

Fertilizer INTERNATIONAL

Nitrogen project report

Sulphur: the fourth crop nutrient

Innovation showcase

Water-soluble phosphates

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Cover: Vegetables growing using a fertigation system.
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Sulphur: the fourth crop nutrient



Water-soluble phosphates

Read this issue online at:
www.fertilizerinternational.com

Published by:

BCInsight

Fertilizer INTERNATIONAL

www.fertilizerinternational.com

NUMBER 497

JULY | AUGUST 2020

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De-commoditisation, easy for you to say



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“The overriding importance of commodities to growth, market share and profitability – a certainty that has underpinned the fertilizer industry for decades – is on the wane.”

The fertilizer market remains a commodity market. The three major nutrients N, P and K, more often than not, are supplied through four main products: urea, diammonium phosphate, monoammonium phosphate (DAP and MAP) and potassium chloride (MOP). Combined world consumption of these long-standing, globally-traded commodities is north of 300 million tonnes annually.

For decades now, urea, D AP/MAP and MOP have been produced, marketed, sold and traded as standardised products. Their pricing reflects raw material/production costs and the vagaries of supply and demand – rather than their quality, which is already factored in. Value is not generally added and consequently they sell at broadly the same price, regardless of the producer, with little, if any, attempt at differentiation.

That paints a very stable and unchanging picture of the fertilizer market. Yet something fundamental has changed in the last decade.

In particular, the overriding importance of commodities to growth, market share and profitability – a certainty that has underpinned the fertilizer industry for decades – is on the wane. The sector’s strong attachment to commodities is being severed with either alacrity or reluctance, depending on the company.

Sure, commodity fertilizer production remains a cast iron mainstay for most leading manufacturers. But looking at production scale and output in isolation can be deceptive.

Instead, as with any business, you need to follow the money. And when it comes to price premiums, higher margins and market growth, fertilizer producers are increasingly fixated on value-added products. As a consequence, the fertilizer industry is inexorably being transformed by a single and rather ugly word: **de-commoditisation**.

The Mosaic Company, North America’s largest phosphate producer makes a useful case study. A decade ago it was classic commodity fertilizer producer with a traditional product offering based on DAP/MAP and MOP.

Since then, the Florida-headquartered company has ramped-up production of its *MicroEssentials* premium product, a sulphur- and zinc-enriched speciality phosphate fertilizer. Similarly, Mosaic also signalled its shift away from commodity MOP by launching *Aspire*, a boron-enriched premium potash product, in 2014.

The success of *MicroEssentials* is a textbook example of de-commoditisation and product differentiation. Mosaic has taken MAP, a standard commodity product and, by adding value, transformed it

into a higher margin product with valued properties that confer a competitive advantage.

Mosaic has also overturned the myth that speciality products are niche and small volume. Production of *MicroEssentials* has tripled in the last six years, since it first broke through the one million tonne barrier in 2013. The 8.2 million tonnes of finished phosphates produced by Mosaic in 2019 included 3.2 million tonnes of *MicroEssentials*.

The trend for de-commoditisation at Mosaic is mirrored by rival fertilizer producers. Increasing its capacity to produce and sell premium products is an integral part of Yara International’s future growth strategy, for example. Premium products able to deliver high margins – including compound NPKs, calcium nitrate, fertigation and micronutrient products – feature strongly in Yara’s fertilizer portfolio, being responsible for around two-fifths of its global sales volumes.

There is a clear financial imperative driving de-commoditisation. Value-added products currently generate a total premium in excess of one billion dollars for Yara annually – versus the commodity fertilizer alternatives – according to the company’s calculations.

The trend for de-commoditisation is being keenly pursued by technology providers and licensors too. Companies such as Veolia and GEA (water-soluble fertilizers), Stamicarbon (controlled-release fertilizers), Shell Sulphur Solutions, thyssenkrupp and IPCO (sulphur-enhanced fertilizers) are helping fertilizer producers add premium products to their portfolios.

This provides producers with an entry ticket to the higher margin, higher growth speciality market while also reducing their reliance on lower margin, lower growth commodity products. It also lessens their exposure to the notorious price volatility of the commodity market.

There are very real indications that the rise of speciality/value-added/premium products signals a fundamental shift away from commodity fertilizers – a change that is being driven by a raft of economic, agronomic, technological, environmental and regulatory imperatives. There are even signs, in certain select markets, that speciality products could ultimately displace conventional commodities and emerge into the mass market as mainstream fertilizers of choice.

