air.

This innovative technology, by offering a sustainable and competitive alternative to conventional 'grey' ammonia production, paves the way for green fertilizer production from renewable energy sources.

"Stami Green Ammonia is at the heart of Stamicarbon's innovation program, and we are excited to see this technology implemented in several projects around the world," said Pejman Djavdan, Stamicarbon CEO. "It represents a significant leap forward for the production of green fertilizers based on renewable resources."

Alessandro Bernini, the CEO of Maire, Stamicarbon's parent company, said: "Stami Green Ammonia technology, using renewable energy instead of fossil fuels, represents an important step forward in achieving the fertilizer industry's goals of sustainable, carbon-free solutions. This important milestone further confirms Maire's role as a leading technology integrator and enabler of the energy transition globally."

Successful Fort Dodge ammonia plant revamp

Koch Fertilizer has performed a $140 million revamp at its Fort Dodge, Iowa, ammonia plant. The investment is expected to increase annual ammonia production capacity by 85,000 tons, as well as improve the plant's reliability and its environmental and safety performance.

The revamp was delivered by thyssenkrupp Uhde and Johnson Matthey working in collaboration. A joint team from both companies carried put a project to install the uhde® dual-pressure process upstream of the existing ammonia synthesis loop.

To achieve the additional production capacity, process experts from thyssenkrupp Uhde developed a new cartridge insert for the existing pressure shell. This incorporates the latest process design principles.

Most of the installation work for the revamp was carried out while the existing plant was running. Commissioning of the new uhde® ammonia converter also ran smoothly with no delays, thanks to on-site support from Johnson Matthey.

For this revamp project, a key challenge was increasing ammonia capacity while coping with the very low ammonia synthesis operating pressure (960 psig/66 barg). This was solved by combining Johnson Matthey's high-performance catalyst KATALCOTM 74-1 with an adapted process design from thyssenkrupp Uhde.

The highly efficient combination of the uhde® dual pressure process and KATALCOTM 74-1 catalyst installed at Fort Dodge is already used elsewhere at some of the world's largest ammonia plants – these operating with annual production capacities of more than one million tonnes.

"We have worked hand in hand with our customers and our partners at Johnson Matthey to make this happen," said Thore Lohmann, executive director fertilizer & methanol at thyssenkrupp Uhde. "With our engineering and plant building expertise, we have ensured a smooth integration of the uhde® dual pressure process. The same approach can be applied in many other plants as well."

EGYPT

EPC contract for Aswan ammonium nitrate plant

KIMA has awarded an engineering, procurement and construction (EPC) contract by for a nitric acid and ammonium nitrate plant to a joint consortium of Tecnimont and Orascom Construction. The new plant will be constructed at KIMA's existing nitrogen complex in Egypt's Aswan Governorship.

The scope of work includes project engineering and the supply of materials and equipment, as well as construction activities to be carried out by Orascom Construction. The lump sum, turn-key contract is worth $300 million, with about $220 million of this amount covering Tecnimont's contribution to the project.

The 600 t/d of nitric acid generated by the new plant will be fully dedicated to the production of 800 t/d of granulated, fertilizer-grade ammonium nitrate. This will be sold domestically to Egyptian farmers and exported to international markets.

This latest nitrogen project follows the successful construction and start-up of a large-scale ammonia and urea plant by Tecnimont and Orascom Construction for KIMA at the same Aswan site in 2020.

Alessandro Bernini, CEO of Maire, Tecnimont's parent company, said: "We are really honoured to keep on supporting a prominent player such as KIMA in the development of the Egypt's fertilizer value chain. With this award we further consolidate a long-lasting, fruitful relation and strengthen our industrial footprint in North Africa, thanks to our strong capability in executing EPC projects."

Completion of the project is currently scheduled for the first half of 2026. The finalisation of the EPC contract is, however, dependent on KIMA successfully securing a financing package.

BULGARIA

Agropolychim to double its fertilizer capacity

Casale have signed an agreement with Agropolychim to double the company's annual production capacity for ammonium nitrate (AN), calcium ammonium nitrate (CAN) and urea ammonium nitrate (UAN) to 1.5 million tonnes.

Casale and Agropolychim celebrated more than 50 years of successful partnership in May with a new agreement to license and engineer a new nitric acid plant.

To achieve this, Casale will license and engineer a new state-of-the-art dual pressure nitric acid plant. The new plant is expected to be commissioned by the end of 2027. It will also maximise the on-site use of green energy.

The expansion project is part of a planned investment of €250 million by Agropolychim in its business over the next five years. The company is seeking to strengthen its strategic position as one of world's only carbon-neutral fertilizer producers. Agropolychim believes the new investment will place it at the forefront of low-carbon fertilizer and ammonia production in south-eastern Europe.

The latest project marks more than 50 years of successful partnership between Agropolychim and Casale. Agropolychim has been operating a dual pressure nitric acid plant based on the Swiss licensor's technology since 1973. This is a testament to the reliability, ease of operation and safety of its technology, commented Casale.

In 2004, Agropolychim also pioneered the introduction of N_2O abatement technology in nitric acid production – long before it became the European norm. The example set by Agropolychim has subsequently led to the reduction of millions of tonnes of CO_2 emissions (equivalent), ensuring that European plants have since become the world's 'cleanest' nitric acid producers.

Agropolychim's new nitric acid plant, with its dual pressure technology, sustainable design, negligible emissions and zero effluents, will far exceed current European standards, according to Casale.

Since 2018, Agropolychim has been generating 36 MWh of steam for its process needs from biomass energy. This 'green' power source allowed the company to maintain its production at above 100 percent of rated capacity during 2022, despite the gas crisis that caused widespread curtailments elsewhere in Europe (*Fertilizer International* 510, p8). Biomass energy has also enabled Agropolychim to cut its natural gas consumption by 98 percent over the last five years.

Casale says its nitric acid technology and equipment know-how will maximise the on-site availability of this green energy.

CHINA

UAS granulation plant for Xinjiang Xinji Energy

China Tianchen Engineering Corporation, one of China's leading engineering and contracting companies, has selected Casale's fluid bed urea ammonium sulphate (UAS) granulation process for a new project for Xinjiang Xinji Energy and Chemicals Co Ltd.

The pioneering venture – known as the Recycling Economy Joint Chemical EPC project – will construct a UAS plant in Tiemenguan city, Xinjiang, China. It will be the first application of Casale's UAS granulation process in China.

Casale is providing the project with process design package (PDP) services and a license for its patented UAS granulation process. The company will also supply proprietary equipment needed by the Xinjiang plant.

The flexible design of Casale's process will allow the new plant to produce UAS with a variable ammonium sulphate content of up to 20 percent. The granulation unit will have a production capacity of 1,800 t/d for UAS when operating at maximum ammonium sulphate content.

"Both parties are pleased to contribute to the development and promotion of fertilizer production diversification in China with the first application of the UAS process in this country," Casale said in a statement.

The new plant is scheduled to be commissioned by 2025.

Canpotex secures potash supply agreement

Canpotex reached an agreement with China's potash buying committee in early June for the supply of standard-grade potash. This covers potash shipments to China by the Canadian potash export consortium until the end of December 2023 at a price of $307/t on a cost and freight (cfr) basis.

"China is an important market for Canpotex, and we're pleased to reach an agreement with China's potash buying committee," said Gordon McKenzie, Canpotex president and CEO. "We look forward to continuing our support of food security in China by providing our customers there with a reliable and stable supply of potash as China's agriculture sector continues to grow."

The volumes of potash that Canpotex will supply to China this year under the agreement have not been disclosed.

TAIWAN

SABIC Agri-Nutrients ships blue ammonia to Taiwan

SABIC Agri-Nutrients Company (SABIC AN) has sent its first commercial shipment of low-carbon ammonia to the Taiwan Fertilizer Co (TFC).

SABIC AN, a public joint-stock company, is 50.1 percent owned by the Saudi petrochemicals and mining giant SABIC.

Commenting on the 5,000 tonne shipment of 'blue' ammonia to Taiwan, Abdulrahman Shamsaddin, the CEO of SABIC AN, said, "The shipment of low-carbon ammonia reflects our commitment to delivering low-carbon solutions to our customers and helping them achieve their net-zero targets in various areas such as clean energy transitions and low carbon chemicals/fertilizer solutions. We have already delivered such shipments to several markets such as Japan, South Korea, and India in line with our aspirations to become a leading player in the low-carbon ammonia market."

Dr Huang Yao Hsing, the CEO of the Taiwan Fertilizer Co, added: "TFC has been devoting itself to all possible solutions to achieve the ultimate goal of net zero for years and the arrival of this low-carbon ammonia shipment is a significant milestone to be recorded. By supplying it to the downstream industries including fertilizers and chemicals, low-carbon ammonia presents one of the best solutions to pursue carbon neutrality and as the leading supplier of ammonia in Taiwan, we have the responsibility to introduce it to the market." ■

ERRATUM

Nutrien's Smart Nutrition™ MAP+MST® product was misspelled in the *Delivering sulphur nutrition* feature in our March/April magazine (*Fertilizer International* 513, p33) due to an error in the source document. We'd like to apologise to Nutrien for this misspelling. You can read more about this innovative product on page 41.

People


PHOTO: IFA

Tony Will of CF Industries is IFA's new chair.

Tony Will, the president and CEO of CF Industries, is the new chair of the International Fertilizer Association (IFA). He was elected in June alongside a number of other executive board members and board directors.

"I am honoured to serve as Chair of IFA and help advance this vital organization's mission to promote the efficient and responsible production, distribution and use of plant nutrients," Will said. "Our industry is at the forefront of some of the world's most important challenges, from food security to climate change. I look forward to working with our members and the IFA team to continue our leadership role in addressing these global priorities, collaborating not just within our own industry but with government and other stakeholders as well."

Jeanne Johns, the former managing director and CEO of Incitec Pivot Ltd, was elected as IFA's new vice chair. Both Will and Johns will serve on the executive board of IFA, which also welcomed two further new appointments: **Ahmed El Hoshy**, CEO of OCI Global and Fertiglobe, and **Abdulrahman Shamsaddin**, CEO of SABIC Agri-Nutrients.

Svein Tore Holsether, president and CEO of Yara, remains on the executive board as immediate past chair, along with **Raviv Zoller**, president and CEO, ICL Group and **Alzbeta Klein**, IFA's director general.

"Helping to feed the world sustainably is at the core of what we do, and IFA is fortunate to have such seasoned executives on our board," Klein said.

Five new board directors were also elected by IFA's membership:

- **Robert Wilt**, CEO, Ma'aden
- **Maen Nsour**, President and CEO, Arab Potash
- **Julian Palliam**, president and CEO, Foskor
- **Yasser Alabassi**, President, GPIC
- **Wang Bei**, General Manager, CNAMPGC Holding Ltd Co.

IFA members also re-elected **David Delaney** of Itafos and **Suresh Krishnan** of Adventz to the board of directors.

Lars Røsæg, Deputy CEO of Yara International and its EVP for corporate development, will leave the company by the end of 2023. His is taking up a new position as an investment partner at Norwegian firm Salvesen & Thams.

"I'd like to thank Lars for his strong contributions to Yara's progress and our close professional collaboration over many years and wish him the best of luck in his new position," said Svein Tore Holsether, Yara's president & CEO.

"Serving in Yara's management under Svein Tore's leadership has been the greatest privilege of my career, and Yara's strategic direction and organizational capacity puts the company in pole position for the future. After nearly five years as a member of the executive team I have decided that it's time to take on a new challenge and take my career in a different direction," said Lars Røsæg.


PHOTO: YARA

Pål Hestad has stepped down from Yara's executive board but retains a leadership role.

Johan Labby was also appointed as Yara's EVP for global plants & operational excellence at the start of July. He replaces **Pål Hestad** who has stepped down from the company's executive board but remains in a leadership role within Yara.

As of 1st July, Yara International's executive board will now have the following members:

- **Svein Tore Holsether**, President and CEO
- **Mónica Andrés Enríquez**, EVP Europe
- **Chrystel Monthean**, EVP Americas
- **Fernanda Lopes Larsen**, EVP Africa & Asia
- **Kristine Ryssdal**, EVP & general counsel
- **Lars Røsæg**, EVP corporate development & deputy CEO
- **Thor Giæver**, EVP & CFO
- **Solveig Hellebust**, EVP people, process and digitalization
- **Johan Labby**, EVP global plants & operational excellence.

Calendar 2023/2024

JULY

11-12
IFA Global Markets Conference,
LONDON, UK
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

OCTOBER

2-3
TFI World Fertilizer Conference,
WASHINGTON DC, USA
Contact: Valerie Sutton
Tel: +1 202 962 0490
Email: vsutton@tfi.org

10-12
IFA Crossroads Asia-Pacific,
BANGKOK, Thailand
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

17-19
Argus Fertilizer Europe Conference,
LISBON, Portugal
Contact: Argus Media
Tel: +44 (0)20 3923 0741
Email:
conferencesupport@argusmedia.com

FEBRUARY 2024

5-7
Argus/CRU Fertilizer Latino Americano 2024, MIAMI, Florida, USA
Contact: Argus Media
Tel: +44 (0)20 3923 0741
Email:
conferencesupport@argusmedia.com

26-28
CRU Phosphates 2024 Conference & Exhibition, WARSAW, Poland
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup.com

Who's who in fertilizer handling and precision blending

An overview of the very latest in fertilizer handling and blending, including new contracts, company news and advances in technology.

BEDESCHI

The fertilizer handling experts

Andrea Vitturi, chief R&D and engineering officer

Bedeschi is a well-established supplier of crushing and handling machines for cement, steel, coal, the mining sector and other industries. The Italian industrial manufacturer moved into the marine sector 15 years ago and now offers a range of large-scale onshore shiploading equipment. Due to its experience and know-how, the company has continued to set the standard for fertilizer bulk handling – offering turnkey solutions for every type of fertilizer.

Strong growth in fertilizer trading and shipments is expected in response to a rising global population. This will be required to meet the growing need for crop nutrients as agricultural production expands to keep the world fed and food supplies secure.

The Covid-19 outbreak negatively affected the fertilizer industry, similar to other segments of the bulk handling industry, with significant downtime during the lockdowns of 2020 and 2021. Despite this, the fertilizer market has stabilised over the last 18 months as production and demand have recovered.

The challenge when handling fertilizers is their corrosive nature and their tendency to breakdown easily, generate dust and – because they are hygroscopic – absorb water. To counteract this, Bedeschi always puts in place a range of measures to preserve the integrity of fertilizer materials. When it comes to handling machines, for example, the company uses materials that resist attack, such as stainless steel, plastic components made of glass-reinforced plastic (GRP), or high-durability paint for structural parts, since fertilizers are highly corrosive.

PHOTO: BEDESCHI

Bedeschi shiploader being transported to Yara's quay at Sluiskil in the Netherlands.

Because they break relatively easily, it is essential to guarantee the gentle treatment of fertilizer granules during handling and, by avoiding dust generation, also ensure that the highest environmental standards are being met. Bedeschi therefore pays extra special attention to loading chutes. This includes performing in-depth studies.

The company's controlled-flow chutes, for example, are designed to keep loading speeds within acceptable values during vessel loading, and also limit the drop height to avoid degradation in cargo quality. In addition, to avoid dust generation during handling, the choice of the chute is also extremely important. For dust control, Bedeschi therefore recommends the use of pipe conveyors or enclosed conveyors and dust suppression systems, according to the cargo being handled.

Fertilizers are hygroscopic materials, as previously stated, so protecting them from water or rain is extremely important

too. This is another reason why Bedeschi always uses enclosed conveyors or pipe conveyors when handling fertilizers.

Thanks to the achievements of its R&D department, and its focus on green technologies, Bedeschi can design state-of-the-art handling systems and environmentally-friendly solutions that fully meet client needs.

Bedeschi has demonstrated the quality of its fertilizer handling equipment through its long-term collaborations with industry giants such as Yara International (*Fertilizer International* 491, p30) and OCP Group. Notable examples of recent fertilizer and sulphur sector contracts are provided below.

QatarEnergy, Qatar

Bedeschi is to supply new sulphur-handling equipment to the NXFP sulphur project (*Fertilizer International* 514, p12).

This follows QatarEnergy's award of a $600 million construction contract to the project's joint venture partners, Spain's Técnicas Reunidas (70%) and China's Wison Engineering (30%) in April last year.

The NXFP project will process and extract sulphur from liquefied natural gas (LNG) for export at Qatar's Ras Laffan Industrial City (RLIC) complex. The project's new sulphur plant has the capacity to process around 5,000 t/d of molten sulphur.

As part of a large-scale and comprehensive supply and engineering contract with Técnicas Reunidas and Wison Engineering, Bedeschi will supply:

- Six conveyor belts with a total length of 1,400 metres with a capacity of 550 t/h, including galleries and transfer towers
- Four conveyor belts with a total length of 480 metres with a capacity of 2,000 t/h, including galleries and transfer towers
- One conveyor belt with a total length of 120 metres with a capacity of 3,700 t/h, with a gallery and transfer tower
- Two trippers with a capacity of 550 t/h
- A double arm portal reclaimer with a capacity of 2,000 t/h

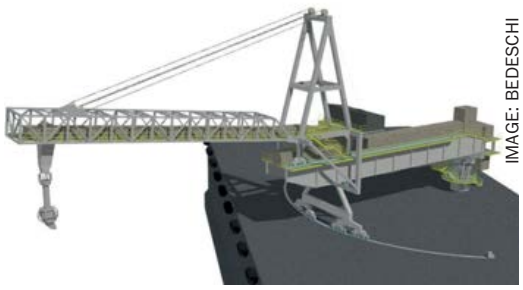


IMAGE: BEDESCHI

Bedeschi is supplying a radial ship loader to the NXFP sulphur project in Qatar.

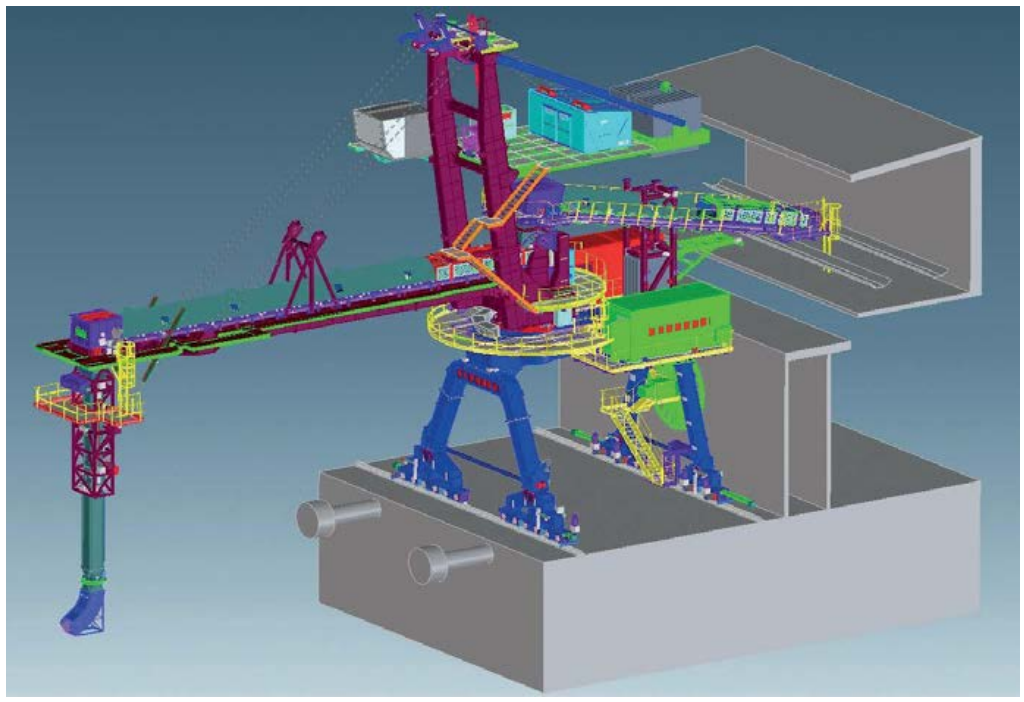


IMAGE: BEDESCHI

Schematic of Bedeschi's new shiploader for Fertil at Ruwais terminal.

- A travelling slewing shiploader with a capacity of 2,000 t/h
- A radial shiploader with a capacity of 3,700 tonnes per hour (see schematic).

Fertil, Ruwais, Abu Dhabi

Bedeschi is supplying a new 1,200 t/h capacity shiploader for Fertil's Ruwais terminal in Abu Dhabi (*Fertilizer International* 510, p10).

The tailor-made 'luffing and slewing' type shiploader (see schematic) will be delivered on site fully constructed. Installation of the new shiploader will not disrupt Fertil's operations at Ruwais.

The new machine will replace the existing shiploader used for fertilizer and granular urea loading operations at the terminal. It runs on rails and uses a towed tripper to divert product from a wharf gallery conveyor onto the transfer belt that supplies the loading boom belt.

The machine's design, engineering and construction are all based on Bedeschi know-how and have been customised to meet Fertil's requirements – with the specific design and performances characteristics developed jointly with the client's technical team.

OCP, Phosboucraa, Morocco

Phosphate production giant OCP has awarded long-term partner Bedeschi a new engineering, procurement and construction (EPC) contract for its Phosboucraa production complex, 30 kilometres from Laayoune (*Fertilizer International* 511, p11).

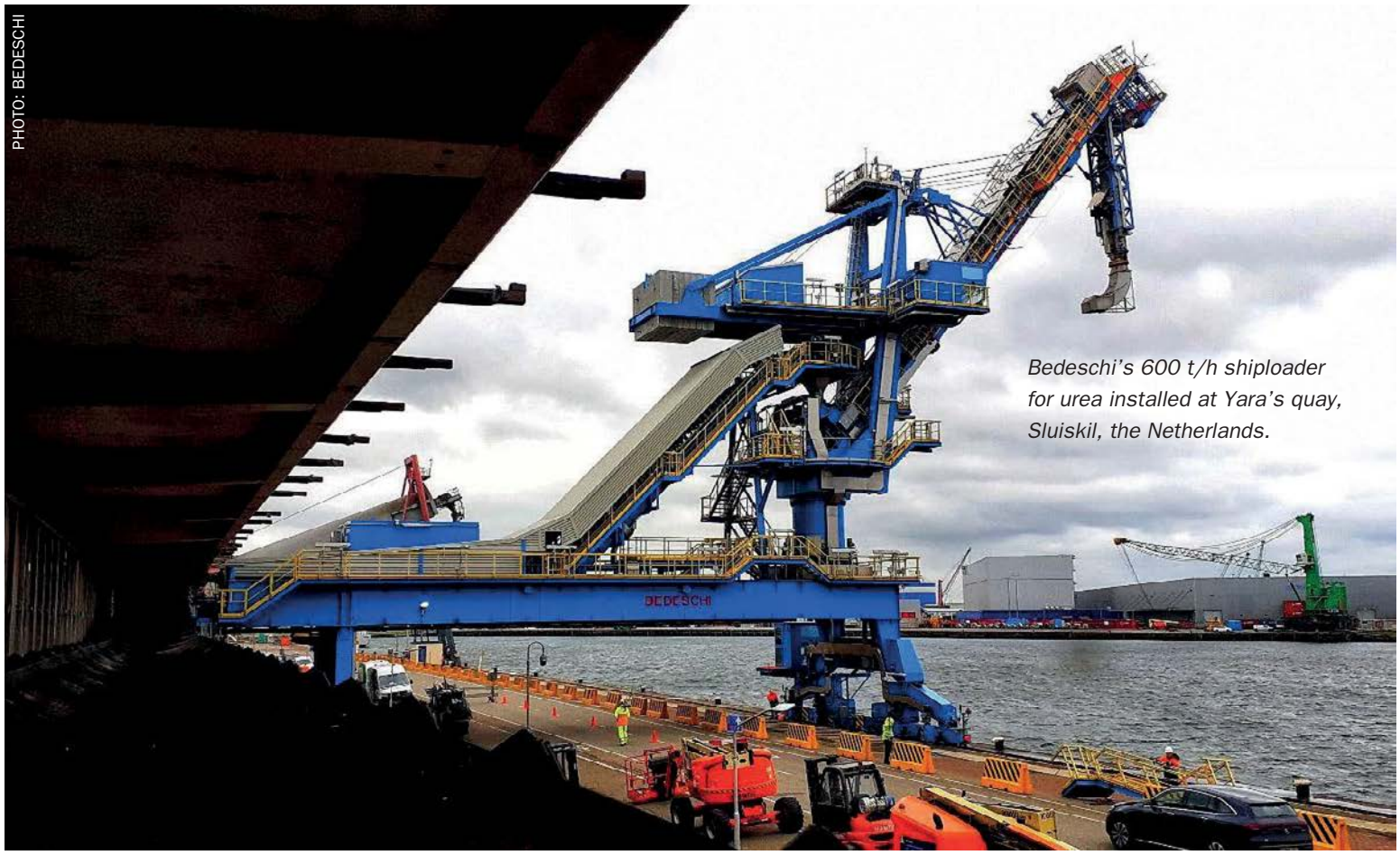
Bedeschi will supply three new automated bulk handling and storage systems with a combined annual capacity of 300,000 tonnes. Two of these will handle fertilizers for export while the other will handle imported sulphur.

The bulk handling equipment installed at Phosboucraa as part of the contract will include three trippers, three reclaimers, and six conveyor belts with a capacity of up to 2,000 t/h. These items are similar to those already supplied and installed by Bedeschi at OCP's massive Jorf Lasfar phosphate complex in Morocco (see photo below).

The new contract is of strategic importance to OCP and its development plans for the country's 'southern axis'.

PHOTO: BEDESCHI

A Bedeschi 2,400 t/h fertilizer reclaimer installed at OCP's Jorf Lasfar complex in Morocco.



Bedeschi's 600 t/h shiploader for urea installed at Yara's quay, Sluiskil, the Netherlands.

The Bedeschi 1,000 t/h fertilizer shiploader installed at PT Petrokimia Gresik's Demarga jetty in Indonesia.

PT Petrokimia Gresik, Indonesia

Bedeschi has fulfilled an order with PT Petrokimia Gresik to supply a 1,000 t/h shiploader (SHL 25/1400) for use at the company's Demarga jetty, Gresik, Indonesia. This is now operational (see photo) and loading NPK and NPS fertilizers onto vessels of up to 30,000 dwt size.

The order was signed with Barata Indonesia, a local engineering company responsible for civil works at the jetty including the structural steelwork for the shiploader. PT Petrokimia Gresik has previously selected Bedeschi as its supplier for circular storage and longitudinal storage units at the Demarga site. These were fitted with PAL PD portal scraper reclaimers.

Yara, Sluiskil, the Netherlands

Bedeschi recently installed a shiploader to handle urea at Yara's Sluiskil plant in the Netherlands. Sluiskil is a major fertilizer production complex and the largest manufacturing site for ammonia and nitrate fertilizers in Europe.

The complex comprises of three ammonia plants, two nitric acid plants, two nitrate granulation plants and two urea plants, one for prilling and the other for granulation. The complex is located close to Antwerp with direct access to the North Sea.

A new slewing shiploader (SHL 28/1200) with a 600 t/h design capacity was manufactured by Bedeschi to efficiently load urea onto barges and shipping vessels under heavy duty conditions. The shiploader was recently transported from Mammoet's quay to Yara's quay at Sluiskil, travelling 1.5 kilometres in just 15 minutes using Matador 3, a floating sheerleg (see main photo).

The sandwich conveyor installed at Sluiskil is the project's main technological innovation. This high angle conveyor consists of two belts placed one on top of the other and gently conveys material inside an enclosed channel. The sandwich conveyor is positioned on the main gantry and runs along the high 40 degree incline between the jetty gallery level and the shiploader boom (see photo). This type of conveyor offers the following advantages:

- The ability to cope with a large change in slope over a small distance – overcoming the limitations of the maximum incline angle of conventional conveyors
- Improvements in environmental safety as the transported material is completely enclosed between two belt loops
- Its design and geometry makes spillages or dust emissions to the atmosphere highly unlikely.

The shiploader is now fully operative (see photo).

Bedeschi has a long history of cooperation with Yara, having previously installed:

- A 250 t/h capacity urea shiploader operating in France
- A 500 t/h capacity shiploader handling various fertilizer types operating in Italy
- A 500 t/h urea shiploader operating in Germany.

SACKETT-WACONIA

A focus on precision blending

Kelvin Feist, director of sales & marketing

Established in the United States 125 years ago, Sackett-Waconia has a long track record in the design and manufacture of fertilizer handling, blending and process equipment. The company, which was purchased by PVS Chemicals in April 2022 (*Fertilizer International* 508, p10), specialises in customised systems designed to match individual customer requirements.

Sackett-Waconia's blending systems and equipment can be found throughout North America and around the world. Its robust equipment is engineered specifically for the rigours of the fertilizer industry and is designed with a long service life in mind. The company specialises in designing and supplying complete systems for:

- Terminals
- Fertilizer blending, granulation and compaction
- Superphosphate production
- Coatings, both powders and liquids
- Water-soluble fertilizer blending.

Sackett-Waconia delivers safe, reliable, and efficient equipment with advanced automation to customers worldwide. The company's overall goal is to promote the sustainable use of fertilizers – through balanced nutrient use and better nutrient use efficiency – while maintaining production speed and never compromising on safety.

Sackett-Waconia offers many system designs and blending options to suit the varied requirements and locations of its customers. These range from tower blending systems, with in-floor reclaim systems and overhead storage, to its Precision Horizontal Blending system. The company's systems combine certified, static weighments with high-quality, high speed blending and, says Sackett-Waconia, have a greater accuracy than comparable declining weight or volumetric-based blending equipment.Sackett-Waconia's current focus is on advanced and automated Precision Fertilizer Blending® (PFB) systems. These are offered in two options:

- **AccuBlend™ systems:** These incorporate NTEP certified weigh hoppers, arranged horizontally, precise PLC-controlled dosing, and blending using either an HIM 2.0 precision mixer or orbital blender.
- **Precision Fertilizer Blending® (PFB) tower systems:** These offer an effective way to reduce the overall footprint of the blending system, and can vary in capacity from 90 ton mini towers to larger towers with 300+ tons of overhead storage capacity. The company's flagship line of towers featuring the HIM 2.0 precision mixer and Smart Blending™ system.

> **Sackett-Waconia blending installations can be found throughout Africa, the Americas and Oceania.**

The consistent, accurate and precise blends (NPKs plus micronutrients) produced by the company's equipment provide a balanced mix of nutrients to match soil-specific nutrient requirements. Sackett-Waconia blending installations can be found throughout Africa, the Americas and Oceania. Three recent projects are highlighted below.

AccuBlend system for Loyder, Sao Paulo, Brazil

Brazil's Loyder, part of the Essere Group, has commissioned a new 64,500 square foot (6,000 m^2) fertilizer plant. This is dedicated to the production of enhanced efficiency fertilizers and innovative products that improve plant resistance to abiotic stress.

Loyder placed a contract with our local Sackett do Brasil team to design and build an AccuBlend system with controls and automation – firstly at their Olimpia site, Sao Paulo, and then at nine other follow-on locations. An all-stainless AccuBlend with an HIM 2.0 precision mixer was chosen as the model for all 10 locations. This system has an overall bagging output of 60+ tons per hour, as specified by the customer.

Project specifications at a glance:

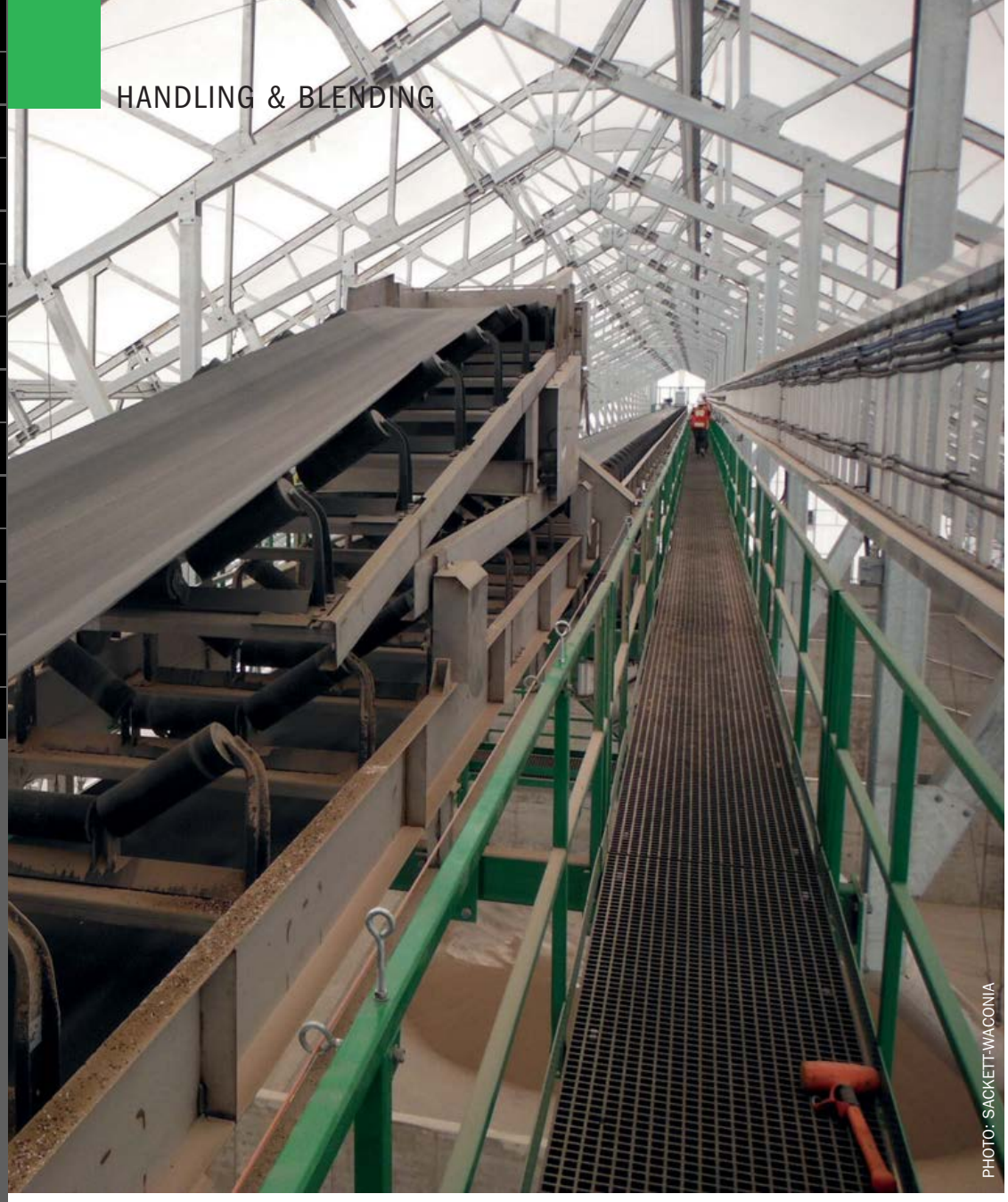
- Facility Size: 64,500 square feet
- Blending System: AccuBlend System with controls and automation
- Blender: HIM 2.0 precision mixer
- Capacity: 60+ tons per hour in 50 kg or 1,000 kg bags.

PFB Tower for Cargill in Alberta, Canada

Cargill's new plant in Camrose, Alberta, Canada, features the latest in Sackett-Waconia blending technology paired with high-speed receiving and wholesale operations. The system receives from rail or truck and transfers materials via belt conveyor and bucket elevator to a tripper conveyor. This configuration provides maximum filling within the bins. For loadout, the Precision Fertilizer Blending Tower® is fed


PHOTO: SACKETT-WACONIA

Receiving system at Loyder's Olimpia fertilizer plant, Sao Paulo, Brazil.



Tripper conveyor (750 tonne/hour) at Cargill's new blending plant in Camrose, Alberta, Canada.

Blending/bagging system installed for Beaty Fertilizer in Cleveland, Tennessee.

by an in-floor reclaimer. The materials are then conditioned before being loaded into the overhead storage.

The Camrose plant was designed for high-capacity operations while, at the same time, keeping the blending accuracy to an exact formula to support 4R Nutrient Stewardship and nutrient use efficiency.

Project specifications at a glance:

- Receiving System: 750 (+/-) tonnes per hour rail and truck receiving
- Blending System: PFB Tower with multiple loadout options operating in blend or wholesale modes
- Storage: 275 tonnes capacity overhead, in 12 bins (8 macro and 4 micro), and 4,100 tonne capcity wholesale bins
- Blender: 4.5 tonne (5 ton) HIM 2.0 precision mixer
- Handling capacity: 275 (+/-) tonnes per hour via 4 tonne batches
- Discharge: to trucks.

Compact PFB Tower for Beaty Fertilizer in Cleveland, Tennessee

Beaty Fertilizer purchased their first compact PFB tower from Sackett-Waconia in 2016. The company has since upgraded this, along with their receiving system, and added a second compact tower. The installation of the original tower raised operational capacity and led to a large improvement in product quality. The resulting uptick in business allowed Beaty Fertilizer to invest in an additional second tower – effectively doubling the company's blending capacity.

The new system is completely built from stainless materials and features a HIM 2.0 precision mixer. Beaty also chose an upgraded screener to increase system speed, together with expandable dosing that incorporates an NTEP certified weighing system.

PFB towers are designed to ensure the highly accurate individual weighing of materials and provide superior blending. These design characteristics support 4R Nutrient stewardship by ensuring the nutrient content of blended products – the 'right source' – fulfils customer specifications as closely as possible.

Project specifications at a glance:

- System: PFB Tower with expandable feed and pre-screening
- Storage: 10 ton weigh hopper
- Blender: HIM 2.0 precision mixer
- Discharge: To bagging
- Receiving System: 200 tons per hour, rail and truck.

EMT

Rising to the challenge of global project delivery

Zico Zeeman, commercial director

PHOTOS: EMT

EMT's 200-metre-long blending plant installed for ISAOSA in Topolobampo, Mexico, is one of the longest in the world.

Netherlands-based EMT is one of the world's largest fertilizer blending and bagging equipment producers. In recent times, the company has successfully delivered a variety of projects worldwide in highly challenging circumstances.

Each project came with its own unique set of hurdles that needed to be overcome. These included:

- A project that needed to install one of the longest fertilizer blend units in the world.
- A project that needed be delivered to a site almost exactly on the opposite side of the world.
- A project that needed to be fully mechanically engineered and tailor-made to fit into an existing warehouse.

EMT successfully overcame all of these challenges and, consequently, these project installations are now fully operational. In this article, we highlight three of their outstanding recent projects. These illustrate how EMT is able to put its 35 years of turn key factory experience into producing solutions that can help you with your project.

ISAOSA, Topolobampo, Mexico

EMT installed a state-of-the-art fertilizer blending factory for ISAOSA (Insumos y Servicios Agrícolas de Occidente S.A.) at the port city of Topolobampo in the Gulf of California, Mexico. Impressively, this is one of the longest fertilizer mixing lines in the world.

The completed machine is designed to operate at a capacity of 300 tonnes per hour and is more than 200 metres in length. This high capacity is achieved by running two lines in parallel. This ensures the blend quality is near perfect and also allows the machine to be filled by multiple front-loaders simultaneously.

In line with the latest advances in fertilizer treatment, a liquid inhibitor is applied as a direct coating to urea prior to blending. Initially, a conditioner is added to break up any lumpy urea material before the liquid is added via an injection point installed directly into a blending screw. By weighing both the urea conditioner and the inhibitor, the flow of both liquids is constantly monitored and adjusted to ensure the treatment of the end-product is exactly as required.

The complete blend line is computer controlled and can easily be operated with one operator from the central office. With this new machine line, ISAOSA can triple its annual production capacity to 300,000 tonnes.

Ballance, Whangarei, New Zealand

EMT has also installed a large mixing, bagging and bulk truck filling plant at Ballance's Whangarei Hub in New Zealand. This involved delivering, unpacking, assembling and then commissioning the contents of 15 high-cube, 40-foot long shipping containers on the other side of the world.

EMT installed a 17-hopper Weighcont blending machine for Ballance. This consisted of nine weighing hoppers each fitted with a specifically designed double-dosing cone that met the low input height of the existing equipment.

These double hoppers are filled using a large bucket shovel. The product assigned to these double hoppers is dosed with two dosing belts, ending up on a central conveyor.

As well as the nine double hoppers, EMT installed eight additional single hoppers with a single dosing belt. These are filled with product from big bags or from small bags weighing 25-50 kg.

The plant's central conveyor belt transports materials to a coarse sieve where lumps are removed from the product stream. These are broken down to the correct size by a lump breaker to ensure no product is lost.

After being conditioned this way, the product is transported to two parallel truck loading lines. These bulk-load the product into 48-tonne double-trailer trucks. These carry 24 tonnes in the first trailer with an additional 24 tonne trailer behind.

Both trailers are fully filled using a movable transport system located above the trucks. Alternatively, the product can be placed in big bags or small bags for onward transport to the farmer or distributor.

The decision to select EMT's Weighcont blender for the Ballance project was driven by the need for accuracy, efficiency and consistency in the mixing process – while still maintaining a high tonnage throughput of up to 250 tonnes per hour.

Atena, La Rochelle-Ceddex, France

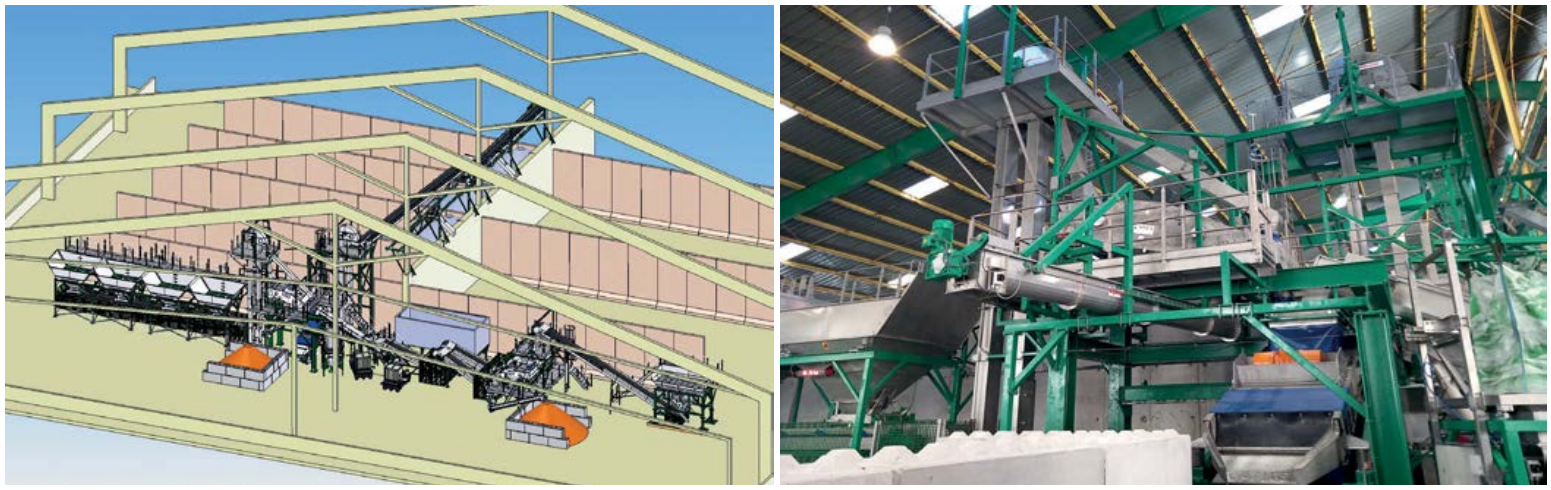
As well as delivering on challenging large projects, EMT was recently tasked by Atena with resolving its intricate handling and blending needs and translating these into a practical functioning machine line. Taking these difficulties into consideration, EMT went on to successfully install a state-of-the-art fertilizer production line for Atena at La Rochelle-Ceddex, France, in the first-quarter of 2023.

This machine line consisted of three parts:

- The urea coating-line
- The NPK-line
- The central blend and discharge line.

The urea-line starts with a 10.5-tonne weighing hopper equipped with a conditioner that breaks oversize material down to less than 15 millimetres. This line is flexible and can either screen-out dust or bypass this screening stage entirely and transport material direct to the coating unit instead. Within this unit, coating liquid is

EMT's 17-hopper Weighcont blending machine installed for Ballance in Whangarei, New Zealand.



PHOTOS: EMT

EMT successfully installed a state-of-the-art fertilizer production line for Atena at La Rochelle-Ceddex, France.

added to raw materials via the coating screw. The resulting product is then conveyed to the transport line.

The NPK-line starts with a four-hopper Weighcont blender. This transports material to an elevator where it is then directed to one of two lines: material is either screened for fines or instead bypasses this stage and is discharged directly onto the coarse screen.

Both NPK lines merge again on arrival at the coarse screen and are fed into the blending screw where powders or liquid can be added to the total blend. The final product is lifted by a second elevator onto a conveyor. Here, it is either distributed to the bulk bays, or to a bagging line located 70 metres ahead in the middle of the warehouse.

At EMT, we know that many factors must be considered with this type of fertilizer blending plant – particularly the characteristics of the raw materials and the required specifications of the final product. For the Atena project, these factors required the installation of two different treatment lines, this being necessary for coating one product before mixing the final blend.

As well as this, delivering the required capacity is crucial when designing production lines. For this project, for example, a double screen setup was chosen to enable the urea line to achieve the desired capacity of 120 tonnes per hour. With a double screen arrangement, the plant can operate at higher capacity as the screen is no longer a bottleneck in the process. ■

Biostimulants come of age

Kimitec's MAAVi Innovation Centre at Vícar, Almería, Spain, is Europe's largest R&D centre for natural farming products.

Biostimulants cover a diverse range of products designed to improve nutrient use efficiency and protect crops from abiotic stress. Growers generally purchase biostimulant products to improve crop yields and/or crop quality.

The main types of biostimulant (Table 1) include:

- Seaweed and other plant extracts
- Humic and fulvic acids
- Inorganic salts such as phosphites
- Chitin and chitosan
- Anti-transpirants
- Amino acids and peptides.

Many biostimulants are sourced from previously discarded industrial wastes, including sewage sludge, crustacean shells, and animal by-products.

Table 1: **Main types of non-microbial biostimulants**

Product type	Description
Seaweed extracts	Extracts include compounds such as polysaccharides and plant growth regulators (PGRs).
Humic substances	Humic or fulvic acid compounds extracted from decayed plant or animal material.
Phosphites	Inorganic salts including phosphites (PO_3)
Chitin and chitosan derivatives	Chitin is an abundant natural polysaccharide obtained from crustaceans. Chitosan is derived from chitin.
Anti-transpirants	Compounds such as abscisic acid and waxes which reduce transpiration by plants.
Protein hydrolysates and free amino acids	Protein hydrolysates are sourced from animal and plant residues. Free amino acids are obtained from the breakdown of agro-industrial by-products with enzymes.

Source: AHDB/Storer et al. (2016)

Most crop inputs such as pesticides and fertilizers are generally classified by their composition and function. Biostimulants are different. These products – due to the enormous variability in their chemical composition *and* physical properties – are defined solely by their function (*Fertilizer International* 493, p20).

Yet even defining the primary function of biostimulants has not been easy. The European Biostimulants Industry Council (EBIC), for example, carried out a year-long consultation before agreeing on the following functional definition:

"A plant biostimulant means a material which contains substance(s) and/or microorganisms whose function when applied to plants or the rhizosphere [soil] is to stimulate natural processes to benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and/or crop quality, independently of its nutrient content."

EBIC has argued for this practical definition because, in its view, this corresponds most closely to manufacturer claims about how biostimulants function and how growers view biostimulant products.

Importantly – as the EBIC definition suggests – the main function of biostimulants, despite their enhancing effects, is not to act directly as either pesticides or fertilizers. This distinction means that biostimulants have generally fallen outside of regulation or have been regulated differently to other agricultural inputs.

Interest in biostimulants has increased significantly over the last decade. To the extent that their use is now well established in higher value crops such as fruits, vegetables and potatoes. Increasingly, they are also being considered for broad acre crops – such as winter cereals and oilseed rape in the UK and Europe – although uptake remains limited (*Fertilizer International* 493, p20).

Previously, a lack of consensus and the absence of an agreed definition has undoubtedly held back the regulation of the biostimulants sector globally, although this is now beginning to change.

Application

Biostimulants are generally applied in one of three ways[1]:

- To crop leaves as a foliar spray
- To the soil – as a liquid (spray or via micro-irrigation) or in granular or powder form
- As a seed treatment.

Foliar applications predominate, accounting for around 70 percent of market sales by value, while seed treatments are the fastest growing of these three segments[1]. As well as being sold as standalone formulations, biostimulants are also being incorporated within other products. It is becoming increasingly common for biostimulants to be added to commodity and speciality fertilizers and marketed as a functional ingredient.

Biostimulants need to be correctly formulated due to compatibility issues. Chitosan, for example, is incompatible with seaweed extracts and humic acids, as it will flocculate[1].

Market size and growth

The global market for biostimulants (including microbial biofertilizers) was estimated at $2.56 billion in 2021, according to a recent report by S&P Global[1]. This compares to a market size of $2.32 billion in 2020 and $2.1 billion in 2019. The market is current growing at around 10 percent per annum.

Seaweed extracts make up the largest segment with a 40 percent market share equating to $935 million in 2021. Humic and fulvic acid products are the second largest market segment, being valued at around $843 million[1].

Biostimulant sales first began to take off in the early 2000s driven upwards by factors such as[1]:

- The development of more-effective products
- The ability to file patents to protect proprietary innovations
- The entry of venture capital and other investors into the market
- Better knowledge among growers
- New legislation to improve grower confidence.

Last year's record fertilizer prices, following Russia's invasion of Ukraine, also spurred demand – with some evidence suggesting farmers favoured biostimulants while cutting back on fertilizer expenditure. Whether this trend will continue as fertilizer prices fall remains to be seen.

Previously, lingering reputational doubts about biostimulants and, for some products, the paucity of evidence about their efficacy (*Fertilizer International* 493, p20) have acted as a drag anchor on the market. Especially when combined with a lack knowledge among both farmers and crop advisers about what is still an emerging product market.

Table 2: **Biostimulant effects on plant nutrition, growth/yield and stress tolerance: summary of the UK evidence base for cereals and oilseed rape.**

	Promote plant nutrition?			Improve plant growth and yield?			Promote biotic stress tolerance?	
Product type	Nitrogen	Phosphorus	Other nutrients	Hormonal	Growth	Yield	Pathogen	Pest
Seaweed extracts	🔴	🔴	🔴	🟡	🟡	🟡	🔴	🔴
Humic substances	🟡	🔴	🔴	🔴	🟡	🟡	⚪	⚪
Phosphite and other inorganic salts	⚪	⚪	⚪	🔴	🟡	🟡	🟡	⚪
Chitin and chitosan derivatives	⚪	⚪	⚪	🔴	🟡	🟡	🟢	🔴
Anti-transpirants	⚪	⚪	⚪	🟢	⚪	🟡	⚪	⚪
Protein hydrolysates and free amino acids	🔴	⚪	🔴	⚪	🔴	🔴	⚪	⚪

KEY

- 🟢 *Good evidence base (including multiple field-based experiments on cereals or oilseed rape).*
- 🟡 *Moderate evidence base (good number of experiments, including some field-based experiments on cereals or oilseed rape).*
- 🔴 *Low evidence base (principally laboratory-based experiments with little or no data on cereals or oilseed rape).*
- ⚪ *No evidence base (not enough evidence available).*

Source: Storer et al. (2016). AHDB Research Review No. RR89

ACADIAN PLANT HEALTH: CHANGING THE BIOSTIMULANT GAME

A global presence

Acadian Plant Health is a division of Acadian Seaplants Limited™ – the largest independent marine plant harvesting, cultivation, and extraction company in the world. Acadian is an international leader in biostimulants for both high-value and broad-acre crops. The company manufactures patented, science-based, innovative products with a focus on sustainability and regenerative agriculture.