Yes, de-commoditisation may be an ugly word – but it’s certainly one we’re going to hear a lot more of in future. ■

S. Inglethorpe

Simon Inglethorpe, Editor

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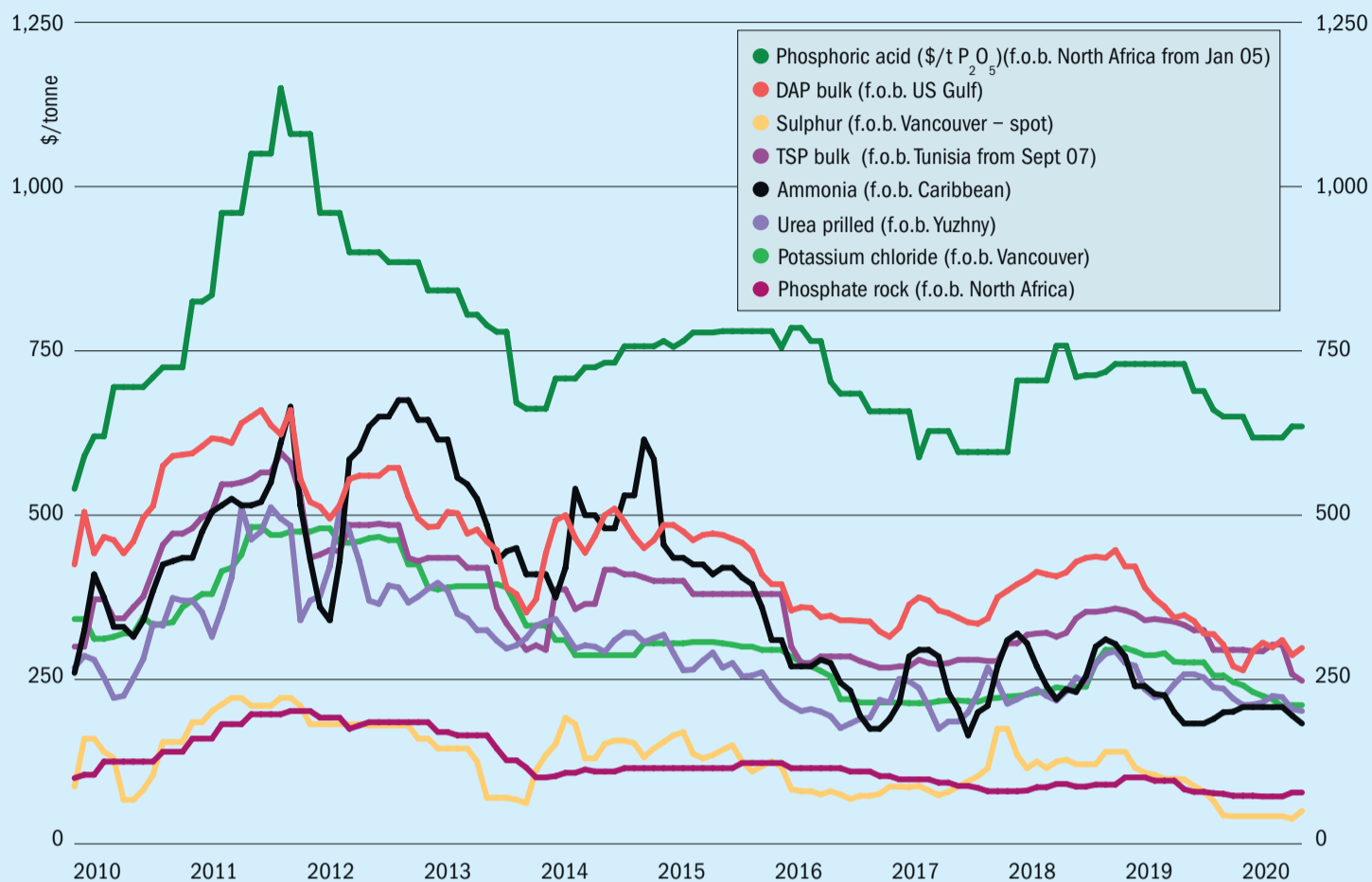
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Market Insight

Historical price trends \$/tonne



Market Insight courtesy of Argus Media

PRICE TRENDS

Urea: Prices bottomed out in mid-May following an Indian tender purchase of more than 600,000 tonnes of urea. This was supplied from Ukraine, Egypt and the Middle East at \$227-231/t cfr, as Chinese suppliers were unwilling to sell at this price level. These purchases tightened the market. After an initial stand-off, prices began to firm in early June, with traders needing to cover short sales made for shipment in June and the first half July.