With its patented seaweed technology – and its new corporate vision 'Sea Beyond' – Acadian is aiming to become a world-leading crop abiotic stress management company in the biostimulant sector. Its products are already applied to over 100 crop types in more than 80 countries worldwide.

R&D, sustainability and partnership

Acadian offers technological solutions for an agricultural production system already highly stressed by climate change. The company's science-based approach and extensive research and development activities are delivering a complex array of biologically active compounds which are extracted from the sea. These products improve plant establishment and growth, as well as crop resilience, in the face of stressors such as drought, heat, cold, salinity.

When applied to plants in specific formulations, these extracts have the capacity to modify the physiological processes in plants in a way that enhances nutrient uptake and utilisation. These bioactive compounds use chelation to help plants attract and absorb nutrients in the soil. This enables growers to use fertilizers more effectively, since more nutrients end up in the plant.

Acadian Plant Health products behave as active ingredients that either function on their own or work in synergy with other crop inputs. In particular, they are designed to deliver long-term benefits from regenerative agricultural practices.

Ascophyllum seaweed being commercially harvested with a rake, Scotland.

PHOTO: ACADIAN PLANT HEALTH

By simultaneously improving on-farm sustainability and boosting productivity, these products provide growers with a strong return-on-investment (ROI).

The company believes in the power of collaboration to accelerate agricultural sustainability and, consequently, is forging partnerships with leading agricultural industry businesses and innovators. Working closely with formulators, crop protection and fertilizer companies, Acadian's aim is to unite the best of its product portfolio with the best conventional crop inputs. This 'best of both worlds' approach enables the company's biostimulants to deliver stronger, high yielding crops in a sustainable manner.

Proven products

Acadian sums up its business ethos as follows:

"We believe what we must do as an industry is see beyond the current state of the agricultural inputs industry and offer solutions that provide high-value, crop productivity technology that shifts from a peripheral add-on to an essential component of sustainable agriculture. The world is changing, and we know things must change on a global basis.

"One company can't do it alone. We must work together to advance sustainability for the benefit of plant and planet.

"We believe it is possible to improve crop production management, while respecting the environment and society. We're dedicated to driving breakthrough innovations and proven products in crop care and nutrition." ■

Agronomic understanding is better for some biostimulant products than for others. Seaweed extracts are probably the most familiar biostimulant, as these algal products have been available on the market for many years. Phosphites are also relatively widely used and well-known to agronomists and growers[2].

While there is mounting evidence that many biostimulants can increase plant growth and yield (*Fertilizer International* 493, p20), definitive proof about other beneficial effects is often limited or incomplete (Table 2). Because of this, clear guidance on how to maximise benefits and achieve consistent results from biostimulants is generally necessary.

Regional consumption

Regionally, biostimulant consumption is segmented between the following four major end-markets[1]:

- Europe, the largest regional market for biostimulants, accounting for 38 percent of global sales
- Then Asia-Pacific, the second largest market, with 27 percent of global sales
- Followed by Latin America with 20 percent of global sales
- And finally North America in fourth place, with 13 percent market share.

In Europe, three countries – Spain, Italy, and France – are leading the way on biostimulant production and use, reports S&P Global[1], with the region's market dominance encouraging a strong biostimulants industry to flourish.

Researchers at Kimitec's MAAVi Innovation Centre at Vícar, Almería, Spain

PHOTO: KIMITEC

KIMITEC: A VISION BASED ON NATURAL PRODUCTIVITY

Kimitec, a Spanish-based multinational biotechnology company, first set out to offer natural alternatives to synthetic chemicals in agriculture more than 15 years ago – with a business model that places consumer health, respect for the environment and natural productivity at the heart of agricultural production. Now operating in over 90 countries, the company is dedicated to the research, development and marketing of biopesticides, biostimulants, prebiotics and probiotics for the farming industry.

Renowned product portfolio

Kimitec's established global presence and strong market position is supported by leading products, such as:

- The biostimulants Bombardier® and Batallón®
- The rooting enhancer Rhyzo®
- The prebiotics Prebiota Ultra™ and Xtender Row Ultra™
- The pure and highly concentrated mycorrhizal gel inoculant Mycogel®.

The company is also about to introduce its first natural biomiticide to the market. This innovative product offers protection against a broad spectrum of spider mites. It will be registered initially in the US this year and then introduced in Mexico and Brazil in 2024.

Committed to research and innovation

With an R&D team of more than 80 people and research investment totalling more than €20 million since 2013, research and innovation are at the heart of Kimitec. The company runs its own individual R&D projects as well as participating in major collaborative projects. Notably, Kimitec is the only European biotechnology company to have been awarded five projects by the EU's prestigious Horizon 2020 research programme.

Kimitec opened its MAAVi Innovation Centre® in 2019. This is Europe's largest R&D centre for natural farming products – and one of the largest biotech centres for natural agriculture in the world. MAAVi – an abbreviation of 'making a vision' – was set up to help deliver on the company's business ambitions, as set out in Kimitec's vision statement: "We believe in a different way of producing food and we want to be the natural alternative to synthetic chemicals, without jeopardizing efficacy and productivity."

MAAVi operates under an 'open innovation' model that promotes collaboration with people and organisations outside the company. This allows Kimitec to use the centre's product discovery and development capabilities to help big producers and well-known agribusinesses produce more sustainable foods. For example, Bayer formed a global strategic partnership with Kimitec earlier this year for the discovery and commercialisation of crop protection and biostimulant products derived from natural sources. Last year, UPL's Natural Plant Protection (NPP) business unit also introduced five new biostimulants developed at MAAVi to the American market.

Additionally, Kimitec has more than 55 of its own research projects in the pipeline currently. All of these are focused on developing natural, effective, productive and residue-free solutions to the main issues facing the global farming industry.

At the end of 2021, MAAVi launched its own artificial intelligence (AI) platform called LINNA®. The platform enables further research into natural molecules and compounds, only one percent of which are presently known, as well as accelerating the research process and extending this into animal and food production. LINNA® will improve Kimitec's ability to develop natural solutions to major global agriculture challenges. This is particularly important in Europe and North America, where growers will increasingly require natural crop inputs in future, as set out by the EU's Farm to Fork strategy and the US's New Green Deal policies. ■

"Currently, it is estimated that almost half of the total market value of biostimulants in Europe is represented using biostimulants for row crops, including cereals, oilseeds, pulses, and fibre crops," says S&P Global[1]. "Around 30 percent of use is attributed to fruits and vegetables, and around 11 percent to turf and ornamentals."

The US accounts for around three-quarters of North American biostimulant sales. Field crops are the largest US market for biostimulants. Around 50 percent of sales are targeted at soybeans. Maize and wheat combined are the next largest category, being responsible for another 20 percent of use. Biostimulants in the US also have a strong foothold in high-value vegetable crops – tomatoes, cucumbers, and potatoes – and the cultivation of wine grapes[1].

"Market growth is still hampered by the lack of overarching [US] biostimulant legislation. The need to register biostimulants under fertilizer legislation at state level makes it difficult for companies to easily register these products across states. Currently, several initiatives have been initiated to harmonize the registration approach," reports S&P Global[1].

Asia-Pacific is the fastest growing region for biostimulant sales. In China, usage has been aided by government policies favouring humic acid and microbial fertilizers. The country is already a major producer of seaweed extract and chitin[1].

Agricultural powerhouse Brazil dominates the Latin American biostimulant market. Market penetration is high with biostimulants being applied to around 44 percent of the total crop area. This is linked to the country's routine use of microbial inoculants (biofertilizers) in large-scale soybean cultivation, together with the prevalence of high-value crops. Brazilian biostimulant sales are expected to rise – the switch to organic cultivation being one driver[1].

Usage by crop

Broadly speaking, the agricultural biostimulant market can be split into the following four categories on a crop basis[1]:

- Row crops including cereals
- Fruit and vegetables
- Turf and ornamentals
- Other crops.

Biostimulant consumption is divided evenly between the first two categories, with each accounting for around 40 percent of total market sales. Although application rates per hectare are lower for row crops and cereals – versus fruit and vegetables – their total acreage is much larger[1].

While yield improvements are likely to be a key motivating factor for the adoption of biostimulants, growers are also seeking crop quality gains. Quality characteristics (e.g., homogeneity, colour and size) are particularly crucial for fruits and vegetables as they affect the sales price of produce. Some biostimulants even claim to improve fruit setting, storage and handling characteristics[1].

The market penetration of biostimulants remains small in comparison with conventional crop nutrient and protection products. In Europe, for example, the largest regional biostimulants market, biostimulants are currently applied to just 0.3 percent of total agricultural land[1].

Organic farmers were early adopters of biostimulants, as most products, being derived from natural sources, qualify for organic certification.

"With the emphasis now on sustainability across the whole agricultural sector, the scope is increasing to promote biostimulants on non-organic crops, as part of integrated crop management, aiming at cutting back on the use of other chemical inputs, while increasing crop yield and quality," comments S&P Global[1]. "Therefore, there is huge potential for growth."

Regulation – increasing harmonisation

The rapid growth in the biostimulants market has generally outpaced regulation of the sector. It is probably no coincidence that the EU is both the most well-regulated and the largest regional market for biostimulants. Products are covered by the 2019 EU fertilising products regulation (Regulation (EU) 2019/1009). This entered into force in July last year and allows CE-marked biostimulants to be placed on the market. The regulation defines biostimulants as fertilising products and not plant protection products:

"A product stimulating plant nutrition processes independently of the product's nutrient content with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere:
(a) nutrient use efficiency
(b) tolerance to abiotic stress
(c) quality traits
(d) availability of confined nutrients in soil or rhizosphere."

US market regulation, in contrast, is much more fragmented with crop inputs such as fertilizers generally being registered at state level. The 2018 Farm Bill did, however, introduce the following definition of biostimulants into federal legislation for the first time:

"A substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit:

- nutrient uptake,
- nutrient efficiency,
- tolerance to abiotic stress,
- crop quality
- or yield."

More recently, the bipartisan Plant Biostimulant Act re-introduced to Congress in 2023 sought to:

- Amend the Federal Insecticide, Fungicide, and Rodenticide Act to define what is a plant biostimulant and exclude it from being regulated under the Act.
- Require the US Environmental Agency to revise the existing Code of Federal regulations to include this new plant biostimulant definition
- Require the US Department of Agriculture to study how plant biostimulant products can contribute to soil health.

Corey Rosenbusch, president and CEO of US trade association The Fertilizer Institute, praised this legislative move: "The Fertilizer Institute (TFI) Biostimulants Council is thankful to Reps. Panetta and Baird for reintroducing this important legislation. This bill provides a critical definition for plant biostimulants which will help states establish a clear path to market for these important products and technologies, critical to a variety of growers."

Biostimulant regulations applying in other countries include:

- In India, the Fertilizer Control Order (FCO) of 1985
- In South Africa, the Fertilizer Regulation (2017)
- In Brazil, the Lei 6.894/1980 (LEI ORDINÁRIA)
- In Chile, the Ley 21-349.

Agreed standards for biostimulants are also now becoming available. The International Organization for Standardization (ISO) published a revised ISO 8157:2022 standard for 'Fertilizers, soil conditioners and beneficial substances' last year.

ROVENSA NEXT: ENABLING THE GREEN TRANSITION

Rovensa Next, the new global business unit established by Rovensa Group, is dedicated to creating biosolutions for agriculture. The company operates as a global network with 30 R&D excellence centres and laboratories, 14 production plants, and sales in more than 90 countries.

Integrated and diverse

Rovensa Next integrates ten individual Rovensa Group companies – Agrichembio, Agrotecnología, Idai Nature, Microquimica, MIP Agro, OGT, Oro Agri, Rodel, SDP, and Tradecorp. Bringing these companies together under one business unit has enabled Rovensa Next to create one of the industry's broadest portfolios of bionutrition, biostimulant, biocontrol and bioenhancer products. This holistic portfolio offers:

- Solutions for integrated pest and disease management
- Minimisation of abiotic stress
- Sustainable crop nutrient management
- Stimulation of natural plant processes
- Crop quality enhancements.

Products are designed to meet growers' needs by improving crop yields and performance. They are applicable to key crops, covering all phenological and growth stages from seed to shelf.

Stimulating natural plant processes

Rovensa Next, by promoting sustainable agriculture practices, is enabling the 'green transition' in agriculture. The company believes that biostimulants can provide a sustainable solution to the many challenges faced by growers, such as climate change, limited natural resources and biodiversity loss. This is due to their ability to help crops achieve their maximum potential by stimulating natural plant processes and improving:

- Nutrient use efficiency
- Tolerance to abiotic stress
- Crop quality traits
- The availability of nutrients locked within the soil or rhizosphere.

Local expertise and innovation

The location of Rovensa Next's manufacturing plants allows the company to capitalise on local expertise and innovations. In Campinas, Brazil, for example, the company has developed a highly efficient biofertilizer that is sustainably sourced from a unique microbial fermentation process. The microorganisms delivered by this product results in a higher-quality harvest by increasing the nutrient uptake of crops.

In Kilcar, Ireland, meanwhile, Rovensa Next specialises in the sustainable harvesting and processing of seaweed through an exclusive and gentle extraction method. This preserves the plant stimulating compounds naturally present in fresh seaweed. Additionally, Rovensa Group's recent acquisition of Cosmocel has increased its biostimulant expertise and global reach. This Mexican-based company is a leading player in the biostimulants market.

Crop monitoring of positive biostimulant effects, such as improved nutrient use efficiency, resistance to abiotic stress and better crop quality.

PHOTO: ROVENSA NEXT

Biostimulants for all growth stages

Specific biostimulants within Rovensa Next's portfolio target the individual requirements of each growth phase such as sowing, wake-up, flowering, fruit setting, fruit swell & development, ripening and shelf-life. The portfolio includes:

- **Biofertilizers**: Azzofix, a microbial-based seed treatment, improves nutrient use efficiency and crop nutrient management. This liquid co-inoculant for corn and soybean contains *Azospirillum brasilense*, an atmospheric nitrogen-fixing and growth stimulating bacteria. Another example is Phos-Up. This biofertilizer is formulated with the bacteria *Pseudomonas fluorescens*, known for its ability to re-solubilise and unlock phosphorus immobilised in the soil to promote plant growth.
- **Microbial extracts**: Biimore is a biostimulant derived from a sustainable plant fermentation process. Its high efficacy, when applied at ultra-low doses during the fruit swell and development stage, has been shown to increase fruit yield and fruit weight by up to 28 percent and 19 percent, respectively. It also improves other quality parameters such as size, sugar content and shelf-life. Notably, Biimore was one of the first biostimulants to be registered under the FPR in Europe.
- **Humic biostimulants**: One example is Turbo Root, a complete starter and root regeneration fertilizer. It contains humic and fulvic acids that stimulate fine root development, while enhancing the physical, chemical and biological characteristics of the soil. It is recommended during the initial stages of vegetative growth and can also be applied whenever root regeneration is necessary.
- **Seaweed extracts**: Phylgreen, the company's flagship seaweed extract, is a pure *Ascophyllum nodosum* biostimulant that reduces the severity of abiotic stress, so helping to maximise yields and profitability.
- **Amino acids**: Delfan Plus, a highly concentrated L-α free amino acid biostimulant, relieves abiotic stress when applied to crops. It is particularly effective in crops experiencing chemical or osmotic stress due to drought and salinity. Delfan Plus also improves nutrient uptake during co-application with fertilizers. Another example is Vegenergy Pro Q, a L-α free amino acids and potassium fertiliser. This is recommended for crops after fruit set until pre-harvest. It has a low salt index and is free of both nitrates and chlorides. ■

One of the main changes was the inclusion of the following specific description of biostimulants:

"[A] product that contains substance(s), microorganism(s), or mixtures thereof, that, when applied to seeds, plants, the rhizosphere, soil or other growth media, act to support a plant's natural nutrition processes independently of the biostimulant's nutrient content."

While also noting that: "The plant biostimulant thereby improves nutrient availability, uptake or use efficiency, tolerance to abiotic stress, availability of confined nutrients in the soil or rhizosphere, and consequent growth, development, quality or yield."

In the EU, the European Committee for Standardization (CEN) has published five guidance documents on biostimulant claims to support implementation of the fertilising products regulation. This includes documents on

- General principles (CEN/TS 17700-1:2022)
- Nutrient use efficiency (CEN/TS 17700-2:2022)
- Tolerance to abiotic stress (CEN/TS 17700-3:2022).

Leading companies

The biostimulants sector is populated by many longstanding small- and medium-scale enterprises (SMEs). These have proliferated thanks to the low barriers to market entry – such as the absence of any registration requirements in many countries. Joining these SMEs are two new types of entrant attracted by predictions of strong global market growth[1]:

- Firstly, large companies entering the top end of the market by buying biostimulant technologies or product lines through merger and acquisition (M&A) activity
- Secondly, small research companies.

Large agrochemical companies have a growing market presence – as they seek to build integrated product portfolios designed to increase crop yields. Their entry into the sector is a sensible strategy, given the overlap and common ground between biopesticides and biostimulants. Notable examples of M&A activity include[1]:

- Corteva Agriscience's buy-out of the Spanish biological crop protection supplier Symborg in 2022
- Syngenta's purchase of the leading biologicals and biostimulants business Valagro in 2020
- UPL's purchase of biostimulant company Arysta LifeScience in 2018.

Increasingly, major fertilizer producers are entering the market too, using M&A activity and/or partnerships to build comprehensive biostimulant product offerings.

Spain's Grupo Fertiberia, for example, recently acquired Trichodex, a biotechnology company located in Seville. Founded in 1991, Trichodex manufactures products based on patented biological processes. These improve crop protection and boost profitability by using microorganisms to produce 'bioactive' compounds. The company currently markets its biotech products in a dozen countries in Europe and Latin America.

The purchase of Trichodex is part of Fertiberia's strategy to offer high added-value biofertilizers and biostimulants as part its product portfolio. "The combination of Trichodex biotechnology with the development of innovative products from Grupo Fertiberia will provide farmers with cutting-edge sustainable tools to improve their crops," commented Javier Goñi, president of Grupo Fertiberia.

Fertilizer producer ICL and biotech company PlantArcBio have successfully collaborated on the development of a novel biostimulant. The new product uses RNAi technology to maximise the natural yield-increasing mechanisms of plants. It has been shown to successfully improve crop yields while having a minimal impact on the environment.

This biostimulant has significantly increased seed weight per hectare for canola crops in early-stage field trials. ICL and PlantArcBio are planning larger-scale field trials that will test the new biostimulant technology using both commercial sprayers and standard farming practices. Greenhouse trials for soybeans and rice are already in progress, with early results showing good potential.

ICL and PlantArcBio have already filed a joint patent for this biostimulant covering its application on multiple crops.

"The use of novel biostimulants based on RNAi technology helps promote sustainability, by reducing the use of chemicals in agriculture," said Hadar Sutovsky, ICL's VP for external innovation and the general manager of ICL Planet. "[it] does its work, then rapidly disappears from both the plants

Fig. 1: **Leading biostimulant companies**

and the environment, lasting no more than a few days, as it is highly biodegradable and also leaves no residual footprint."

"The positive canola field trial results constitute another milestone in strengthening PlantArcBio's capabilities in the development of RNAi-based products," said Dror Shalitin, the founder and CEO of PlantArcBio. "ICL, a market leader in crop nutrition products, is a great strategic partner for us to commercialize this sustainable technology worldwide."

A selection of leading biostimulant companies is shown in Figure 1.

Product spotlight

A plethora of new biostimulant products are being brought to market every year. Two products, in particular, were showcased by exhibitors ADM and Monband at the International Fertilizer Association's annual conference in Prague in May – the largest and most prestigious event on the fertilizer industry calendar.

Monband's new **MBT Puli-Nano 15+2** liquid biostimulant contains a mixture of humic and fulvic acids, plus polysaccharides and various amino acids, with the following overall composition and characteristics:

- Nano grade suspension
- Containing 15 percent humic acid plus two percent fulvic acid
- 17 percent total humic extracts
- pH of 6.5-7.5
- Black liquid
- 12 percent organic matter
- Seven percent organic carbon
- Easy to handle and apply.

This liquid was developed for fertigation in open field crops and soil injection – and is suitable for vegetables, fruit trees, banana, potato and flowers. It is designed to stimulate crop parts, both above and below ground, and promote root and shoot growth and budding. MBT Puli-Nano 15+2 is also recommended as a soil improver due to its ability to:

- Adjust soil pH
- Ameliorate soil salinity
- Improve soil microbial activity, physical and chemical properties
- Improve soil structure and water retention.

The product also increases nutrient use efficiency and reduces nutrient leaching. It is compatible with most fertilizers and pesticides.

In summary, MBT Puli-Nano 15+2 offers four key benefits to growers:

- **Nutrient use efficiency (NUE):** MBT improves NUE by supporting better root development – so enabling plants to absorb more nutrients and water – and/or by improving the soil availability of nutrients.
- **Crop quality**. By encouraging more vigorous and healthy plants, MBT improves both crop quality and yield quantity. Improved nutrient uptake, in turn, reduces nutrient losses and delivers sustainable profits to growers.
- **Soil health**. MBT improves soil health and long-term fertility by having a positive effect on water use efficiency and soil restoration.
- **Resistance/tolerance to climate change**. MBT can enhance plant tolerance to abiotic stresses such as drought and extreme temperatures.

ADM's **NeoVita™ 43** is a novel biostimulant that has been shown to improve corn yields. It promotes nutrient availability and uptake in corn by mimicking plant root exudates (organic substances secreted by the plant) that support soil microbes. Applications stimulate microbial activity, increase nutrient use efficiency and enhance plant vigour.

Multiyear trials at the University of Illinois found that NeoVita 43 increased corn yields by up to 440 kg/ha when combined with a liquid fertilizer starter, versus the starter alone. This yield boost is achieved at a suggested retail price of less than $20/ha, making the product one of the most effective crop inputs on the market, according to ADM.

The product can be applied in-furrow with a liquid starter fertilizer at planting (at a rate of 10 litres per hectare) and does not require additional mixing or special handling. It is available as a ready mixed solution and is compatible with 10-34-0 starter fertilizers. For farmers already using in-furrow treatments in cornfields at planting, NeoVita 43 provides an easy way to boost yields, optimise nutrient use efficiency and improve fertilizer return on investment (ROI), says ADM.

Biostimulant effectiveness

New evidence on the efficacy of biostimulants was revealed in systematic global review published last year[3]. This analysed the results of 180 field trials worldwide. Yield gains from biostimulants applied in open-field agriculture were evaluated for the following categories:

- Biostimulant type
- Application method
- Crop type
- Climate conditions
- Soil properties.

Results show that applying biostimulants to crops delivers an average yield benefit of 17.9 percent. Plant extracts, including seaweed extracts, were the best performing biostimulant category with an average yield increase of 26.6 percent. Phosphites, in contrast, delivered the smallest yield gains (+8.6%).

Soil-applied biostimulants delivered yield benefits about 10 percent higher than foliar and seed applications. The researcher found this a surprising outcome, given that foliar and seed applications, by delivering biostimulants directly to the plant, should promote faster uptake of bioactive ingredients.

Biostimulant effects were most positive in arid and desert climates. Overall, water availability was as a critical factor governing effectiveness, with yield gains showing a clear negative trend with increased precipitation.

Biostimulants were also most effective in soils that are sandy, saline, nutrient-deficient with low organic matter content and a non-neutral pH.

When biostimulant effectiveness was compared across different crop types, vegetables showed the highest yield benefit (+22.8%) and roots/tubers the lowest (+10.6%). Legumes also responded more significantly to biostimulant applications than fruits, cereals, and other crops.

"Biostimulants improve crop yield by reducing yield reductions under stress conditions," the researchers conclude[3]. "This approach can help improve food security for the growing world population under increasing climate change threat." ■

References

1. Altman, M., 2022. *Biostimulants 2022*. Crop Science Report. IHS Markit, now part of S&P Global.
2. Storer, K. et al., 2016. *A review of the function, efficacy and value of biostimulant products available for UK cereals and oilseeds*. AHDB. AHDB Research Review No. 89.
3. Li, J. et al., 2022. A Meta-Analysis of Biostimulant Yield Effectiveness in Field Trials. *Front. Plant Sci.* 13:836702.

The mineral nutrition of nut tree crops

PHOTO: ICL/NATALY COHEN KADOSH

Tree nuts are an important dietary source of unsaturated fatty acids, vitamins and minerals. Orchards require balanced fertilization to promote healthy root growth, maintain tree vigour, and achieve yield targets in response to growing market demand. ICL agronomists **Cristian Filote, Gali Carmi** and **Patricia Imas** review their nutrient needs.

Above: Almond trees in bloom at an orchard in Israel.

Nut crops are a group of speciality crops – generally trees – that produce edible seeds within a shell. These seeds are typically consumed in dry form and provide an important dietary source of unsaturated fatty acids, vitamins, and minerals such as potassium, phosphorus and magnesium. The long-term consumption of nuts, as part of a healthy human diet, contributes to a lower risk of cardiovascular disease, reductions in blood cholesterol levels, and a decline in all-cause mortality.

Production

World tree nut production has risen over the past decade to reach 5.3 million tonnes in 2022/23. The most common tree nuts in order of their production volumes are: Almonds; Walnuts; Cashew; Pistachio; Hazelnuts; Pecans; Macadamia; Pine nuts; Brazil nuts.

Tree nut plantations (orchards), whether cultivated under irrigated or rain-fed conditions, need maintaining with a specific and adequate fertilization regime. This is essential for the sustainable and economically-viable management of plantations over their long life cycle.

The United States is the world's leading tree nut producer, with a global market share of around 36 percent. Almonds, pistachios and walnuts are the most widely grown US nuts, accounting for 59 percent, 22 percent and 15 percent, respectively, of domestic tree nut production. Turkey is the second largest world producer, being responsible for an 11 percent share of global production, with hazelnuts and pistachios accounting for 63 percent and 30 percent of Turkish output, respectively.

Nutrient requirements

Nut trees require all three macronutrients – nitrogen (N), phosphorus (P) and potassium (K) – in significant amounts. Their roles are as follows:

- Nitrogen promotes vegetative growth
- Phosphorus supports root development and fruit production
- While potassium enhances overall tree health and disease resistance.

Deficiencies in any of these major nutrients negatively affects tree physiology – resulting in visible leaf symptoms (Figure 1) – and ultimately nut yields.

PHOTOS: ICL/NATALY COHEN KADOSH

Fig. 1: Visual deficiency symptoms in almond leaves for nitrogen (left), phosphorus (middle) and potassium (right).

Sulphur (S) is also an important nutrient: sulphur deficiency in the soil can cause slow growth rates, yellowing leaves and lower fruit yields. Deficiency is also becoming more common. Growers must therefore be aware of the need to add sulphur on a regular basis – preferably as sulphate, the plant-available form of sulphur.

Calcium (Ca) is required for the growth and function of root tips and is also a component in leaf cell walls. Magnesium (Mg) is also a vital nutrient, primarily as a component of chlorophyll. It also aids in enzyme function, protein synthesis and the formation of sugars and starches.

Nut trees also need micronutrients – including zinc (Zn), boron (B), iron (Fe), manganese (Mn), and copper (Cu). These micronutrients play vital roles in various metabolic processes and ensure proper tree growth.

CASHEW: THE INDIAN EXAMPLE

The average productivity of cashews in India is 900 kg/ha. On the subcontinent, the average macro-nutrient removal rates for mature, six-year-old, fruit-bearing cashew trees is around:

- 339 g/plant/year for nitrogen
- 55 g/plant/year for phosphorus
- 182 g/plant/year for potassium.

In Indian orchards, fertilizer use efficiency is maximised by timing fertilizer applications between September and December as this period coincides with tree flushing, early flowering and high root activity.

Ideal application timings are either at the onset of the monsoon, or immediately after the monsoon when soil moisture is still adequate. However, application during the post-monsoon period is advised when only a single application is possible, due to labour constraint or other reasons. In any case, fertilizer applications should be done after weeds and foliage have been cleared from the base of individual trees.

In the laterite soils found in the heavy rainfall areas on India's west coast, circular trenches (25 cm deep and 15 cm wide) are opened at distance of 0.5, 0.75, 1 and 1.5 metres away from trunk during the first, second, third and fourth year after planting, respectively. In the loamy soils of the low rainfall east coast, fertiliser is instead generally applied in 50-centimetre circular strips. Trenches should be closed immediately after fertilizer application with green leaves used as mulch. ■

Table 1: **Fertilizer recommendation for young and fruit-bearing cashew trees in India. Cashew nuts (*Anacardium occidentale*) accounted for 20 percent of global production in the crop-year 2022/23**

Plants age		N	P_2O_5	K_2O	Organic manure
	Planting density	(g/plant/year)			(kg/plant/year)
1	Traditional spacing (200 trees/ha) Ultra-density planting (625 trees/ha)	150 46	40 25	40 30	4-5
2	Traditional spacing (200 trees/ha) Ultra-density planting (625 trees/ha)	300 115	80 33	80 60	5-10
3	Traditional spacing (200 trees/ha) Ultra-density planting (625 trees/ha)	450 185	120 50	125 120	10-20
4	Traditional spacing (200 trees/ha) Ultra-density planting (625 trees/ha)	600 185	150 50	250 120	10-20
5	Traditional spacing (200 trees/ha) Ultra-density planting (625 trees/ha)	750 185	250 50	250 120	10-20

Notes: Optimal leaf analysis values: N: 1.10-1.70%; P: 0.10-0.21%; K: 0.36-0.75%; Ca: 0.40-0.75%; Mg: 0.20-0.50%; B: 12-16 ppm; Cu: 7-15 ppm. Fe: 35-72 ppm; Mn: 13-34 ppm; Zn: 13-22 ppm.

Source: ICL

Table 2: **The nutrient requirements of fruit-bearing almond trees, by phenological stage. Almonds (*Prunus dulcis*) accounted for 27 percent of global production in crop-year 2022/23**

	Nutrient amounts per tonne of in-shell nut yield	Foliage growth & bloom	Fruit-set & enlargement	Kernel bulking-up to maturity	Early post-harvest
	(kg/t)	Percentage per stage			
N	45	20	30	30	20
P_2O_5	5	30	35	30	5
K_2O	49	20	30	40	10
SO_3	1.6	20	45	35	0
CaO	4	15	40	35	10
MgO	2.7	30	30	30	10

Notes: Optimal leaf analysis values: N: 2.2-2.8%; P:0.1-0.3%; K:1.0 2.4%; Ca:2.0-4.0%; Mg:0.3-0.7%; S: 0.3-0.6%; B: 30-65 ppm; Cu: ≥4.0 ppm; Fe: 30-250 ppm; Mn: 20-100 ppm; Zn: 18-75 ppm.

Source: ICL

Table 3: **The nutrient requirements of fruit-bearing walnut trees, by phenological stage. Walnuts (*Juglans regia*) accounted for 22 percent of global production in crop-year 2022/23**

	Nutrient amounts per tonne of in-shell nut yield	Bud break & bloom	Shoot & foliage growth & hull expansion	Shell hardening	Nut fill	Post-harvest
	(kg/t)	Percentage per stage				
N	31	30	20	20	30	0
P_2O_5	10	70	10	10	10	0
K_2O	25	20	40	20	20	0
SO_3	1.8	30	30	30	10	0
CaO	2.7	40	10	10	30	10
MgO	3	50	10	20	20	0

Notes: Optimal leaf analysis values: N: 2.2-3.2%; P: 0.15-0.5%; K: 1.2-2.4%; Ca: 0.6-1.2%; Mg: 0.25-1.0%, S: 0.2-0.5%; B: 36-150 ppm; Cu: 6-15 ppm; Fe: 75-150 ppm; Mn: 20-60 ppm; Zn: 20-60 ppm.

Source: ICL

Table 4: **The nutrient requirements of fruit-bearing hazelnut trees, by phenological stage. Hazelnuts (*Corylus avellana L.*) accounted for 11 percent of global production in crop-year 2022/23**

	Nutrient amounts per tonne of in-shell nut yield	Flower initiation	Flowering & root growth	Nut-set & growth	Mature nuts drop
	(kg/t)	Percentage per stage			
N	12.3	15	35	35	15
P_2O_5	1.7	30	20	20	20
K_2O	25	10	30	40	20
SO_3	3.2	20	30	30	20
CaO	2.8	30	20	20	30
MgO	2	20	30	30	20

Notes: Optimal leaf analysis values for hazelnut: N: 2.2-2.5%; P: 0.14-0.45%; K: 0.8-2.0%; Ca: 1.0-2.5%; Mg: 0.25-0.50%; S: 0.13-0.2%; B: 31-75 ppm; Cu: 5-15 ppm; Fe: 51-400 ppm; Mn: 26-650 ppm; Zn: 16-60 ppm.

Source: ICL

Fertilizer recommendations

In orchards, required fertilization rates can be estimated from the quantities of nutrients removed from the soil during nut harvesting, i.e. the amount of nutrients remover per one tonne of 'in-shell' nut yield (Tables 2-5). Efficiency coefficients (nutrient ratios) are also valuable for calculating the relative application rates of the three major nutrients. For tree nuts, N:P:K coefficients are typically 0.45:0.25:0.70.

As well as knowing the overall amount of nutrients removed per tonne of crop yield, it is also necessary to know the right application timing and nutrient requirements by phenological stage (Tables 2-5).

Leaf analysis is a reliable tool for diagnosing the nutritional status of any crop. Leaves are generally analysed from the

end of July to early August in the Northern hemisphere. Nutrient deficiencies can be corrected for by comparing results to optimal values (Tables 1-5).

For nut trees grown on alkaline soils, ammonium sulphate is the preferred nitrogen fertilizer, while ammonium nitrate performs best for nitrogen applications on low-pH soils. All nut trees react positively to the incorporation of manure into the soil just before flowering (April-May in northern hemisphere). This can be sourced from husbandry animals or as green manure derived from legumes.

Pistachio's nutrient needs

Pistachio trees are prone to alternate bearing. This is the tendency to produce a much greater-than-average crop in one year, followed by a much lower-than-average crop in the subsequent year. This drastically affects both crop productivity and fertilizer requirements.

Pistachio's yields in an 'off' year, for example, are 25-33 percent lower than those in an 'on' year. Correspondingly, the amount of the nutrients applied prior to and during the 'on' year need to be greater than during the 'off' year. A total nitrogen application rate of 224-252 kg/ha is recommended for pistachio during an 'on' year, for example, while during an 'off' year only 50 percent of that amount is typically necessary. Likewise, while a total potassium application of 118-224 kg/ha is advised for pistachio during an 'on' year, the application should be reduced to just 33-50 percent of this rate during an 'off' year. ■

Table 5: **The nutrient requirements of fruit-bearing pistachio trees, by phenological stage. Pistachio nuts (*Pistacia vera*) accounted for 14 percent of global production in crop-year 2022/23**

	Nutrient amounts per tonne of in-shell nut yield	Bud break & bloom	Fruit-set & enlargement	Kernel filling	Hull split to harvest
	(kg/t)	Percentage per stage			
N	25.6	15	25	40	20
P_2O_5	7	30	15	35	20
K_2O	22.8	10	30	50	10
SO_3	2.3	30	30	30	10
CaO	2	50	15	15	20
MgO	2.2	40	15	25	20

Notes: Optimal leaf analysis values for pistachio: N: 2.2-2.9%; P: 0.14-0.17%; K: 1.8-2.2%; Ca: 2.1-4.0%; Mg: 0.5-1.2%; S: 0.2-0.4%; B: 150-250 ppm; Cu: 6-10 ppm; Fe: 105 ppm; Mn: 35 ppm; Zn: 10-18 ppm. *Source: ICL*

PHOTO: ICL/NATALY COHEN KADOSH

Almond nutrition trial in lysimeters at the ARO Gilat Research Centre, Israel.

EFFECTIVE NUT NUTRITION WITH ICL PRODUCTS

Water-soluble fertilizers

ICL has a specific range of water-soluble and liquid fertilizers designed for drip irrigation and foliar application. The company's Novacid range is made from highly pure ingredients and all the micronutrients present are chelated. Valuably, it is a granular water-soluble solid and therefore – unlike liquid acids – is safe to handle.

Novacid products are perfect for growers needing to deal with high alkalinity in their irrigation water. Their acidic nature means that all the nutrients dissolve efficiently, even in hard water, and the drip lines are kept free of limescale build-up.

Previously, research trials have proven the effectiveness of foliar feeding in the fertilization of almonds and other nuts. ICL's innovative foliar technologies, such as Nutrivant and Agroleaf, are particularly well suited to tree nuts.

The Nutrivant foliar product line combines crop-specific nutrient mixes with a proprietary adjuvant (Fertivant) that can break through the leaf cuticle. The innovative Agroleaf foliar product range is designed for both the correction and prevention of nutrient deficiencies. Agroleaf, developed by ICL researchers, is equipped with two proprietary technologies: M-77 for chelating micronutrients and DPI (Double Power Impact), a plant stimulant that optimises nutrient uptake through the foliage.

Controlled-release fertilizers (CRFs)

ICL's Agroblen CRF range is ideal for establishing nut plantations (Table 6, top). These fully coated NPK granules deliver crop nutrients over a period of 8-9 months or 12-14 months, depending on the region where the plantations are being established.

By placing only a few grams directly into the planting holes, Agroblen supplies nutrients in a controlled manner and according to plant needs. Because of this, NPK losses are significantly reduced, thereby ensuring more nutrients are available for plant uptake. The controlled release of nutrients over time also eliminates the labour, equipment and material costs associated with the multiple application of conventional granular fertilizers.

ICL also offers Agromaster – a CRF product line that combines both coated and uncoated NPKs – for young and fruit-bearing plantations (Table 6, bottom). These powerful fertilizers partly deliver nutrients in an uncoated form for immediate take-up by plants to stimulate intensive growth. At the same time, they also provide NPKs in coated form. This prevents nutrient losses via run-off, leaching from light soils and/or losses under heavy rainfall conditions.

The use of Agromaster products allows fertilizer rates to be reduced without affecting crop yields. They are also versatile and, by creating a buffer supply of nutrients in the soil, especially valuable in circumstances where fertigation is not possible.

Table 6: **General CRF recommendations for nut crops**

Product	NPK (%)	Longevity (months)	Application rate (g/plant)	Remarks
New plantations: Tropical areas				
Agroblen	17-5-11+TE*	12-14	100-200	In planting holes
	17-8-9+3MgO			
New plantations: Mediterranean areas				
Agroblen	17-5-11+TE*	8-9	100-200	In planting holes
	17-9-11+Ca/Mg/S			
Young & fruit-bearing plantations: Tropical & Mediterranean areas				
Agriform*	13-8-18	5-6	200-300	Twice per season around the trees or side dressing
	13-9-27+2MgO			
Agromaster	16-11-21			

**Available only in US*

Source: ICL

PHOTO: ICL/CHRISTI FALEN

Polysulphate trial on Butte Padre almond orchard.

Nonetheless, the perfect fertilization plan is always based on fertigation with water-soluble fertilizers, as this precisely supplies nutrients to nut trees according to both the age of the plantation and the tree's phenological stage.

Polysulphate

Polysulphate® is a unique multi-nutrient fertilizer rich in four key plant nutrients: sulphur, potassium, magnesium and calcium. It contains the natural mineral polyhalite and is exclusively mined in the UK by ICL.

Polysulphate is provided to growers in its natural state, with no industrial processing, being delivered directly from mine to field. As a natural mineral fertilizer, it is widely approved for use in organic agriculture – holding organic certification in many countries internationally.

Polysulphate is a low environmental impact fertilizer with the lowest carbon footprint on the market, when compared to competitor products. Its use therefore helps farmers to lower greenhouse gas emissions (GHGs) and manage their carbon targets.

Polysulphate applications supply nutrients in a balanced way that nurtures nut trees and maintains soil fertility. Research shows that nutrients (S, K, Mg and Ca) are gradually made available to the crop over time due to Polysulphate's mineral composition. The product's gradual and prolonged nutrient release profile maximises nut yields by promoting healthy tree growth and development.

Polysulphate also provides a low-chloride source of potassium, as well as being a reliable source of sulphur. Trials conducted on Californian almond trees in the US have demonstrated that applying Polysulphate can deliver a 5-11 percent increase in kernel yield in comparison to growers' standard practice. ■

Tree nuts: the importance of calcium and sulphur

Tessenderlo Kerley International recently published a tree nut crop brochure. This article draws on the brochure to highlight the importance of two essential nutrients, calcium and sulphur, as part of a balanced fertilization programme for nut crops.

The most common nuts produced worldwide include almond, walnut, pistachio and hazelnut. These are cultivated under either irrigated or rainfed (often water stressed) areas and, consequently, large variations in nut yield occur[1].

Yield is also affected by differences in crop practices, particularly the fertilization regime. A common denominator across all nut crops is therefore the importance of balanced fertilization. Indeed, a balanced fertilization programme is the prerequisite for healthy root growth, the maintenance of tree vigour, as well as the crop productivity needed to achieve target yields and meet growing market demand[1].

This article highlights the role of calcium and sulphur in the fertilization of nut crops – and the benefits of applying these nutrients together within a single product. A more comprehensive overview of nut cop fertilization is provided in Tessenderlo Kerley International's crop brochure for nuts[1].

Calcium and sulphur – two essential nutrients

Fruit and nut trees thrive on calcium (Ca) as it improves both leaf and fruit quality. This essential macronutrient is involved in many plant processes, including cell elongation, cell division, germination, pollen growth and senescence. Adequate leaf calcium content ranges from two percent in almond to four percent in pistachio[1].

Calcium has an impact on the interior quality of nuts. Calcium fertilization in deficient soils is a necessity – this being very important in acidic soils. Calcium's immobility in the plant also requires periodic supplementation to maintain adequate levels in the upper canopy[1].

Sulphur (S) is widely recognised as the fourth major plant nutrient. It is essential for promoting the healthy tree growth needed to deliver high nut yields. The uptake and availability of sulphur is less sensitive to soil pH and this nutrient can therefore usually be taken up readily across a range of orchard soil conditions[1].

Sulphur fertilization is a beneficial way of enhancing the uptake and use efficiency of nitrogen, phosphorus, potassium and zinc – due to sulphur's synergistic relationships with all these four nutrients. Adequate leaf sulphur content for nuts varies from around 0.2 percent in walnut to 0.6 percent in almond[1].

Within the tree, sulphur is incorporated into certain amino acids (cysteine, methionine) and subsequently becomes part of vitamins, oils, and lipids such as sulpholipids. Deficiency symptoms generally occur in the younger plant tissues first. That is because, once locked within these complex molecules, sulphur is not easily mobilised within the plant[1].

Early calcium application essential

"While the total calcium content of soils often appears to be satisfactory, the level of plant-available calcium present in the soil solution can often be below the threshold necessary for adequate crop supply. The calcium demand from nut trees can be surprisingly high too. A walnut orchard in France, for example, will export between 25-35 kg/ha of CaO through harvested nuts at a yield of 3-4 t/ha," comments

TESSENDERLO KERLEY INTERNATIONAL

Walnut tree orchard, France.

Régis Muteau, lead agronomy manager at Tessenderlo Kerley International.

For walnut, as in many trees, calcium is essential for the regeneration of rootlets and secondary roots after the winter period. Somewhat paradoxically, it is during this largely dormant period – before vegetative growth begins – that calcium deficiency can be the most detrimental. This is despite the fact that the early growth stage at the start of the season is when the calcium needs of walnut trees are at their highest, this stage being responsible for 30 percent of total uptake.

"Calcium inputs (7-10 kg/ha of CaO) at the very beginning of the growth cycle, even in the few weeks before bud break, have a strong influence on the annual rooting of the walnut tree – and therefore on the uptake of all nutrients provided by soil-applied fertilizers from the very start of the season," comments Régis Muteau.

Ultimately, these early additions of calcium will also have positive repercussions for walnut size (caliber) at harvest. This effect was verified by Tessenderlo Kerley International in crop trials that applied calcium thiosulfate on *Fernor* variety walnuts in

the Dordogne and Lot regions of France in 2020 and 2021. The increase in walnut size from applications of CaTs® to the soil (150 l/ha) resulted in a 26 percent yield surplus.

"Remember too that liquid calcium is also a beneficial soil flocculant. This means that early application of a liquid calcium fertilizer such as CaTs® will improve soil structure very quickly," comments Régis Muteau.

Dual benefits delivering sulphur with calcium

The multiple effects of a liquid fertilizer such as CaTs® on nut yield – and on the size of the nuts in particular – is explained by the fact that sulphur in the form of thiosulphate (S_2O_3) is supplied alongside calcium.

The presence of sulphur in this reducing form improves nitrogen use efficiency (NUE). This is a fundamental to the effectiveness of calcium thiosulphate. This is linked to the well-known fact that sulphur and calcium are key enablers of the nitrate reductase reaction. This allows nitrates to be metabolised by plants into amino acids and proteins. A liquid calcium and sulphur fertilizer such as CaTs®, by providing these two nutrients together, therefore significantly increases the efficiency of nitrogen fertilizer applications too.

Calcium thiosulphate can improve both the yield and quality of walnut kernels.

"Finally, it should also be noted that nuts, such as hazelnuts and almonds, are fruits that typically require sulphur in large amounts. This is because their kernels are very rich in sulpholipids. These are essential for walnut oil production, for example, and it is estimated that the sulphur input of 80 kg/ha (SO_3) will have to be supplied to walnut orchards to cover the export in nuts at harvest for a yield of 3.5-4 t/ha," sums up Régis Muteau.

Calcium thiosulfate

Calcium thiosulphate products such as CaTs®, due to the positive rooting effects of calcium on orchard trees, coupled with the benefical presence of sulphur, are leading liquid fertilizers for the cultivation of nut crops such as walnut. Because of their ability to improve nutrient use efficiency (NUE), they also contribute to the goal of reducing nitrogen applications in agricultural – especially nitrate use. Overall, calcium thiosulphate, as a precision liquid fertilizer, can improve both the yield and quality of nut kernels while in parallel helping deliver improvements to soil health. Its flocculating behaviour is particularly beneficial to soil structure. ■

References

1. TKI, 2020. *Nuts crop brochure*. Tessenderlo Kerley International. Available from: https://www.tessenderlokerley.com/en/nuts [Accessed June 2023]

Innovative fertilizer products and pioneering producers

A review of recent additions to fertilizer product portfolios and new process technologies, as innovation within the industry accelerates to decarbonise production and improve nutrient use efficiency (NUE).

The use of green fertilizers could cut the climate impacts of cereal growing by 20 percent, according to Yara and its partner Lantmännen.

PHOTO: BCINSIGHT/SIMON INGLETHORPE

The last 12 months have been a highly productive period for fertilizer industry innovation.

In major project launches, SQM unveiled a novel iodine speciality fertilizer, while ICL introduced a controlled-release fertilizer (CRF) with a biodegradable coating. ICL also brought Nutriduo, an innovative new micronutrient product, to market in Brazil. This foliar fertilizer is enriched with selenium, magnesium and zinc (*Fertilizer International* 513, p24)

In India, both Coromandel International and IFFCO have launched nano fertilizers and ramped-up production.

Yara, meanwhile, has agreements in place to market and sell ground-breaking 'green' fertilizers. These have an 80-90 percent lower carbon footprint than their conventional equivalents.

AgTech start-ups have also come to the fore. These were showcased and given an opportunity to pitch to the fertilizer industry at CRU's Fertilizer AgriTech Forum in Dallas last September (*Fertilizer International* 511, p25). One of the participants, Californian AgTech start-up Nitricity, went on to secure $20 million of investment for its sustainable and local nitrogen fertilizer production technology.

For the second year in a row, the International Fertilizer Association (IFA) also featured a dedicated start-up corner as part of the exhibition accompanying its annual conference. A prominent exhibitor was Fertipaq, a Netherlands-based company that manufactures an organic liquid sulphur fertilizer by de-sulphurising wastewater streams.

Ultrasol®ine K Plus – a new speciality fertilizer with iodine

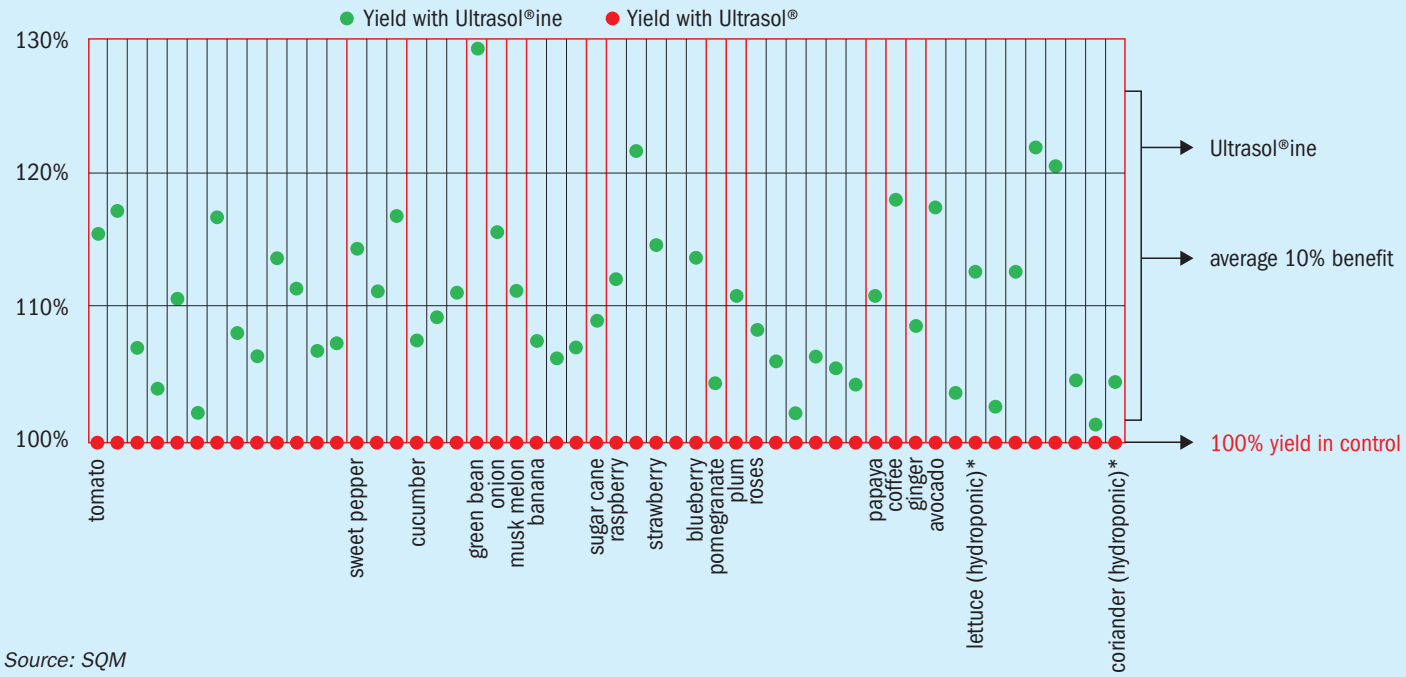
SQM has launched a new speciality fertilizer that supplies iodine to fertigated crops. This allows growers to apply iodine as a plant micronutrient in a form that is guaranteed to be safe and at an effective science-based dose.

The newly-launched product, known as Ultrasol®ine K Plus, combines two essential plant macronutrients – potassium and nitrate nitrogen – with iodine. The product ensures that all three nutrients are applied at well-defined application rates. This makes it easy for the grower to maintain an effective and safe concentration of iodine in the root zone. As a result, Ultrasol®ine K Plus can prevent iodine deficiency in crops without the risk of excessive iodine application.

The product has already been extensively tested globally and is backed by more than 100 well-documented trials with growers. The experience of these growers has confirmed that iodine delivers distinct crop benefits – including improvements to:

- Root growth
- Above ground plant growth
- Photosynthesis
- Nitrogen metabolism

Fig. 1: **The application of iodine to crops delivers 10 percent* more marketable yield. Results for fertigation with Ultrasol® (KNO_3) versus fertigation with Ultrasol®ine K Plus (iodine-enriched KNO_3).**



Source: SQM

**Average yield improvement from trials on 52 farms located in 14 countries with coverage of 19 different crops:*
Overall, the trials demonstrated that Ultrasol®ine K Plus enables iodine to be easily applied and improve crop performance – with this leading to higher yields, better quality and therefore greater revenues. The product was made available in the European market in July 2022.

- Tolerance to abiotic stress
- Flowering and fruit quality with less fruit rot and better shelf life.

Typically, the application of iodine to crops delivers 10 percent more marketable yield (Figure 1). This is the average yield improvement from trials on 52 farms located in 14 countries with coverage of 19 different crops. These trials compared Ultrasol®ine K Plus to potassium nitrate without iodine for the same crop, on the same planting date with the same fertilizer programme. Crops included: tomato, lettuce, sweet pepper, cucumber, musk melon, sugarcane, pomegranate, papaya, banana and coffee.

Ultrasol®ine K Plus was developed in response to new information published in a landmark paper in 2021[1]. This highlighted the importance of iodine as an essential plant nutrient.

It has long been known that iodine is essential for human and animal health. But this paper demonstrated that plants need micro doses of iodine as well. For the first time, the presence of 82 naturally-occurring iodine-containing proteins was also identified in higher plants. Drawing on these and other findings, the researchers concluded that[1]: "Results are strongly suggestive of the role of iodine as a plant nutrient."

Subsequently, based on this compelling new evidence, iodine was mentioned as a beneficial nutrient for plants in the recently published 4th edition of Marschner's authoritative *Mineral Nutrition of Plants*[2].

The potential of iodine to reduce yield loss in salt-stressed crops was also confirmed by an agronomic study last year[3]. This examined the role of iodine as a micronutrient in tomato. In non-stressed plants, the presence of iodine in the nutrient solution increased plant growth and fruit yield and had a positive effect on the firmness of the fruit. In salt-stressed plants, iodine boosted overall tomato yield when applied in micromolar doses – increasing both the number of fruits per truss/per plant and individual fruit weight.

SQM has observed similar beneficial effects on strawberries grown under saline growth conditions in California. In replicated trials, the presence of iodine in the nutrient solution, by alleviating salt stress, led to greater fruit yield and fruit quality.

New biodegradable coating technology

ICL has developed a new generation of biodegradable coatings for its controlled-release fertilizer (CRF) portfolio (*Fertilizer International* 510, p24). The new coating technology is designed to meet the requirements of the new EU fertilising products regulation (2019/1009) and reduce the environmental footprint of CRFs. It will also help Europe's farmers meet the requirements of the EU's Green Deal policy.

This patented innovation, named eqo.x, coats nitrogen fertilizer granules applied to field grown crops. The technology has already been fully tested in the field – and shown excellent results in terms of ease of production, nutrient use efficiency, and reducing volatilisation and leaching losses.

According to ICL, eqo.x is one of the most important innovations and technological launches since CRFs were first introduced to the market decades ago. It is expected, once again, to shape the future of fertilization.

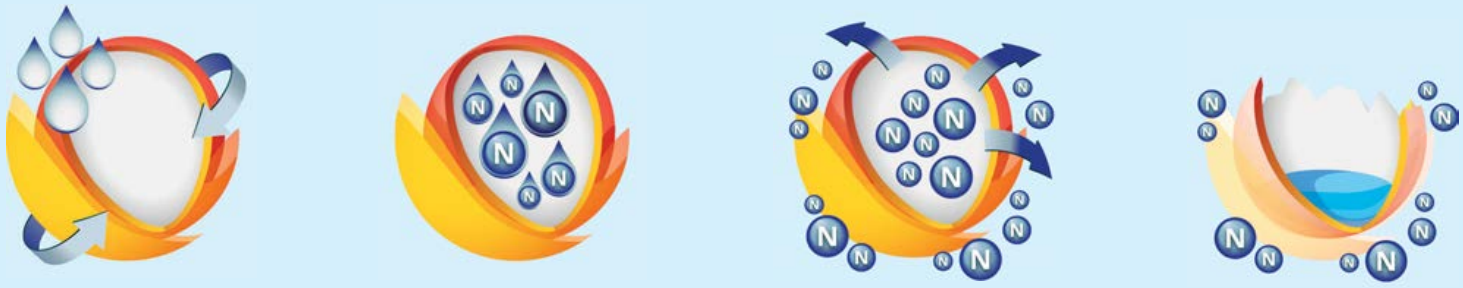
"We see this as a huge step forward in the use of enhanced efficiency fertilizers for the agricultural market," comments Ronald Clemens, ICLs Global Marketing & Portfolio Manager CRF. "The biodegradable release technology will be able to reduce all kinds of nutrient losses, and combines this with all the known advantages of CRFs, such as reduced application frequency and application rates."

He adds: "This innovation makes it possible for farmers to reduce fertilizer rates without losses in yield. In that

Fig. 2: **How eqo.x technology works is similar to existing coating technologies**

Source: ICL

Working principle



Once applied in the soil, moisture penetrates the biodegradable coating and reaches the nutrient core.

Nutrient inside starts to dissolve and begins to release back into the root zone by diffusion.

Influenced by soil temperature, nutrient solution is released day-by-day through the biodegradable coating thus reducing nutrient losses to the environment.

The coating shell degrades in soil, into CO_2 and water, offering a sustainable solution for future farming.

respect, eqo.x is ahead of the present regulations and ready for future standards coming."

Clemens explains how the new biodegradable coating functions (Figure 2):

"Eqo.x works similar to our existing coatings. The soil temperature affects the speed of release in a similar way to E-Max coatings. That makes it easy for the farmer to use the new product, as neither the application or the performance will change.

"The new technology offers an improvement in release patterns, making CRFs with eqo.x technology even more reliable and predictable than before. And after the longevity ends, the coating shells will degrade even faster to CO_2 and water, leaving no trace behind."

Wide ranging trials with eqo.x technology have all shown an increase in NUE. This is to be expected with a CRF, says Ronald Clemens: "The technology contributes to reducing nutrient losses and improved nutrient use efficiency. It will help farmers to maximise their yields.

"We have tested in crops like potatoes, but also in very hot conditions in rice cultures where the product is fully under water. We have tested the release specifications in the lab under various temperature regimes, in water and in soil as well as under practical circumstances. In all those conditions, the nutrient use efficiency was significantly increased, giving better results than growers practice – in terms of yield, number of applications or application rates."

ICL will start to deliver eqo.x technology to the market in its Agrocote and Agromaster formulations this year. In the meantime, the company's R&D team is continuously working on new solutions.

"We are extremely happy that this innovation is already available now – so that we are prepared for the future," sums up Ronald Clemens. "The next step is to move more of our coating technologies to faster degradability."

Nitricity secures funding

Last October, Californian AgTech start-up Nitricity successfully raised $20 million as part of a 'Series A' capital investment round.

The fundraising round was led by Khosla Ventures and Fine Structure Ventures. Three other investors, Energy Impact Partners, Lowercarbon Capital and MCJ Collective, also participated. Nitricity has raised $27 million in total funding to date, including this new financing.

"This fundraising round brings us one step closer towards sustainable and locally produced fertilizer," said Nicolas Pinkowski, CEO and co-founder of Nitricity. "It's time to bring this to market. We have aggressive growth plans in motion."

Nitricity's innovative technology turns air and water into nitric acid using solar energy and a plasma reactor. The nitric acid generated can then be converted into a range of liquid fertilizers by combining with other inputs such as limestone, phosphate rock and potassium hydroxide.

The company's aim is to electrify and locally distribute nitrogen fertilizer production using low-cost solar or wind power. This approach disrupts the nitrogen industry's current highly centralised and fossil fuel reliant production model.

"This electrified technology provides fertilizer in a climate-smart nitrate form, designed for efficient application, allowing it to address greenhouse gas emissions beyond ammonia-based technologies," said Joshua McEnaney, president, CTO and co-founder at Nitricity. "This is an opportunity to attack not just the 1-2 percent of global GHG emissions in the production, but the additional five percent of GHG emissions in the application by mitigating nitrous oxide formation. We are pushing hard to scale up and implement this solution."

Nitricity has shown the potential of its new approach to fertilizer production at California State University's Center for Irrigation Technology at Fresno – where it was successfully used for the fertigation of tomatoes. This demonstrated the ability of Nitricity's system to produce and apply nitrogen fertilizers close to the end-user.

"Today's fertilizer industry is facing the perfect storm of high GHG emissions, high fossil fuel consumption, rising costs and geopolitical disruptions," said Rajesh Swaminathan, partner at Khosla Ventures. "Nitricity's decentralized approach to manufacturing fertilizers using just air, water and renewables-based electricity was born out of a vision to completely transform a 100-year-old industry, and we are excited to be partnering with them."

"Nitricity has made rapid progress since our initial investment in their Seed round," said Allison Hinckley, senior associate at Fine Structure Ventures, a venture capital fund. "In response, we are increasing our support of the company to aid in bringing their differentiated, decarbonized fertilizer products to market in the near term."

Nitricity is fast-tracking the development of its renewables-based technology and is aiming to make this commercially-available within two years.

Yara and Lantmännen to bring fossil-free fertilizers to market

Yara has been pioneering the introduction of green fertilizers to the marketplace. The Norwegian crop nutrient giant plans to start manufacturing these this summer.

The company signed the world's first commercial contract to sell fossil-free fertilizers to Lantmännen, a leading European agricultural cooperative, in January 2022 (*Fertilizer International* 506, p8). These will be produced by Yara and marketed by Lantmännen in Sweden later this year.

The commercial deal with Lantmännen provides guaranteed market access for the green fertilizers Yara will produce using renewable energy. This should help decarbonise the food chain while offering consumers more sustainable food choices.

Yara plans to supply the market with nitrate-based fertilizers with an 80-90 percent lower carbon footprint. These carbon savings will be validated by DNV, an independent assessor.

Yara's first fossil-free fertilizer deliveries will use green ammonia sourced from a large-scale pilot project at the company's Porsgrunn plant in Norway. This is on track to begin commercial production in 2023. Porsgrunn will initially produce around 20,000 tonnes of green ammonia annually. This volume will then be converted into 60,000-80,000 tonnes of fossil-free green fertilizer.

Yara should be well-positioned to scale-up green ammonia manufacture in future from its portfolio of under-development projects in Norway, the Netherlands and Australia. The company is planning to convert its entire Porsgrunn plant to green ammonia within the next 5-7 years.

"We have to transform the food system to deliver on the Paris Agreement, and this will require collaboration across the entire food chain instead of working in silos," said Svein Tore Holsether, Yara's president and CEO. "The Yara-Lantmännen partnership is a concrete example of how this can be done."

"With green fertilizers from Yara in place, we enable Swedish farmers to continue to be at the forefront as well as bringing sustainable food to consumers," said Per Olof Nyman, Lantmännen's president & CEO. "With this partnership, we can continue to meet an increased market demand for sustainable products."

Lantmännen – through its *Farming of the Future* programme – has already reduced the climate footprint of wheat cultivation by as much as 30 percent since 2015. Including green fertilizers within this programme should reduce the climate impacts of cereal growing by a further 20 percentage points.

Yara has also agreed to supply fossil-free fertilizers to El Parque Papas, Argentina's largest potato grower later this year (*Fertilizer International* 512, p8). Yara calculates that the use of its green fertilizers for potato crop nutrition will cut greenhouse gas (GHG) emissions at farm level by around 29 percent, versus standard fertilization practice. Green fertilizers will also reduce the overall carbon footprint of consumer snacks like potato chips (crisps) by around 5-10 percent.

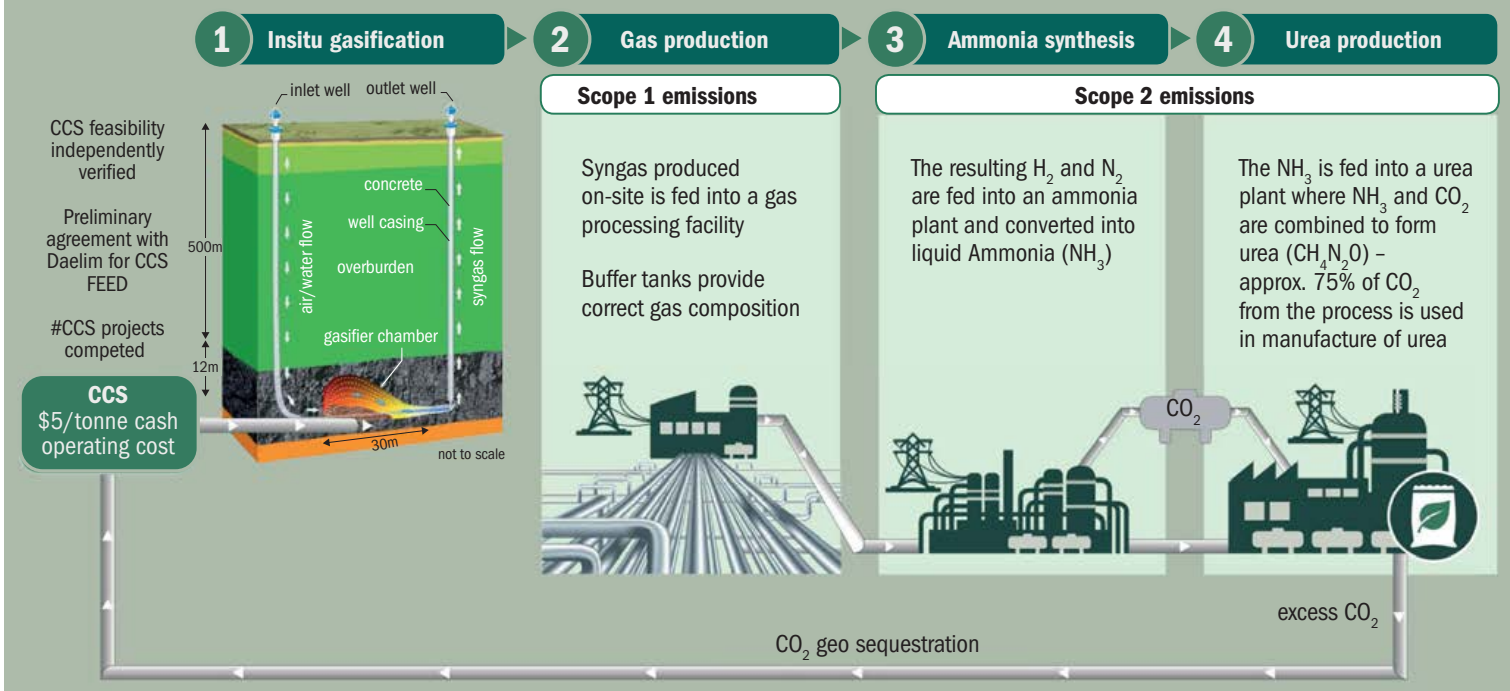
"Most people probably don't think about emissions when eating their chips. But there are huge opportunities to decarbonize snacks, if we find business models that enable each step of the value chain to contribute and to benefit. This is why the agreement between Yara and El Parque papas is important – we show that this can be done," said Svein Tore Holsether, Yara's CEO.

El Parque Papas is Argentina's single biggest potato farmer. The company supplies 14,000 tonnes of potatoes to Argentinian food processors every year. These are used to produce some of the country's most popular potato chips.

Carbon-neutral urea production

Stamicarbon has been selected as the licensor for the NeuRizer urea project (NRUP) in Leigh Creek, Australia. The site is located 550 kilometres north of Adelaide in South Australia.

Fig. 3: **The carbon-neutral urea production process for NRUP incorporates in-situ gasification and carbon capture and storage (CCS)**



Source: NRZ

NRUP is aiming to be Australia's first fully integrated, carbon-neutral urea production plant, having on-site availability for all the inputs (gas, power and CO_2) required for low-carbon urea production.

KBR will provide technology licensing and engineering for the project's 1,600 tonne/day ammonia plant. This will be based on KBR's highly efficient Purifier® process. Stamicarbon, meanwhile, will deliver the process design package (PDP) for the project's 2,850 t/d capacity urea melt and granulation plant. NRUP will use Stamicarbon's Launch Melt™ flash design for the melt plant (with a pool reactor) and its Launch Finish™ granulation design for the granulation plant.

Stamicarbon's Launch Melt™ design significantly reduces the melt plant's steam consumption due to its high energy efficiency. Its Launch Finish™ fluid-bed granulation design also has favourable characteristics. These include low formaldehyde consumption, low dust and ammonia emissions, high product quality, and high on-stream times. Launch Finish™ also significantly reduces the physical footprint and capital cost of the plant by minimising the equipment required. Fewer equipment items also help cut maintenance costs and deliver operational savings.

Doug Kelly, KBR president, technology, said: "We are excited to provide our energy-efficient ammonia technology for NeuRizer's flagship carbon-neutral project for the local and export agriculture markets. This project reaffirms our commitment to continuing to explore novel ways to help our clients meet their business and sustainability targets."

Stephen Zwart, Stamicarbon's vice president of licensing, said: "This is the first new grassroots urea capacity in Australia in decades. It is a genuinely solid project with an innovative concept that has been built from the ground up. We are proud to be contributing to carbon neutral fertilizer solutions that will help close urea supply-demand in Australia, supporting farmers and food production across the country."

The NRUP will produce low-cost, high-quality, carbon-neutral urea using novel in-situ gasification (ISG) technology (Figure 3). Urea synthesis and production will consume a large proportion of the carbon dioxide generated during syngas production – with any excess CO_2 being captured and stored underground (geo-sequestration).

A bankable feasibility study (BFS) and front-end engineering design (FEED) work are currently in progress and will be followed by a final investment decision (FID) for NRUP. Project start-up is currently scheduled for 2025.

India ramps up nano fertilizer production

Private sector Indian fertilizer producer Coromandel International launched a new nanotechnology-based phosphate fertilizer, Nano DAP, in June.

"We have completed around 700 field trials... to establish the efficacy of the product. It has also received regulatory clearance," the company said in a statement.

Coromandel is setting up a new production plant to manufacture Nano DAP in Andhra Pradesh to begin supplying the market this year.

The new product was developed at Coromandel's R&D centre at the Indian Institute of Technology, Bombay. The Chennai-based company – part of Murugappa Group – said the efficacy, biosafety and toxicity of Nano DAP was investigated prior to its launch via extensive field studies.

"Nano DAP will go a long way in driving the sustainability of Indian farms through improving nutrient uptake, lowering water consumption and minimising environmental losses," said Arun Alagappan, Coromandel's executive vice-chairman.

The adoption of Nano DAP should also make farm economics more attractive by driving sustainable fertilizer usage and site-specific nutrient applications, Alagappan said. He also praised the Indian government for its help.

"I would like to thank the government for its continuous guidance, extending policy and regulatory support and providing the requisite impetus for adoption of new technologies in farming," he said.

The Indian Farmers Fertilizer Cooperative Limited (IFFCO) is also scaling-up its production of nanotechnology fertilizers. Indian government minister Amit Shah officially launched IFFCO's new liquid nano DAP product in April.

IFFCO will sell half-litre bottles of nano DAP at INR 600, less than half the current price of an equivalent 50 kg bag of conventional DAP. It will be available to farmers from the 2023 kharif season.

IFFCO is setting up production plants for nano DAP at Kalol and Kandla in Gujarat and Paradeep in Odisha. The Kalol plant is already in production and IFFCO says it will manufacture 50 million bottles on nano DAP this fiscal year, equivalent to 2.5 million tonnes of conventional DAP. The company plans to scale up nano DAP production to 180 million bottles by 2025/26.

"The launch of IFFCO's liquid DAP nano is an important beginning towards making India self-reliant in the field of fertilizers," Shah said. India currently imports around 10 million tonnes of DAP annually, with more than half of this volume sourced from West Asia and Jordan.

The start of nano DAP production follows IFFCO's launch of nano urea liquid in June 2021 (*Fertilizer International* 503, p20). The company is mass producing half-litre bottles of the nano urea from three new production plants – Kalol, Gujurat and Aonla and Phulpur in Uttar Pradesh.

Initially, these sites will provide enough capacity to produce 140 million bottles annually, although IFFCO plans to ramp up production to 320 million bottles per year. The company calculates that producing nano urea at this scale will be enough to replace 13.7 million t/a of standard urea production.

Currently, Indian farmers have a financial incentive to overuse urea as it attracts significantly higher government subsidies relative to other types of fertilizer. IFFCO's new nano urea liquid, in contrast, is a much more efficient nitrogen product. Each bottle – which contains 40,000 ppm of nitrogen – delivers enough crop nutrients to replace at least one 45 kilo bag of standard commodity urea, according to IFFCO.

IFFCO believes its new nano urea product can avoid many of the environmental problems associated with the use of standard granular urea, such as nitrous oxide and ammonia emissions, soil acidification and water eutrophication. As well as cutting environmental losses, IFFCO says nano urea is more sustainable in other ways: "It will reduce the input cost to farmer. Due to its small size, the bottle can be kept in the pocket and will significantly bring down the cost of logistics and warehousing also," the company said.

Nano fertilizers have been heralded as a potential game changer for the market, although this does hinge on their acceptance by farmers. IFFCO is therefore planning a massive nationwide campaign to demonstrate and train farmers about the usage and application of nano urea.

Harmonising crop nutrition

Nutrien has launched a new product that uses a unique technology to evenly integrate sulphur, phosphate, and nitrogen within fertilizer granules.

Known as Smart Nutrition™ MAP+MST® (9-43-0-16S), Nutrien says the product is one of the most efficient dry fertilizer systems on the market – due to its ability to deliver key nutrients to crops when they need it most during the growing season. It is designed to optimise crop nutrition and boost plant growth while providing a familiar handling experience.

Micronized Sulphur Technology (MST), a patented process under license from Sulvaris Inc., converts elemental sulphur into ultra-fine, evenly sized particles with an average diameter of 15 microns. Smart Nutrition™ MAP+MST® integrates this micronised sulphur directly into the manufacturing process for monoammonium phosphate granules (MAP) – resulting in a highly uniform distribution of MST within the MAP granule.

Crops are dependent on microbes to help make sulphur available for root uptake. They do this by oxidising elemental sulphur – which is not accessible to plants – and transforming it into plant-available sulphate. However, if sulphur particles are large, the surface area exposed for oxidation is relatively small and microbial conversion rates are correspondingly slow. In contrast, when elemental sulphur particles are small, as with MST, there is a much larger surface area available and microbial activity increases substantially. This characteristic, together with the uniform distribution of MST within every MAP granule, offers more rapid conversion to sulphate and therefore better crop performance.

Due to these microscopic-level advantages, Smart Nutrition™ MAP+MST® provides versatility in sulphur management and distinct benefits over sulphate fertilizer products. The oxidation of elemental sulphur is a biological process and the rate at which MST is converted to sulphate is therefore highly temperature and moisture dependent.

When soils are cold, the MST remains in elemental form and remains resistant to leaching. As soil temperatures warm, biological activity increases and starts converting the elemental sulphur into sulphate for quick crop uptake. This allows Smart Nutrition™ MAP+MST® to be applied in the fall (autumn) season without fear of sulphate losses. This is followed by the subsequent slow-release of plant available sulphur in the spring to match crop needs.

Nutrien's new Smart Nutrition™ MAP+MST® product evenly integrates sulphur, phosphate and nitrogen within granules.

PHOTO: NUTRIEN

In US field trials, Smart Nutrition™ MAP+MST® has been shown to deliver an adequate supply of sulphur to crops. For comparison purposes, trial results were compared to the equivalent sulphur supply rates from the application of ammonium sulphate (AMS), a readily available sulphate-sulphur source. Results indicate that Smart Nutrition™ MAP+MST® supplies adequate sulphur to maximise yields, matching the sulphur availability from AMS applications, while protecting the environment from potential leaching losses.

In summary, the key benefits of Smart Nutrition™ MAP+MST® (9-43-0-16S) include:

- High performance across diverse crop, soil and environmental conditions
- Increased nutrient availability for quicker crop uptake
- Slow-release behaviour keeps sulphur available throughout the growing season
- Optimised for dry fertilizer storage, handling, and spreading logistics
- Safe for seeds, handling and storage.

Tuning wastewater into fertilizers

Netherlands-based Fertipaq exhibited at this year's IFA annual conference in Prague – attracting a lot of interest in their novel Fertipaq s600 organic sulphur fertilizer and their 'circular economy' business model.

Fertipaq is a wholly-owned subsidiary of Netherlands-headquartered water treatment technology company Paques. The company sources its concentrated liquid sulphur suspension fertilizer from wastewater treatment plants around the globe.

The Thiopaq desulphurisation units installed at these plants biologically treat and recover sulphur from wastewaters rich in hydrogen sulphide. The sulphur produced by these installations comes from a range of different industries including pulp and paper and food and beverage companies.

Fertipaq s600 has distinct advantages over sulphur products derived from oil and gas production, according to the company. Its hydrophilic properties and very fine particle size (<20 microns), for example, ensure the product is 'rain fast' and oxidises easily to supply crops with the sulphur they need under difficult growing conditions.

Fertipaq s600 is a liquid fertilizer and is therefore sprayable and – advantageously – can be added to and applied alongside nitrogen solutions. Applying sulphur and nitrogen together makes sense, suggests Fertipaq, as these two nutrients are closely connected. Sulphur plays a role in nitrogen uptake, for example, and without adequate nitrogen, photosynthesis cannot take place.

In addition to its concentrated liquid sulphur suspension product Fertipaq also manufactures and sells sulphur cake, a raw material with a high dry matter content that is suitable for various agricultural and horticultural applications. ■

References

1. Kiferle, C., et al., 2021. Evidences for a nutritional role of iodine in plants. *Front. Plant Sci.* 12:616868.
2. Rengel, Z. et al. (Eds.), 2022. *Mineral Nutrition of Plants*. 4th Ed, December 2022. Academic Press.
3. Kiferle, C., et al., 2022. Improvement in fruit yield and tolerance to salinity of tomato plants fertigated with micronutrient amounts of iodine. *Sci. Rep.* 12:14655.

Fertilizer technologies – innovating for the future

Technological innovation is vital to solving the global food challenge and delivering the transition to a low-carbon economy. **Pejman Djavdan**, Stamicarbon's CEO, sets out his vision for a future-proof fertilizer industry – one that will enable the sustainable intensification of agriculture while also protecting the environment.

PHOTO: STAMICARBON

Opening of the Purcell Agri-Tech controlled-release fertilizer (CRF) plant in Sylacauga, Alabama, USA.

One of the most pressing problems confronting humanity this century is how to feed a growing global population in a sustainable way, in harmony with the planet and its finite resources.

The second United Nations (UN) Sustainable Development Goal (SDG) is to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture". This is a fundamentally important and ambitious goal, especially as the world's population continues to increase rapidly – from around two billion in 1927 to three billion in 1960, then more than doubling to seven billion in 2011. By 2055, this figure is predicted to be around ten billion.

In addition to exponential population growth, the amount of food consumed per capita is also on the rise. Consequently the UN's Food and Agriculture Organisation (FAO) has estimated that global crop production needs to increase by more than 45 percent by 2050 if we want to end hunger and malnutrition.

Stamicarbon, the nitrogen technology licensor of MAIRE Group, believes that technological innovation is vital to solving this global food challenge – by intensifying agriculture while at the same time protecting the environment.

Sustainability is also at the heart of the world's climate challenge and – by transforming both processes and economic systems – is enabling the transition from traditional fossil-based industries to sustainable low-carbon-based models. The fertilizer industry is no exception. Stamicarbon is therefore helping to accelerate the energy transition by developing and investing in cutting-edge technologies for future-proof fertilizer production.

Stamicarbon has the following two aims as part of its 'Vision 2030' innovation agenda: firstly, reducing the emissions and energy consumption of fertilizer plants and, secondly, improving the nutrient use efficiency (NUE) of fertilizers. To achieve this, the company is focusing its innovation efforts in three particular areas:

- The sustainable production of nitrogen-based fertilizers from renewable feedstocks using renewable energy
- Making fertilizers more effective and efficient by increasing their NUE
- The digitalisation of fertilizer plants to improve their energy consumption and reduce emissions.

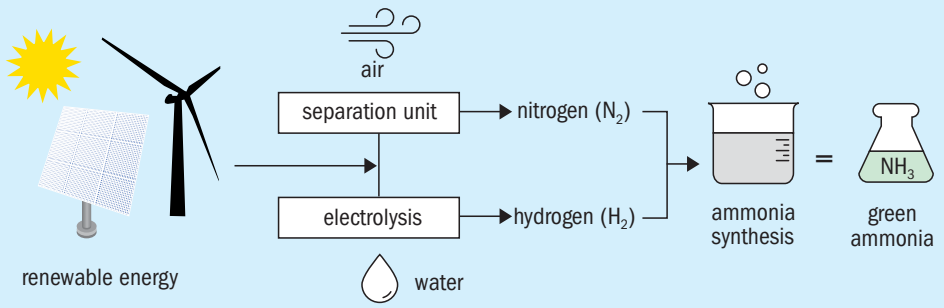
Green ammonia

Fertilizers increase crop yields by adding nutrients to plants – allowing them to grow faster and stronger. Using fertilizers to intensify agriculture is therefore vital for feeding the world's growing population. Equally, it is also clear that the environmental impacts of fertilizer production and on-farm use need to be reduced significantly.

In the past, economy of scale was the primary motivation for building large capacity fertilizer plants. Nowadays, however, a shift in the industry's approach can be seen. This is illustrated by the increasing number of projects for smaller, distributed ammonia production units. These are powered by renewable electricity from small- and medium-scale hydro, wind and solar installations, helping the industry move towards an environmentally-friendly future. This type of distributed production is vital in the transition from fossil fuels to renewable energy resources.

By enabling the production of ammonia using nitrogen captured from the air and

Fig. 1: **Stamicarbon's green ammonia production process**



Source: Stamicarbon

hydrogen generated via water electrolysis, Stami Green Ammonia technology (Figure 1) is a significant leap forward for fertilizer industry sustainability. Unlike traditional ammonia production, this process does not use fossil fuel feedstocks such as natural gas or coal. This innovation will therefore help to significantly reduce ammonia production emissions, which currently comprise about one percent of all greenhouse gas (GHG) emissions.

The Stami Green Ammonia process – being powered by renewable or carbon-free energy sources – enables the sustainable production of green nitrogen fertilizers like ammonium nitrate or calcium ammonium nitrate from a green ammonia feedstock. The green ammonia generated can also be used as a shipping fuel or energy carrier, as well as in fertilizer production.

Distributed ammonia production in sub-Saharan Africa

Distributed ammonia production is particularly important in areas with low fertilizer availability. Sub-Saharan Africa is one region where local, small-scale production can effectively contribute to regional self-sufficiency in fertilizers. Stamicarbon recently completed a pre-feasibility technical study with Minbos Resources to determine the most effective plant configuration for a green nitrates production complex in Malanje Province, Angola. The complex combines Stami Green Ammonia and Nitric Acid technologies. It will be powered using 200 MW of 100 percent renewable electricity supplied by the nearby Capanda Hydroelectric Dam. The study assessed the production of two kinds of nitrates: calcium ammonium nitrate (CAN) fertilizer for domestic use and low-density ammonium nitrate (LDAN) for the mining industry in neighbouring nations.

Enhanced efficiency fertilizers (EEFs)

As well as producing fertilizers sustainably from renewable resources, it is also important to improve the use efficiency of fertilizers. The introduction of innovative fertilizers that are more effective and efficient is enabling the industry to make this sustainable transition.

Nutrients such as nitrogen, phosphorus, potassium and sulphur are vital for plant growth. They do, however, tend to volatilise into the air or leach into the soil with regular fertilizer application – leaving less nutrients available for plants. These losses have undesirable consequences for the environment and human health, by causing high levels of nitrates and phosphorus in groundwater, ammonia volatilisation into the atmosphere, and nitrogen oxide and nitrous oxide emissions. These harm the environment and, ultimately, the planet.

Improving the nutrient use efficiency (NUE) – the ratio between the nutrient input from fertilizers and the nutrient output via crops – can help prevent these losses while providing farmers with economic benefits. Improving the NUE for farmers in China, for example, can reduce fertilizer applications. Elsewhere, enhancing NUE can help increase yields in sub-Saharan Africa, and decrease the environmental impacts of fertilizer use in Europe and the USA.

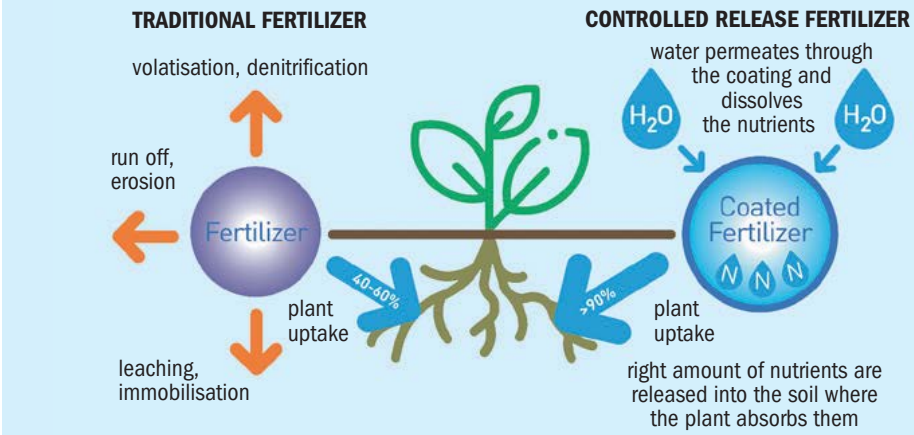
The adoption of enhanced efficiency fertilizers (EEFs) can deliver the increases in NUE needed. EEFs include controlled-release, slow-release, and inhibited fertilizers. These innovative fertilizers prevent nutrient losses by inhibiting natural processes in the soil (inhibited fertilizers) or controlling the delivery of nutrients to plants (slow- and controlled-release fertilizers).

Nitrogen is essential for plant growth, yet up to half of this nutrient is lost to air or surface water when applied. Nitrogen-based EEFs are therefore increasingly common. Coating urea with sulphur or a permeable membrane, for example, helps control the release of nutrients into the soil. These products use the 4Rs principle (delivering the right nutrients at the right time, place and rate) to prevent the oversupply of nutrients and minimise their loss to the air or groundwater (Figure 2).

Coating urea to improve NUE

In 2018, Stamicarbon collaborated with Pursell Agri-Tech in the United States to develop and license controlled-release fertilizer (CRF) production technology. At the heart of this technology is a modular coating plant with a compact design and a relatively low capex. These characteristics allow such plants to be constructed close to existing logistics centres near end-user markets. The first commercial reference plant based on Stamicarbon's Controlled-release Fertilizer Design is located in Sylacauga, Alabama, USA (see main photo). This has the capacity to produce about 275 tonnes per day of CRF and is operated by partner company Pursell

Fig. 2: **Controlled-release fertilizers (CRFs) prevent nutrient losses**



Source: Stamicarbon

Fig. 3: **KPIs displayed on a Process Monitor dashboard**

Agri-Tech on a 24 hour basis for five days per week. Stamicarbon is also collaborating with partners on biodegradable CRF coatings and CRFs containing added (micro-)nutrients.

Optimising fertilizer plants

Digitalisation is becoming increasingly important in the process industry, as it can deliver benefits for technology licensors and fertilizer producers alike. Digital tools, by enabling the collection, analysis and exchange of data, enhance plant efficiency and productivity. The resulting transformation of real-time plant data into meaningful information offers valuable process insights and enhances plant control. This, in turn, drives continuous optimisation by improving production efficiency, reducing plant operating costs and minimising health, safety and environmental issues.

Although the chemisty of urea plants is fundamentally simple, the underlying physics of urea and carbamate mixtures is complex. To cope with this complexity, Stamicarbon offers a Process Monitor as part of its digital portfolio. This is driven by a process model of the plant and helps improve plant load and reduce energy consumption. This model calculates two types of critical parameters from real-time plant data: key performance indicators (KPIs) and soft-sensor key variables (KVs). KPIs include figures such as plant load, energy consumption and emission figures, while KVs include values such as equipment efficiency, equipment load and reactor conversion. Having processed the real-time data, the Process Monitor presents this information via customisable dashboards (Figure 3).

The Process Monitor's engine operates in a secure cloud environment and receives real-time plant data unidirectionally (Figure 4). Urea plants can generate millions of data outputs on any given day. Having complete access to all of this available information in real-time therefore enables operators to better understand plant data and make informed operational decisions.

Process Monitor case study

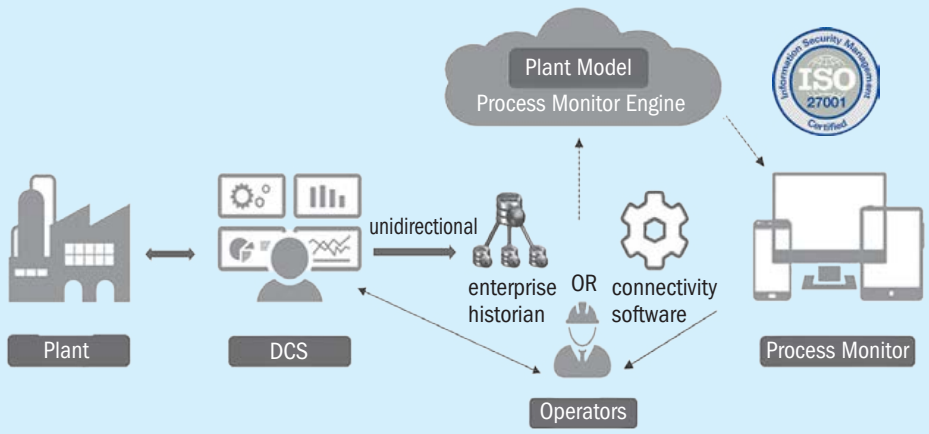
A Process Monitor has been installed at Nutrien's Borger urea plant, Texas, USA. This digital tool is used in combination with Advance Consult™ to evaluate the process data and better understand the meaning of the KPIs and KVs. This has allowed Nutrien to optimise the Borger's plant performance. Measurement errors, equipment bottlenecks and inefficiencies were detected. Deviating operating strategies developed from the model data have also proved very efficient. One such deviating operating strategy, for example, delivered three percent extra production capacity and a steam saving equivalent to 0.3 MMBTU/st urea.

Stamicarbon's Vision 2030

The fertilizer industry – and society as a whole – are aware of the power of innovative technologies for increasing agricultural productivity while simultaneously reducing agriculture's impact on the environment. In response, Stamicarbon is constantly innovating to build a future where people, businesses and the planet can thrive in 2030 and beyond. The company is delivering on the innovation ambitions outlined in its Vision 2030 strategy by focusing on three main areas, as described above.

The sustainable transformation of the fertilizer industry is ongoing and requires ground-breaking solutions to key global challenges – enabling the world to feed itself and improving our quality of life. Stamicarbon, by constantly developing new technologies, collaborating with our partners, customers, and suppliers, and challenging the status quo, is determined to be a part of the solution.

Fig. 4: **Process Monitor architecture**



Source: Stamicarbon

July-August 2023

phosphates & potash INSIGHT

Left: A phosphogypsum (PG) stack.

Choosing the right phosphoric acid process

In this review article, Hatch's **Jayden Ladebruk, Lyndsay Tran, Amelia Parrenin,** and **Edward DeRose** outline the wide range of phosphoric acid production technologies, and discuss how industry challenges are influencing the choice of phosphoric acid process.

Phosphoric acid is a critical raw material consumed on a large scale globally for phosphate fertilizer production. Purified phosphoric acid is also manufactured for high-value food, feed, and industrial end-markets. Demand for phosphoric acid is also projected to increase in the future as it is a key ingredient in the production of lithium iron phosphate (LFP) batteries.

Over time, the industry has examined numerous alternative ways of commercially producing phosphoric acid in response to multiple challenges – such as evolving environmental regulations, declining phosphate ore grades, and tailings management.

Hatch has investigated the wide range of available technologies for phosphoric acid production to: firstly, understand the benefits of each process; and, secondly, help clients adapt to a constantly changing market and operating conditions. These technologies are primarily hydrometallurgical or pyrometallurgical processes.

This article summarises these investigations and in particular:

- Provides an overview of the main commercial process options for phosphoric acid production
- Highlights the various strengths and weaknesses of each production route.

The conventional production route

The standard wet process for phosphoric acid production is a hydrometallurgical method. Sulphuric acid is used to acidulate phosphate rock to produce phosphoric acid and a calcium sulphate (phosphogypsum) by-product.

The phosphogypsum (PG) generated contains different types and quantities of impurities, including radionuclides, due to the natural variations within phosphate rock deposits. While clean gypsum is a valuable by-product, commonly used in building materials, the presence of these impurities often prevents PG from being used or sold. PG therefore usually needs to be managed and stored as waste in phosphogypsum stack impoundments (see main photo).

Acidulation with sulphuric acid currently dominates the industry, accounting for nearly 90 percent of global phosphoric acid production[1]. This is due to the availability and lower price of sulphuric acid and the overall cost efficiency of the process.

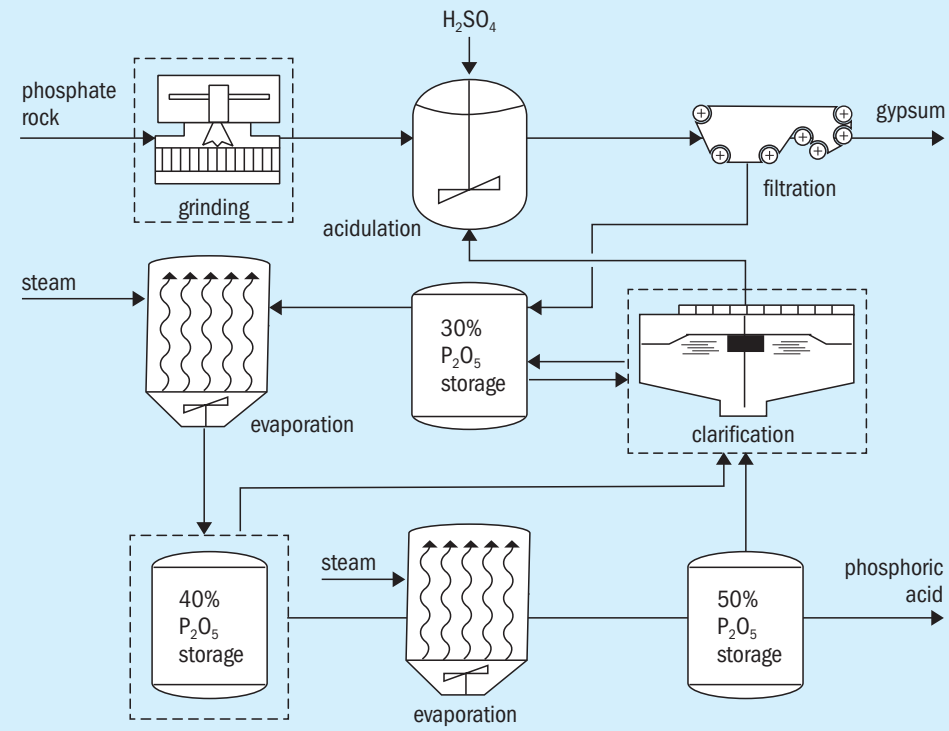
Because this wet process route has been widely adopted and thoroughly investigated over many years, multiple process variations have been developed. Individual process variations are classified based on the calcium sulphate regime under which they operate – these being distinguished by their operating temperature and P_2O_5 concentration.

Table 1: **The five main wet process routes for phosphoric acid production via the acidulation of phosphate rock with sulphuric acid**

Variation	Abbreviation	Typical acid strength	Brief description
Dihydrate	DH	28-30% P_2O_5	Acidulation in DH regime, filtration to separate acid from gypsum
Hemihydrate	HH	40-50% P_2O_5	Acidulation in HH regime, filtration to separate acid from gypsum
Hemihydrate recrystallisation	HRC	30-32% P_2O_5	Acidulation in DH regime, recrystallise to DH, filtration separate acid from gypsum
Dihydrate Hemihydrate	DH/HH	32-35% P_2O_5	Acidulation in DH regime, filtration to separate acid from gypsum, conversion of DH to HH, wash HH cake
Hemihydrate Dihydrate	HDH	46-52% P_2O_5	Acidulation in HH regime, filtration to separate acid from gypsum, wash HH cake, repulp cake, recrystallisation of HH to DH, filtration

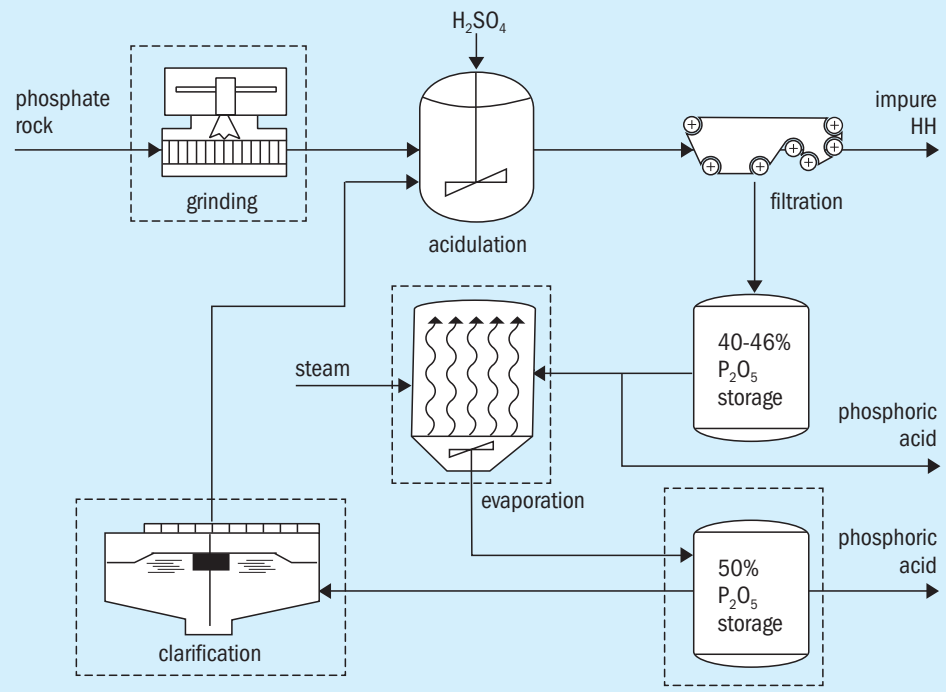
Source: Becker, 1983

Fig. 1: **The dihydrate (DH) process**



Source: Becker, 1983

Fig. 2: **The hemihydrate (HH) process**



Source: Becker, 1983

In general, processes operate under either a dihydrate or hemihydrate regime, with some processes alternating between the two.

The five most common process variations for acidulation with sulphuric acid, as summarised in Table 1, are:

- Dihydrate (DH)
- Hemihydrate recrystallisation (HRC)
- Dihydrate hemihydrate (DH/HH)
- Hemihydrate (HH)
- Hemihydrate dihydrate (HDH).

The DH route

The DH wet acid process involves acidulation under a dihydrate regime (Figure 1) and is currently the most common phosphoric acid production route. Acidulation is followed by filtration, clarification and, finally, multiple evaporation steps to achieve a stronger acid concentration.

"Acidulation with sulphuric acid currently dominates the industry, accounting for nearly 90 percent of global phosphoric acid production."

The DH process has long been favoured due to advantages such as its:

- Simplicity of design
- Technological maturity
- Materials of construction – it only requires a lower grade of stainless steel
- Ease of operation.

Despite these advantages, the DH process generates the lowest strength acid, in comparison to the other process routes, typically accompanied by higher levels of aluminum and fluorine. This makes additional clarification steps necessary along with higher steam consumption for evaporation[1].

Furthermore, the impure PG generated by the DH process requires relatively costly long-term managed storage within a lined impoundment.

The HH route

The HH process (Figure 2) has the following characteristics:

- Similar to the DH process in terms of its simplicity
- But generates a stronger (40-46% P_2O_5) and purer acid (lower SO_4, Al, and F)
- Can handle coarse rock, reducing both grinding requirements and power consumption
- Only needs a single filtration stage.

The HH process generally has lower evaporation and clarification requirements due to the high strength and purity of the acid generated. This reduces the overall capital cost by 20-25 percent versus the DH process. However, its higher acid strength means a larger filter area is required to avoid higher PG crystal lattice losses. Generally, higher temperature and acid strength conditions also make the HH process technically challenging to operate. The HH process, similar to the DH route, generates an impure PG by-product which requires stacking[1].

The HRC route

The HRC process (Figure 3) involves acidulation in the hemihydrate regime followed by recrystallisation in the dihydrate regime. In comparison to the DH route, this process:

- Generates stronger acid at higher efficiency (97%) with lower reagent consumption
- Requires a single filtration stage with a lower filter area
- Produces a saleable PG by-product.

The HRC process does, however, require:

- A finer rock grind
- Sulphuric acid dilution
- A large recrystallisation volume
- Additional clarification and evaporation steps.

Furthermore, as its reaction stage is operated under the HH regime, the HRC process experiences many of the same operational difficulties as the HH process[1].

The DH/HH route

The DH/HH process (Figure 4) involves acidulation in the dihydrate regime followed by filtration. The PG obtained is then recrystallised/dehydrated under the hemihydrate regime followed by another stage of filtration.

In general, the DH/HH route is:

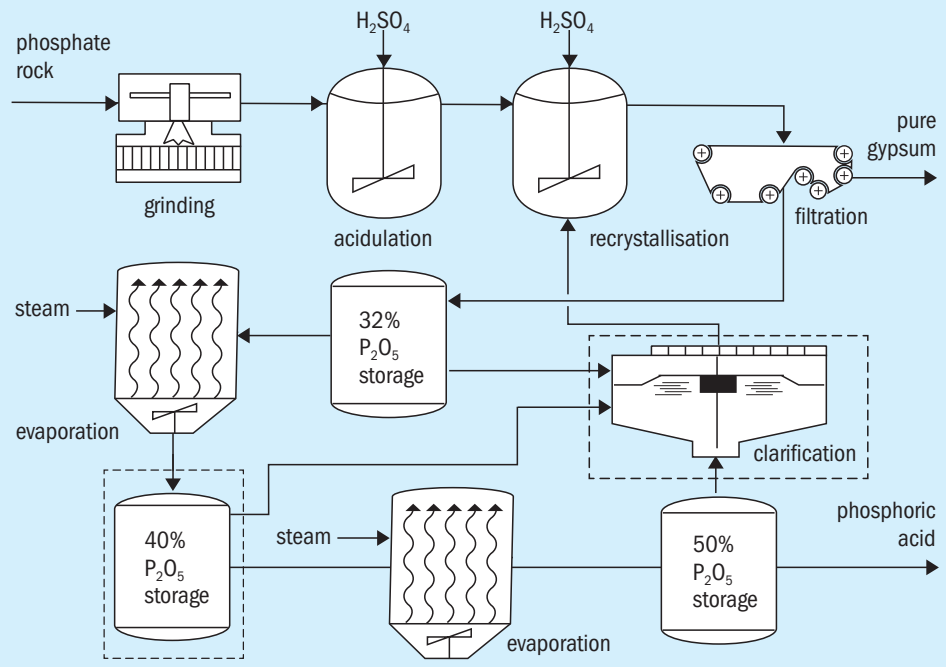
- Highly efficient (98%)
- Technologically mature
- Flexible to different rock sources
- Produces a pure HH cake which can be used directly for plasterboard once rehydrated.

The main pitfalls of the DH/HH route are the need for[1]:

- Additional clarification and evaporation steps
- Two-stage filtration
- Optional rehydration of the HH cake to obtain clean gypsum
- Higher capital costs due to its extra processing steps and the use of sophisticated materials.

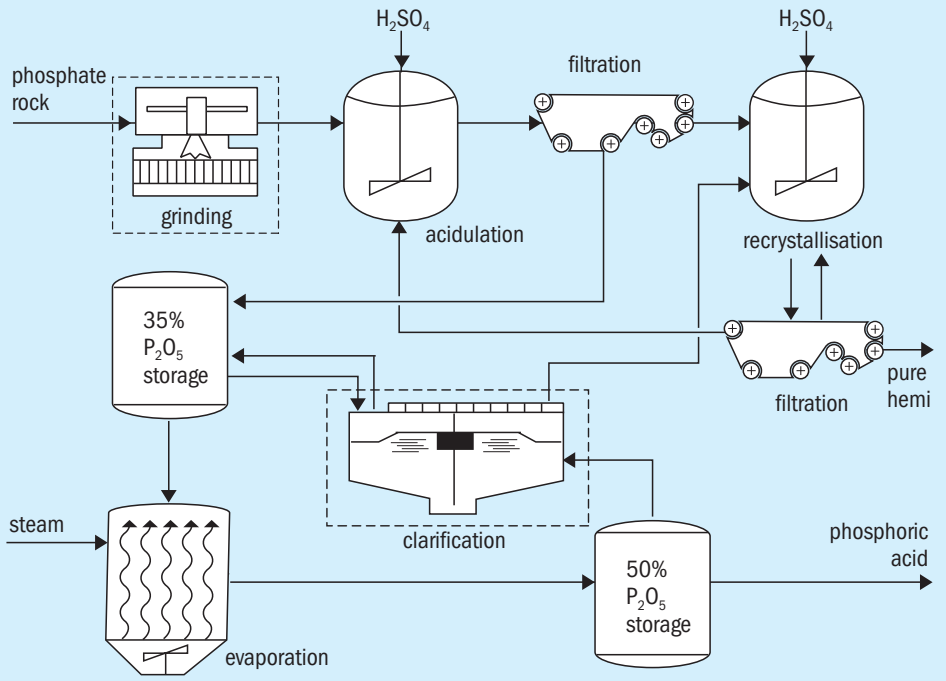
The Central Prayon Process (CPP) and Di-Attack Hemihydrate Filtration (DA/HF) process, both developed by Prayon Technologies, are two examples of the DH/HH route. A conventional DH plant can be upgraded to the DA/HF process (*Fertilizer International* 496, p52) by changing the plant digestion tank into a conversion tank with the addition of a steam sparger and sulphuric acid pipe[2].

Fig. 3: **The hemihydrate recrystallisation (HRC) process**



Source: Becker, 1983

Fig. 4: **The dihydrate hemihydrate (DH/HH) process**



Source: Becker, 1983

The HDH route

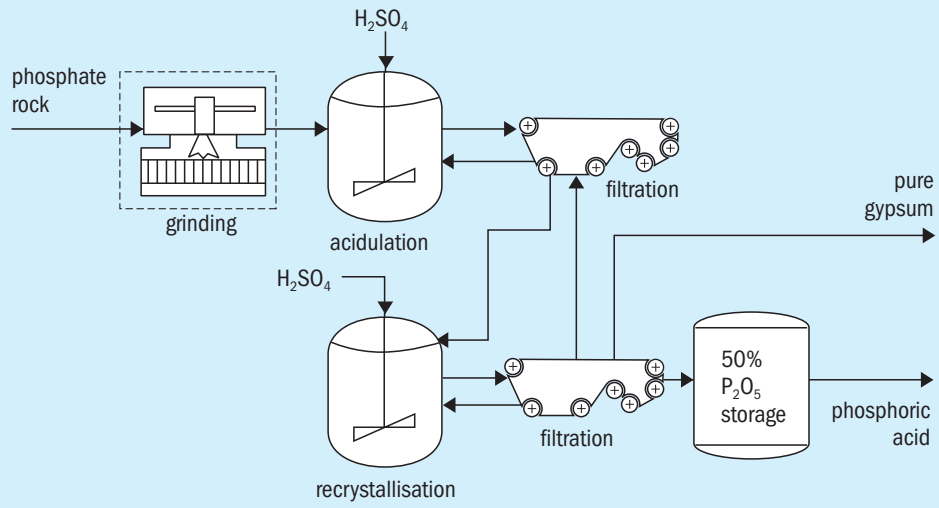
The HDH process involves acidulation in the hemihydrate regime, followed by filtration, then recrystallisation to the dihydrate regime, and finally another stage of filtration (Figure 5). The HDH route is notable for:

- Producing the strongest phosphoric acid concentration of all the sulphuric acid acidulation processes
- Its high efficiency (+98.5%)
- Its ease of operation
- Its low sulphuric acid consumption
- Generating saleable gypsum.

However, the HDH process also[1]:

- Requires two filtration stages
- Needs high-grade alloys
- Is technically challenging to design
- Has difficulty accepting igneous phosphate rock sources.

Fig. 5: **The hemihydrate dihydrate (HDH) process**



Source: Becker, 1983

Table 2: **Summary of the advantages and disadvantages of the five main wet process routes for phosphoric acid production**

Process considerations	DH	HRC	DH/HH	HH	HDH
Produces strong acid directly	X	X	X	✓	✓
Produces pure by-product	X	✓	✓	X	✓
Produces low-impurity acid	X	X	X	✓	✓
Lower capital cost	X	X	X	✓	X
Uses coarse rock	X	X	X	✓	X
Can use rock slurry	✓	X	X	X	X
Proven process for multiple rock types	✓	✓	✓	X	X
Low sulphuric acid consumption	X	✓	✓	✓	✓
High efficiency	X	✓	✓	X	✓
Simple materials of construction	✓	X	X	X	X

Source: Hatch

Sulphuric acid acidulation – process comparison

The five wet process routes each have their own set of advantages and disadvantages, as shown in Table 2. These factors must be taken into consideration and compared when selecting the right phosphoric production process for a given project and client.

Historically, acid strength, capital cost, and acid purity have been prioritised by phosphoric acid producers as determinants in process selection. Each client does, however, have a different set of process needs and requirements. Also, much more attention is now being given to the ability of a process to produce a pure and saleable gypsum by-product – due to cost pressures, increasingly stringent environmental regulations and land-use limitations.

Acidulation with hydrochloric acid

The acidulation of phosphate rock with hydrochloric acid is another commercial phosphoric acid production method. This offers several general advantages, including:

- The production of high-quality phosphoric acid
- Reduction in leaching time
- The ability to use lower-grade phosphate rock as a feedstock.

Acidulation with sulphuric acid produces large volumes of insoluble calcium sulphate. This then needs to be removed by filtration or other mechanical methods. The removal of soluble chloride-based by-products (mainly $CaCl_2$) generated by acidulation with hydrochloric acid, in contrast, involves very different treatment or extraction techniques. The hydrochloric acid route also requires the use of higher cost chloride-resistant construction materials.

The Israeli Mining Industry (IMI) process was the first hydrochloric acid-based technology to be developed commercially (Figure 6). This process digests phosphate rock with hydrochloric acid and filters the resulting slurry to remove insoluble compounds. The remaining liquor is then treated via a counter-current solvent extraction process. This selectively transfers phosphoric acid to an aliphatic solvent (e.g., isoamyl alcohol, n-butanol). The extract is then washed and distilled to separate the phosphoric acid from other components (water and HCl) which are recycled. The IMI process generates concentrated phosphoric acid (95% H_3PO_4, 69% P_2O_5) as a final product[3].

With ore grades declining, acidulation with hydrochloric or phosphoric acid is becoming valued as a pre-purification process that converts impure phosphate rock to either dicalcium phosphate (DCP) or monocalcium phosphate (MCP), respectively. Usefully, the addition of a pre-purification step can eliminate the need for beneficiation from the flowsheet.

Prayon's Ecophos process is one example of a pre-purification process – and is the most widely adopted hydrochloric acid-based technology in the phosphates industry. With this technology, run-of-mine phosphate rock is digested by dilute hydrochloric acid. The resulting slurry is then filtered to remove any insoluble components. In the next step, the filtrate is neutralised with calcium carbonate or calcium hydroxide to produce DCP. This can be treated with dilute HCl or used as the feed for a dihydrate production plant to yield a relatively high quality phosphoric acid[4]. The hydrochloric acid from the process can be regenerated by treating the calcium chloride-rich cake with sulphuric acid.

Phosphoric acid acidulation

Acidulation with phosphoric acid can also be used as a pre-purification process. This is used to generate MCP via the acidulation of phosphate rock with an excess of recycled phosphoric acid. The P_2O_5 acid to P_2O_5 rock weight ratio can range from 8:1 to 15:1. This process can operate in any gypsum regime as acidulation occurs between 45-100°C[5].

Prayon's GetMoreP process is a leading example of an MCP pre-purification process. It generates a saleable gypsum

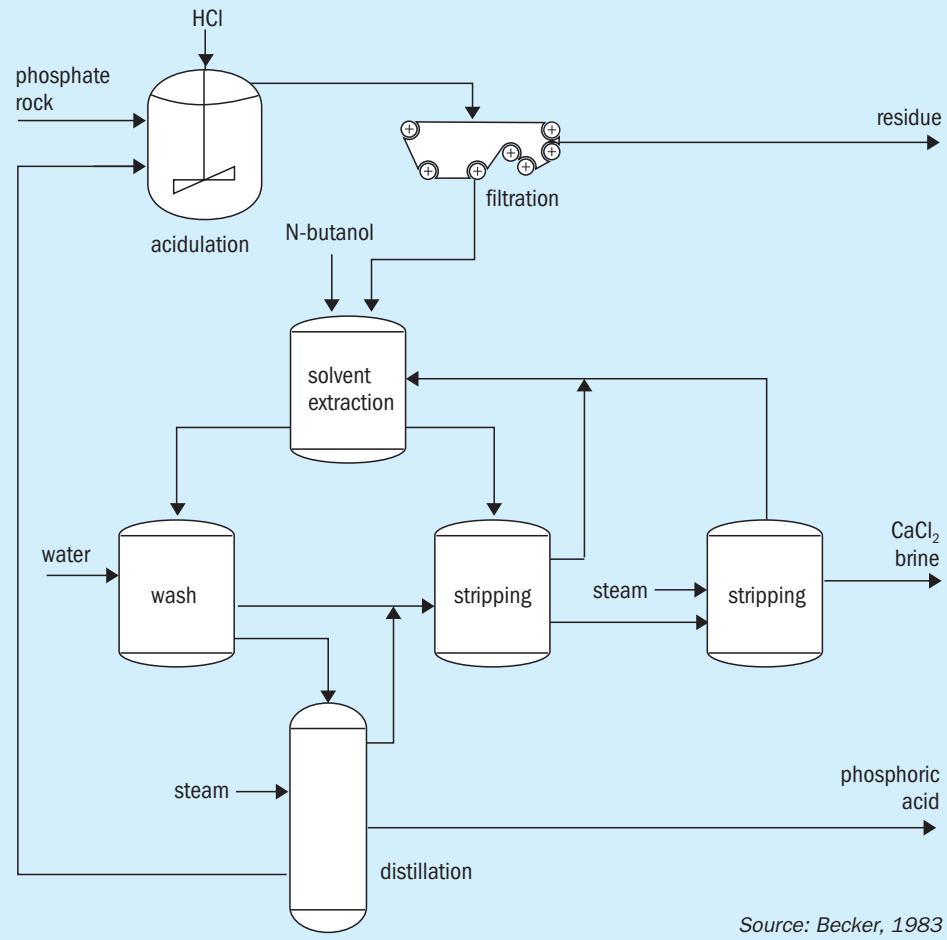
product by removing heavy metals and radioactive elements[6].

Patents for phosphoric acid acidulation generally exploit the fact that many impurities (metal sulphates, silica, fluoride, and iron and aluminium phosphates) have a low solubility in the MCP solution and can therefore be easily filtered out[5]. Some patents also incorporate an impurity removal step. These use reagents (KH_2PO_4/SiO_2, barium salts) or flocculants to target and remove impurities such as fluoride, radionuclides, alkali metal ions and silicates from the MCP solution[7, 8, 9].

Generally, by pre-purifying to MCP, patents claim that the subsequent wet production process should produce phosphoric acid at high concentration (35-55% P_2O_5) and generate cleaner gypsum – even when using lower grade phosphate rock as a feedstock.

One of the main setbacks of acidulation with phosphoric acid is, however, its technological immaturity. Although this process has been researched over the last 50 years, no commercial-scale plants using this technology are operating currently. Additionally, large recycle volumes of phosphoric acid are needed to maintain excess acid in the acidulation step. This drives up the size of equipment and therefore capital costs.

Fig. 6: **The Israeli Mining Industry (IMI) process**



Source: Becker, 1983

Nitric acid acidulation

Phosphate rock can also be acidulated with nitric acid. The nitric acid route – generally known as the nitrophosphate process – dissolves the rock in 50-60 percent nitric acid to form phosphoric acid and calcium nitrate.

The calcium nitrate generated by the process must be removed due to its hygroscopic nature. This is typically accomplished via cooling crystallisation. Solvent extraction, although technically feasible as an alternative to crystallisation, has yet to be commercially adopted in the nitrophosphate process[3].

The filtrate from the process mainly consists of phosphoric acid, some unreacted nitric acid, and traces of calcium nitrate. This mixture can be neutralised with ammonia to produce a compound fertilizer. The calcium nitrate obtained, while it can be upgraded to calcium nitrate fertilizer, is often converted to ammonium nitrate and calcium carbonate instead by treatment with carbon dioxide and ammonia[10].

The main upsides of the nitrophosphate process are that, firstly, it does not produce large quantities of hard to manage phosphogypsum and, secondly, its by-products have value as fertilizers. However, the soluble calcium nitrate by-product that is generated, in comparison to insoluble gypsum, requires more costly and operationally challenging separation methods such as crystallisation or solvent extraction (Figure 7).

Thermal acid process

The thermal acid process was the original production method for phosphoric acid, being in commercial use from the 1930s to the 1950s. Thermal acid production subsequently went into decline, however, as the process could not compete with the lower operational costs of wet processes such as the DH route.

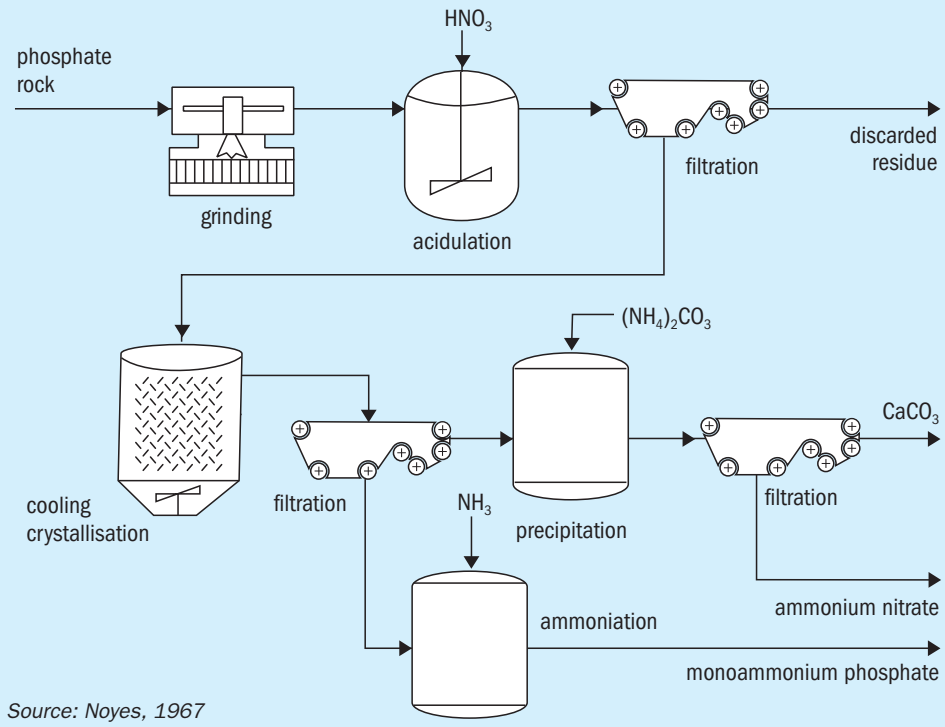
The process involves three major steps: combustion, hydration, and demisting. In the combustion step, phosphorus is oxidized in ambient air in a combustion chamber at a temperature range of 1,650-2,760°C to form phosphorus pentoxide. The phosphorus pentoxide is then hydrated with dilute phosphoric acid (H_3PO_4) or water to produce strong phosphoric acid liquid. The phosphoric acid is demisted from the combustion gas stream, usually with high-pressure-drop demisters. The concentration of phosphoric acid produced from the thermal process normally ranges from 50-62 percent P_2O_5[11].

The thermal acid process can accept low grades of phosphate rock, and efficient plants can recover up to 99.9 percent w/w of the combusted elemental phosphorus as a phosphoric acid product. The product acid is much purer than acid produced by the wet process, and the waste slag from the furnace is relatively benign in comparison to wet process phosphogypsum. The thermal acid process is, however, very energy intensive and costly. With limited heat integration opportunities, an enormous amount of heat is lost to the environment.

Dry (electric-furnace) process

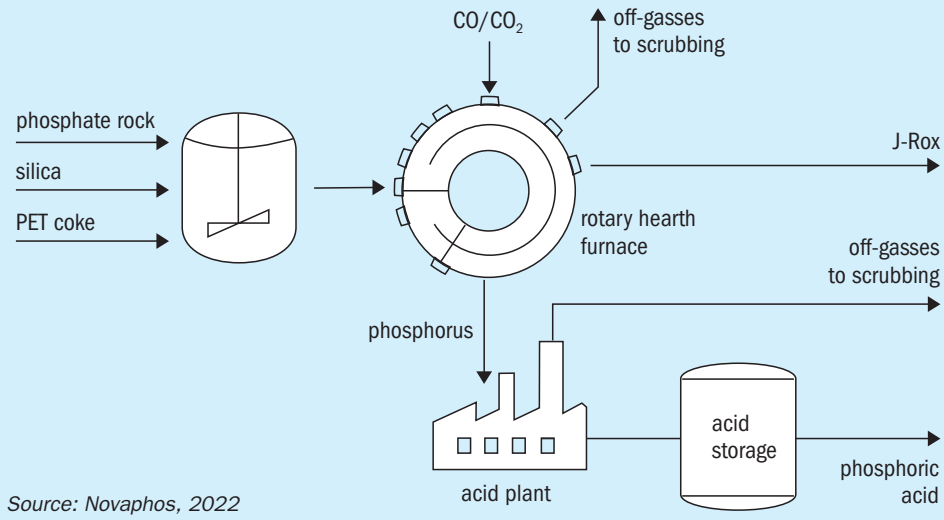
The electric furnace process uses electric resistance heating to generate elemental phosphorus vapour via a sustained reduction reaction from a mixture of phosphate rock, silica, and calcined petroleum coke. The reduction reaction takes place at 1,600°C and is highly endothermic. The phosphorus vapour generated is condensed

Fig. 7: **The nitrophosphate process**



Source: Noyes, 1967

Fig. 8: **The Novaphos process**



Source: Novaphos, 2022

to liquid phosphorus metal and is then oxidised in a phosphorus furnace to form P_4O_{10} gas. A hydrator finally converts this gas into highly pure and concentrated (52-62% P_2O_5) phosphoric acid[12].

The phosphoric acid produced using the electric furnace process is of high purity and the primary waste by-product is inert slag. The furnace process can also accept low-grade phosphate rock, if the main impurity is silica, and the recovery of P_2O_5 is also high – usually 86-92 percent of the furnace charge.

On the downside, the electric furnace process has a high capital cost and suffers from poor thermal efficiency. This is due to the lack of heat integration between the highly endothermic phosphate reduction reaction and the highly exothermic phosphorus oxidation reaction (to produce P_4O_{10} gas). Because of this, the electric furnace process is used almost exclusively to produce phosphorus and phosphoric acid for high value end-markets such as industrial chemicals, insecticides, detergents, and food or animal feed additives[13].

Novaphos process

In the last decade, there has been renewed interest in dry phosphoric acid production processes spurred by new market uses for technical-grade phosphoric acid. The Novaphos process (Figure 8) is one example (*Fertilizer International* 509, p52).

This thermal method produces phosphoric acid through the carbothermal reduction of phosphate rock with silica flux and petroleum coke in a rotary hearth furnace[14]. Elemental phosphorus gas is formed in this furnace, which is then re-oxidised and reacted with water in an acid plant. This generates high quality SPA (super phosphoric acid) grade acid at up to 68 percent P_2O_5. The design configuration used by Novaphos offers operational improvements and capital cost reductions compared to the previous dual-kiln technology.

Although the Novaphos process is an improvement on the original thermal acid process, it remains an energy-intensive and expensive process. Nevertheless, the process can accept low grade phosphate rock, including mine tailings and ore deposits that are too impure for conventional wet acid production processes.

Also, unlike the wet process, the Novaphos process produces a benign, saleable co-product known as J-Rox. This largely consists of calcium, magnesium, and iron silicates and has several valuable applications[14] including use as:

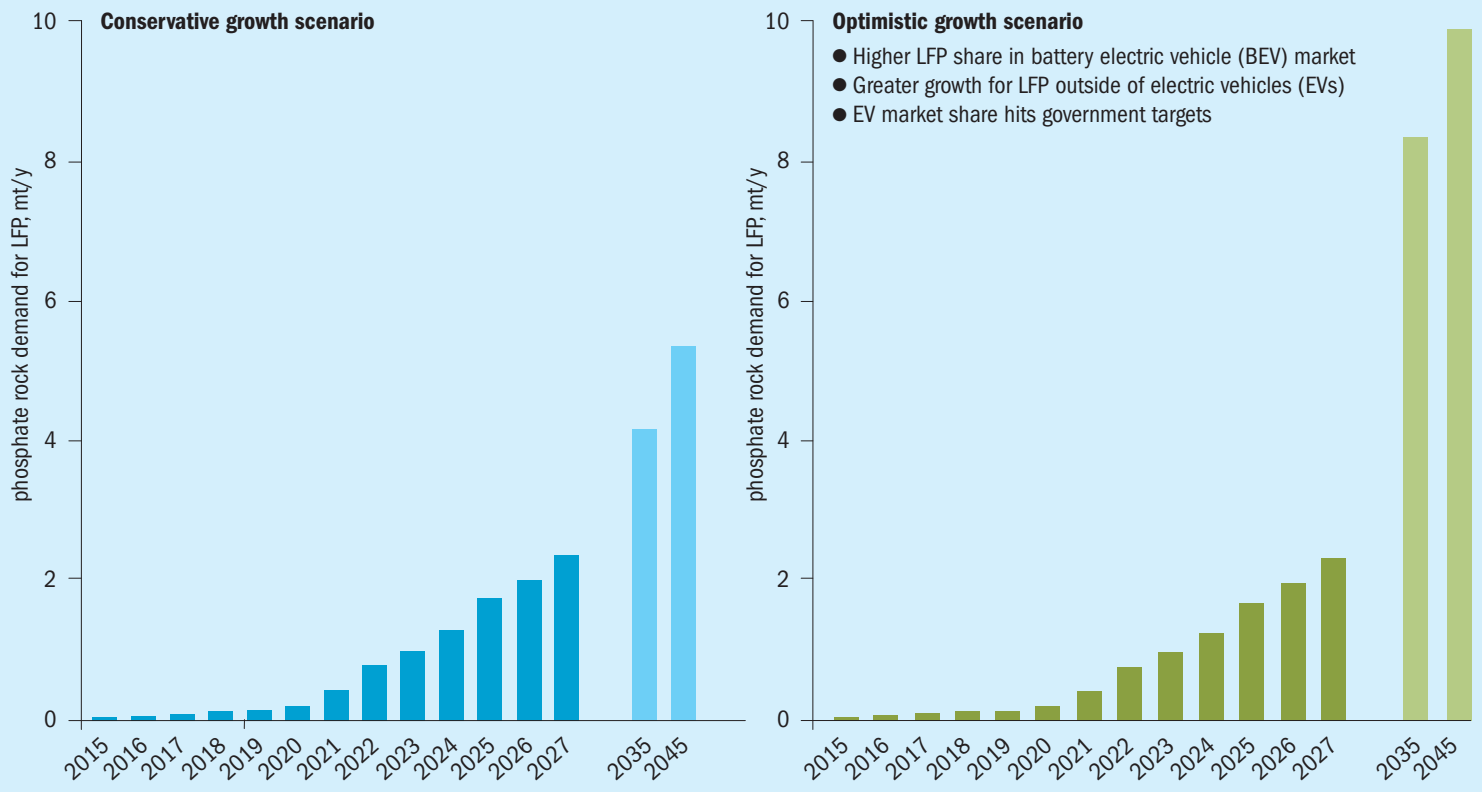
- A replacement for cement in concrete or as a supplementary cementitious material
- A porous, fine aggregate to help with internal curing
- A source of plant available silicon in fertilizers.

Conclusions

The acidulation of phosphate rock with sulphuric acid has been the conventional phosphoric acid production process for decades. It has been widely adopted in the phosphoric acid industry due to its relatively low capital and operating costs. The five main process variants (DH, HH, DH/HH, HDH and HRC) each have their own advantages and disadvantages – including (but not limited to) acid strength, by-product purity, and cost.

Other acidulation methods with alternative acids such as hydrochloric acid (HCl), nitric acid (HNO_3), and phosphoric acid (H_3PO_4) are of increasing interest. These have the potential to produce cleaner and/or stronger phosphoric acids from the filtration stage. Additionally, given that phosphogypsum (PG) stacking is becoming a land management and environmental concern for producers, chloride or nitrate-based processes are potentially more attractive

Fig. 9: **Phosphate rock demand outlook for the lithium iron phosphate (LFP) battery market**



Source: CRU/Knight, 2023

DATA: CRU Industrial and Food Phosphates Market Outlook

as they produce an entirely different by-product altogether.

The choice of acidulation process is often determined on the local pricing, availability and/or sourcing of acids. HCl methods, for example, can consume excess HCl generated by sulphate of potash (SOP) or chlor-alkali production plants. Other producers, meanwhile, may already have access to sulphuric acid, which would make sulphuric acid and phosphoric acid acidulation methods more attractive. Moreover, existing NPK fertilizer producers are likely to have access to nitric acid (or its derivatives), making the nitric acid acidulation route an attractive production choice.

The potential to adopt pyrometallurgical processes for phosphoric acid production is heavily influenced by local energy pricing, and regional/national greenhouse gas (GHG) emissions regulations. Typically, thermal methods will be favoured for end applications where a high-grade phosphoric acid is required (e.g., pharmaceuticals or foods), or when elemental phosphorus is the desired product.

Another factor is the constantly shifting global market for phosphoric acid. Demand for phosphoric acid is projected to increase in future (Figure 9) due to the growing global need for fertilizers and the rapidly rising LFP battery market[15].

The need to raise output and meet other industry challenges are forcing phosphoric acid producers to look at alternative H_3PO_4 production processes. While some processes produce a cleaner or different by-product, and/or a higher strength phosphoric acid, the choice of phosphoric acid production method is ultimately driven by the needs and priorities of each individual producer.

Hatch is able to take its comprehensive baseline knowledge of all the different phosphoric acid production technologies – as described in this article – and support phosphate industry clients, as they adapt to the ever-changing market, by coupling this knowledge with its industry-leading expertise and track record in process design and engineering. ■

References

1. Becker, P., 1983. *Phosphates and Phosphoric Acid*. Marcel Dekker Inc, New York.
2. Prayon, 2022. *DA-HF*. Available from: https://www.prayon.com/en/processes/da-hf/ [Accessed 2022]
3. Noyes, R., 1967. *Phosphoric Acid by the Wet Process* (Volume 9). Noyes Development Corp, London.
4. Takhim, M. et al., 2019. The Ecophos Process. In: *Phosphorus Recovery and Recycling*. Springer, Singapore.
5. Case, E., 1974. *USA Patent No US3792151A*.
6. Prayon, 2022. *DCP Feed – GetMoreP*. Available from: https://www.prayon.com/en/processes/dcp-getmorep/ [Accessed 2022]
7. Holcomb, D. et al., 1984. *US Patent No US4435370A*.
8. Cherdron, E. et al., 1976. *USA Patent No US3949047A*.
9. Kennedy, G. & Lehr, J., 1988. *US Patent No. US4743438A*.
10. Fertilizers Europe, 2000. *Production of NPK Fertilizers by the Nitrophosphate Route*. Booklet No 7 of 8. Fertilizers Europe, Brussels.
11. EPA, 1993. Inorganic Chemical Industry. In: *AP-42 Fifth Edition, Volume 1*. United States Environmental Protection Agency.
12. Walters, M., 2011. A Technical Review of the Improved Hard Process. *The FAI International Technical Conference,* April 2011, New Delhi, India.
13. IFS, 2022. Other aspects and methods of phosphoric acid production. In: *FerTechInform*, International Fertiliser Society. Available from: https://fertechinform.org/knowledgebase/other-aspects-and-methods-of-phosphoric-acid-production/ [Accessed 9 September 2022]
14. Novaphos, 2022. *Our Technologies*. Available from: https://novaphos.com/our-technologies [Accessed 2022]
15. Knight, H., 2023. Phosphate Market Outlook. *CRU Phosphates 2023 Conference & Exhibition*, 27 February – 1 March 2023, Istanbul.

Jansen – Canada's potash megaproject

BHP is committed to investing $5.7 billion to complete the first stage of the Jansen project and bring it into operation by the end of 2026. This under-construction Saskatchewan mine will then ramp up to produce more than four million tonnes of potash annually before the end of the decade.

PHOTO: BHP

The Jansen project is located 140 kilometres east of Saskatoon, Saskatchewan, and is BHP's most advanced under-development project.

BHP's flagship Jansen potash mine project is located 140 kilometres east of Saskatoon, Saskatchewan Canada. It is the company's most advanced under-development project.

BHP, the world's largest miner, says Jansen has sufficient reserves to produce potash for a century, and could eventually grow to exceed 16 million tonnes of annual production capacity, a scale that would rival the size of its flagship Pilbara iron ore mine.

Greenlight for Jansen S1

BHP finally gave the go ahead for stage one of the Jansen potash project in August 2021. This final investment decision (FID) committed the Anglo-Australian mining giant to $5.7 billion of investment to bring the project into production.

Under stage one plans, the 4.35 million t/a capacity Jansen mine is now expected to produce its first potash ore towards the end of 2026, following a six-year construction phase. The mine will then take a further two years to ramp-up to full capacity (Figure 1).

BHP expects stage one of the Jansen mine (Jansen S1) to generate an internal rate of return (IRR) of 12-14 percent – equivalent to a payback period of around seven years – and operate at a healthy earnings (EBITDA) margin of around 70 percent.

"Jansen is located in the world's best potash basin and is expected to operate for up to 100 years. Potash provides BHP with increased leverage to key global megatrends, including rising population, changing diets, decarbonisation and improving environmental stewardship," BHP said in a statement at the time of the FID.

Speaking in August 2021, Mike Henry, BHP's CEO, said Jansen would help the company grow its portfolio of large, low cost and expandable world class assets.

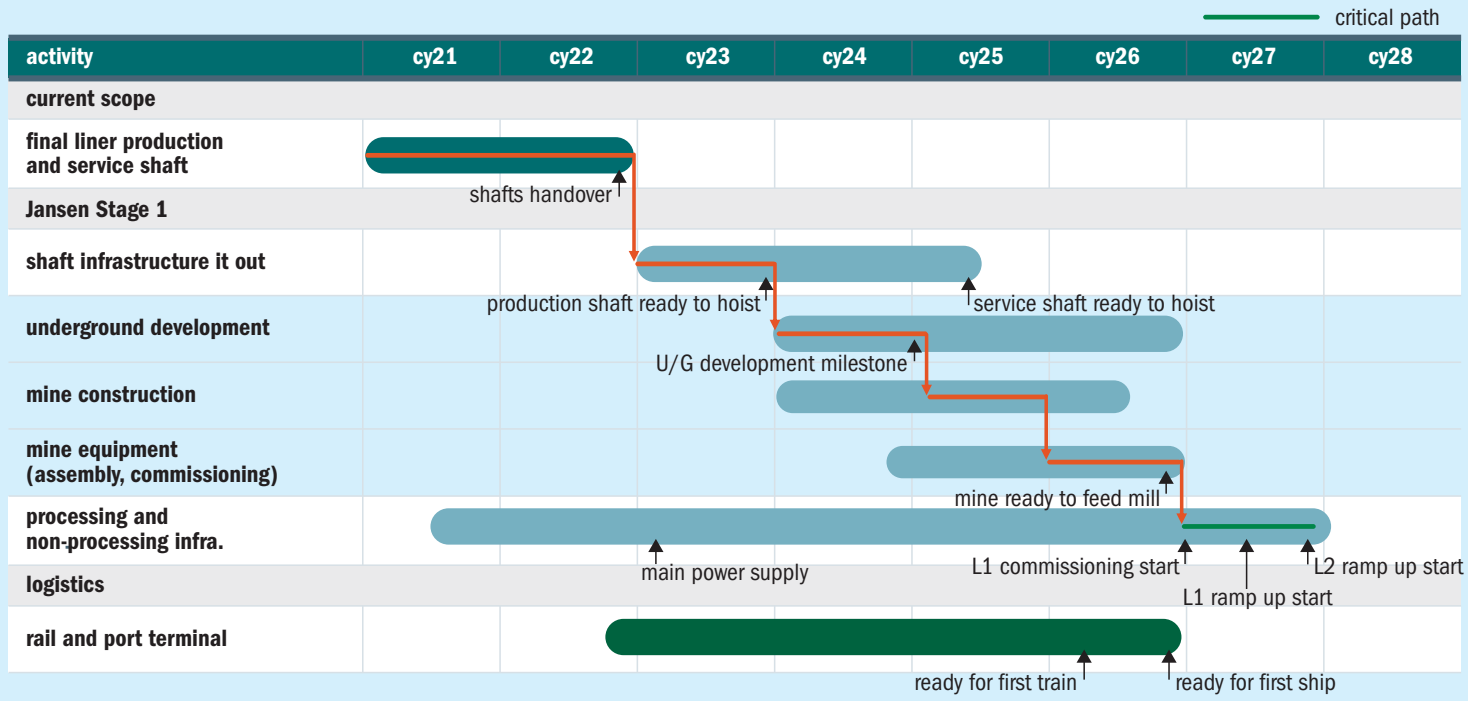
"This is an important milestone for BHP and an investment in a new commodity that we believe will create value for shareholders for generations," Mr Henry said. "In addition to its merits as a standalone project, Jansen also brings with it a series of high returning growth options in an attractive investment jurisdiction."

He added: "Jansen is designed with a focus on sustainability, including being designed for low greenhouse gas emissions and low water consumption."

The $5.7 billion investment in Jansen S1 covers the design, engineering and construction of a complete underground potash mine and all of its associated surface infrastructure. This includes a processing plant, a product storage building, and a continuous automated rail loading system. Jansen's potash output will be shipped to export markets through Westshore in Delta, British Columbia, with the project's new funding also covering the necessary port infrastructure.

In its mid-2022 annual operational review BHP said: "The Jansen shaft project was completed in the June 2022 quarter. Jansen Stage 1 is tracking to plan, with activities progressing at the port and at the Jansen site. We are working to bring forward Jansen Stage 1 first production

Fig. 1: **The critical path for bringing Stage 1 of the Jansen project into production* includes a six-year construction phase and a two-year ramp-up**



Source: BHP

**Construction schedule as of March 2022.*

into 2026 and are assessing options to accelerate Jansen Stage 2."

Jansen S1 is timed to arrive at an opportune moment for new potash supply. "We anticipate that demand growth will progressively absorb the excess capacity currently present in the industry, with opportunity for new supply expected by the late 2020s or early 2030s. That is broadly aligned with the expected timing of first production from Jansen," BHP said.

BHP predicts that Jansen will operate competitively, being positioned in the first quartile of the industry's cost curve. It expects long-term potash prices to be set by Canadian solution mines. These tend to have higher operating and sustaining capital costs than conventional mines like Jansen, as well as consuming more energy and water.

The Jansen S1 mine will convert approximately 20 percent of BHP's 5.23 billion tonnes of measured and indicated resources in Canada into potash ore reserves. The mine's earnings potential is based on average potash price assumptions for the decade 2027-2037 supplied by CRU ($341/t) and Argus ($292/t). Sustaining capital for Jansen Stage 1 is expected to be approximately $15/t, plus or minus 20 percent for any given year.

Mine shaft completion and project progress

In a major milestone, BHP significantly de-risked the project by completing the excavation and lining of Jansen's two 1,000-metre-deep shafts in the second-quarter of 2022.

Commenting on the shafts' completion, Simon Thomas, BHP's president, potash, said: "The team's safety record and performance since January 2020 has exceeded our plan. Our approach to safety, work planning discipline and continuous improvement – along with our collaborative and integrated team approach – really shone in the final stages of this project."

Sinking these large diameter (7.3 metre) shafts was one of the most technically challenging and riskiest parts of the project. Jansen pioneered mechanised shaft sinking and its shaft walls were frozen to a depth of 800 metres. Freezing ensured ground stability and prevented water ingress during excavation. A primary and final liner were then installed to create a waterproof seal that protects the shafts from underground aquifers.

The need to fit out only one of the two shafts for Jansen S1 has allowed BHP to reduce the project's upfront capital costs.

Ultimately, the availability of two shafts will enable large-scale capacity expansions in three subsequent project stages (S2, S3 and S4). These would each add an extra four million tonnes of capacity sequentially[1], as follows:

- **Jansen S1** (current stage): >4 million tonnes of annual potash production capacity, capital intensity of $1,200/t and an IRR of 12-14 percent with a payback of seven years.
- **Jansen S2**: >8 million tonnes of annual potash production capacity, capital intensity of $800-900/t and an IRR of 18-20 percent with a payback of around four years.
- **Jansen S3**: >12 million tonnes of annual potash production capacity, capital intensity of $800-950/t and an IRR of 20-23 percent with a payback of 3-4 years.
- **Jansen S4**: >16 million tonnes of annual potash production capacity, capital intensity of $800-950/t and an IRR of 20-23 percent with a payback of 3-4 years.

These three expansions provide BHP with the option to ramp-up Jansen's annual potash production to more than 16 million tonnes – although this would require regulatory approval, the availability of capital and

JANSEN PROJECT: KEY CONTRACTORS, SUPPLIERS & CONSULTANTS

- **DMC Mining Services**: development of two new mine shafts
- **SNC-Lavalin**: feasibility study and engineering, procurement and construction management (EPCM) services for Jansen S1
- **Sandvik**: electric MF460 borer miners and battery electric vehicles (BEVs)
- **Cementation Americas**: post-liner excavation, steel and equipping
- **Wicehtowak Frontec Services**: a joint venture partnership between ATCO Frontec and George Gordon Developments for camp support services at BHP's Jansen Discovery Lodge
- **2Nations Bird**: a multi-company partnership for works on Jansen S1 and site services
- **Constructors**: a multi-company subcontractor for the site services agreement.

a business case based on sufficient global demand growth. Production on this scale would be equivalent to almost 25 percent of current global demand. BHP does, however, expect annual potash demand to increase to 105 million tonnes by 2040, according to mining.com.

BHP announced in July 2022 that it was accelerating Jansen's construction timetable. This was reported to be in response to global fertilizer supply disruption brought about by market factors such as potash export sanctions on Belarus (*Fertilizer International* 512, p50) and the effects of high gas prices on fertilizer production costs (*Fertilizer International* 513, p13). Consequently, instead of entering production in 2027, as originally planned, BHP has brought forward first production from Jansen S1 to 2026 instead.

Stage 2 brought forward

In February, BHP also announced it was bringing forward its Stage 2 studies for Jansen. The company's July-December 2022 results, released on 21st February, confirmed that:

- Jansen Stage 1 project execution was 16 percent complete, running to plan and budget, and targeting first production by the end of calendar year 2026 with 81 percent of engineering complete and 85 percent of procurement orders placed.
- The Stage 2 feasibility study is underway and is now expected to be completed in the financial year 2024.

If approved, Jansen S2 would be timed to come onstream around 2029, being choreographed to coincide with the end of the ramp-up of Jansen S1. BHP expects the proposed S2 expansion project to be delivered at a lower cost than the current S1 project phase. Although the expansion studies have yet to be completed, the company expects S2 to have a capital intensity of $800-900/t versus 1,200/t for S1[1].

BHP hopes to make the final investment decision for Jansen S2 in 2024. The company has confirmed that all the necessary permits for this second stage expansion are in place and that sufficient port capacity is also available.

Insights from BHP's top team

In a rare interview with the company's executive team, David Lamont, BHP's chief financial officer, talked about the Jansen project in depth with Joel Jackson at last year's BMO Global Farm to Market Conference[2]. Their conversation was revealing.

Lamont had a message for market observers who had been following the Jansen project as far back as 2008.

"It's important to note that it is not like we have suddenly fallen in love with potash. We have been in and around it for a while. We are very excited that we now have our project sanctioned and are looking to get into the market."

With BHP offloading its oil and gas assets in a merger with Woodside Petroleum, Lamont linked the company's future growth prospects to potash mining, and the staged development and expansion of the Jansen project – a characteristic he called 'optionality'.

"We have always said, 'Well, the growth was potash', but perhaps we had not been as explicit to the market around how we saw that over the decades to come. As a result of the Ukraine-Russia situation… [and] whether or not that would create a better window for potentially more… potash to come to market… we have said that we are looking to study Stage 2 and be prepared.

"We are always looking for future optionality. We have Stage 1 and Stage 2, but equally we are not coming into the potash market just to be there for the short term. This is an investment that we see will have a century-long payback. Great resources are hard to find and they only get better over time – and all of that is there [with Jansen]."

Adding potash to its portfolio should strengthen BHP's presence in new markets too.

"Our traditional markets have been more China and India. What potash enables us to do is to look into the US and Brazil as two markets that we do not have as big a presence in. The MOUs that we have in place for over 100 percent of Stage 1's production are diversified. We have them in China, in India, in Brazil and in the US."

BHP has access to sufficient capital expenditure to enable the expansion of the Jansen project over the medium-term, suggested Lamont.

"Historically, BHP has spent $6-6.5 billion on total capex. Over the foreseeable mid-term, we would see that stepping up to about $10 billion – and the Jansen projects have been built into that."

In Lamont's view, being one of the top three potash producers globally was not necessarily what BHP was aiming for.

"We are not sitting here saying that we have to be one, two or three [in the potash market]. What we are saying is that we want to be a meaningful player in any market that we are in. More importantly, we look at the underlying [potash] resource that we have – which sees us low on the cost curve and has scale, optionality and longevity."

The earnings (EBITDA) potential of Jansen remained strong, argued Lamont, even at a fraction of the record potash pricing seen at the time of the interview in May 2022. This was also true, in his view, whether the Jansen project expanded to eight million tonnes or to its full annual production capacity of 16 million tonnes plus.

"If we were to develop [Jansen] based on current pricing and halve that, and we were at 16-17 million tonnes, we would be delivering between $4-5 billion of EBITDA.

PHOTO: SANDVIK

Sandvik battery-electric vehicle (BEV).

[Even] if you say it's eight million tonnes, I will take $2 billion plus of EBITDA any day. That is meaningful.

"We have [expansion] ambitions, yes, but we will do that only if we see that the market conditions are appropriate for us to execute. It is not about, 'I must be one, two or three in the [potash] market'. It is about how we add shareholder value by optimising the resources that we have."

BHP's reputation as an extremely reliable commodity producer was crucial to both its customers and shareholders, said Lamont.

"We want to be known as the most reliable [potash] producer in the market. If we are able to do that at the scale … and at the position we have on the cost curve, we can ensure that we are doing the right thing … for the customers that we ultimately will be supplying. By doing that, we will also maximise shareholder value and return".

Valuably, BHP is bringing its vast mining company experience into the fertilizer industry as it moves into the potash market, summed up Lamont.

"We see a lot of similarities between what we do in our bulk mining operations and what we will be able to bring to the potash industry and to Jansen. We are excited by the possibility of what we can do, and we are excited at being able to leverage some of the skills and capabilities that we have. We think that the market will ultimately enjoy that reliability that we have and are keen to continue to execute [the project]."

Sandvik wins major Jansen order

Sandvik Mining and Rock Solutions has secured a major order for 10 battery-electric vehicles (BEVs) from BHP, along with one electric tethered loader, for the first phase of the Jansen potash project (*Fertilizer International* 513, p38). These BEV loaders and other equipment are scheduled to be delivered between 2023 and 2025.

> **"Jansen will have the lowest carbon emissions per tonne of product produced compared to any potash mine operating today in Saskatchewan.**

The order for battery-electric loaders, placed last June, reflects BHP's focus on both sustainability and advanced technology for the Jansen mine. Sandvik's BEV loaders are designed for minimal underground mining infrastructure – as they eliminate the need for overhead cranes and other heavy handling equipment.

"Electric mining equipment is essential to meeting our goals to reduce emissions, improve productivity and most importantly protect the health of our employees underground. Jansen will have the lowest carbon emissions per tonne of product produced compared to any potash mine operating today in Saskatchewan," said Simon Thomas, BHP's president, potash.

"We are excited to partner with BHP and proud to contribute to the sustainability and productivity of this project. Sandvik electric loaders have been designed to best utilise innovative technology of its battery pack and electric driveline, and maximise the capabilities of our battery technology," said Alex Willows, business line manager for Sandvik Canada.

This latest order follows a SEK 2 billion ($216 million) mining systems contract for the Jansen project won by Sandvik in February 2022. This commits Sandvik to supplying a fleet of electric, cable-connected MF460 borer miners between the third-quarter of 2023 and 2026. These borers have been especially developed for the project following several years of Sandvik-BHP collaboration. ■

References

1. Lamont, D., 2022. BHP presentation. *BMO Farm to Market Conference*, New York, 18-19 May 2022.
2. Lamont, D., 2022. Q&A transcript. Interview of David Lamont, BHP, by Joel Jackson of BMO Capital Markets. *BMO Farm to Market Conference*, New York, 18-19 May 2022.

Advertisers' Index

Advertiser	Page	Website
ANDRITZ AG	OBC	andritz.com/separation
Argus Media Co	31	argusmedia.com
BCInsight	IBC	bcinsight.com
Dead Sea Works	33	icl-group.com
EMT Manufacturer of Blending Bagging & Transport Equipment	17	emt.tech
Köppern GmbH & Co. KG	9	koeppern.de
Ludman Industries	35	ludman.net
Prayon S.A. (Profile)	19	prayon.com
Prayon S. A.	IFC	prayon.com
Weir Minerals	53	global.weir/brands

Next issue: September/October 2023

Distribution at:
Argus Fertilizers Europe, Lisbon, Portugal

- **Europe's NPK producers**
- **Nitrogen technology showcase**
- **Low-chloride crop nutrition**
- **Anti-caking, water repellent and anti-dusting additives**
- **Integrated and efficient phosphate production**
- **Australia's SOP project gold rush**

Closing date for advertisement space booking is 22 August 2023
For further information and to book advertisement space contact:
Marlene Vaz, Advertisement Manager
Email: marlene.vaz@bcinsight.com Tel: +44 (0)20 7793 2569

Editor:
SIMON INGLETHORPE
simon.inglethorpe@bcinsight.com

Publishing Director:
TINA FIRMAN
tina.firman@bcinsight.com

Subscription rates:
GBP 300; USD 550; EUR 450

Subscription claims:
Claims for non receipt of issue must be made within 3 months of the issue publication date.

Sales/Marketing/Subscriptions:
MARLENE VAZ
Tel: +44 (0)20 7793 2569
marlene.vaz@bcinsight.com
Cheques payable to BCInsight Ltd

Advertising enquiries:
MARLENE VAZ
marlene.vaz@bcinsight.com
Tel: +44 (0)20 7793 2569

Previous articles from *Fertilizer International* and *PK Insight* from 1997 to the present are available digitally in PDF format. To make a purchase, or for a list of available articles, please see:
www.bcinsight.com

ISSN: 0015-0304

Design and production:
TIM STEPHENS,
DANI HART, JOHN CREEK

Mixed Sources
Product group from well-managed forests and other controlled sources
www.fsc.org Cert no. SA-COC-001904
© 1996 Forest Stewardship Council

Printed in England by:
Buxton Press Ltd
Palace Road, Buxton, Derbyshire, SK17 6AE

BCInsight

Published by: BCInsight Ltd
China Works, Unit 460,
100 Black Prince Road,
London SE1 7SJ, UK
Tel: +44 (0)20 7793 2567
Web:www.bcinsight.com
www.bcinsightsearch.com

BCInsight

www.bcinsight.com

Publishers to the industry

Fertilizer INTERNATIONAL

nitrogen+syngas

SULPHUR

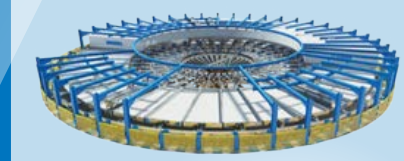
BCInsight Ltd,
China Works, Unit 460,
100 Black Prince Road,
London, SE1 7SJ, UK.

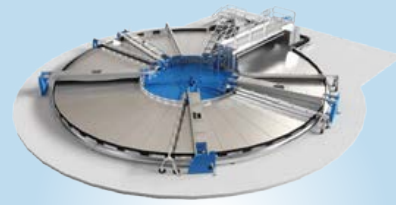
Proud member of

ifa INTERNATIONAL FERTILIZER ASSOCIATION

THE FERTILIZER INSTITUTE

ifs International Fertiliser Society





SUPPORT SUSTAINABLE NATURAL GROWTH

SEPARATION SOLUTIONS FOR AGROCHEMICALS AND FERTILIZERS

Let's support agrochemical and fertilizer solutions that put nature first. We at ANDRITZ achieve this by providing you with the right separation technology, as well as extensive process experience!

With our extensive portfolio of solid/liquid separation technologies and our team of separation specialists, we have both the capacity and the drive needed to create an environment where nature and humans can flourish and thrive together.

High-capacity drying lines for urea, potash, phosphoric acid, and ammonium sulfate as well as decanter and pusher centrifuges, filter presses, vacuum disc filters, and tilting pan filters – you name it. However your product is created, we most likely have everything you need for production: the technology, the process experts, the experience – all backed by proven service and innovative automation solutions.

Whether you are a startup with an innovative idea for creating a new biofertilizer or reducing CO_2, or a partner looking to improve efficiency in an existing process, our team is eager to support you in getting the most out of your process!

For more information, visit our website.

ENGINEERED SUCCESS

ANDRITZ AG / Stattegger Strasse 18 / 8045 Graz / Austria / separation@andritz.com / andritz.com/separation

ANDRITZ