The second week of June was particularly active. More than 500,000 tonnes of granular urea were traded and prices jumped by \$20/t in some areas. Prices rose to \$230-240/t f.o.b. in the Middle East and Egypt – a price recovery that has brought Chinese urea back into play. Demand from China's summer season has waned and, with production remaining high, falling domestic prices have made

Chinese urea competitive at current offers of around \$230/t f.o.b.

Phosphates: Import demand from destinations east of Suez picked up throughout May and June. Indian buyers were the most prominent, receiving 1.3 million tonnes of DAP imports in May and June and scheduling a further 986,000 tonnes for July and August arrival.

Global DAP prices stayed mostly flat in May and June but firmed slightly towards the end of the period. The Argus DAP index – a basket of prices for the five biggest export nations – rose by just 0.4 points to 87.3 between the end of April and mid-June.

MAP prices, in contrast, firmed more strongly, with Brazilian MAP prices rising by \$12-13/t during May and June to \$318/t cfr. Brazil's MAP imports have hit record-highs this year. Crop fundamentals have been lucrative for importers, with barter rates reaching four-year lows. The September start of the key phosphate application

season for the *safra* soybean crop in Brazil means that the window for fertilizer purchases is now starting to close.

Phosphate producers, in advance of the anticipated increase in Latin American demand, reduced output or allocated product elsewhere. Morocco's OCP cut fertilizer granulation by 200,000 tonnes to 650,000 tonnes in June, and is considering carrying this over into July. It also sold significant amounts of DAP to India and Pakistan, lining up 415,000 tonnes for June and July arrival. Chinese phosphate producers also reduced their output, producing at 50-55 percent capacity in mid-June.

Potash: the market remains robust despite the coronavirus pandemic and the associated downbeat economic outlook. The market has held up well, despite Covid-19 impacts, assisted by government measures to maintain food security along the whole supply chain, as fertilizer and farming are widely considered essential. Lower prices have also made MOP increasingly affordable. Nevertheless, demand in Southeast and East Asia has been hit, with uncertain

Market price summary \$/tonne – End June 2020

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phos Acid
f.o.b. Caribbean	175-190	-	f.o.b. E. Europe	f.o.b. US Gulf	293-304	-	-
f.o.b. Yuzhny	180-200	195-215	110-112	f.o.b. N. Africa	291-310	230-265	577-692
f.o.b. Middle East	180-200	219-245**	-	cfr India	315-320	-	607*
Potash	KCl Standard	K ₂ SO ₄	Sulphuric Acid	Sulphur			
f.o.b. Vancouver	182-240	-	cfr US Gulf	30-50	f.o.b. Vancouver	50-57	-
f.o.b. Middle East	179-240	-	-	-	f.o.b. Arab Gulf	57-60	-
f.o.b. Western Europe	-	430-490	-	-	cfr N. Africa	60-75	-
f.o.b. Baltic	180-240	-	-	-	cfr India	69-79+	-

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

logistics, staff shortages and palm plantation shutdowns all taking their toll.

In the US, granular MOP barge prices stabilised in early June. Expectations of domestic summer-fill programmes later in the month continued to limit buyer interest at Nola ahead of a potential price reset.

In Southeast Asia, high stock levels reported by distributors in every country has resulted in yearly demand running at 75-85 percent of normal levels. Second-quarter prices continued to fall, albeit more slowly than in the first-quarter, to a midpoint of \$250/t cfr, even after the announcement of Chinese contracts at \$220/t cfr.

Prices have started to rise in Brazil. Granular MOP prices, which had reached mid-point lows of \$215/t cfr in late April, rose to \$228/t in the first week of June. All three of the country's biggest potash suppliers have told the market they are fully committed in July. Sales for delivery in future months are also rising.

In Northwest Europe, prices continued to fall until mid-April, following the seasonally slow December-February period, as distributors were keen to draw down on their stocks.

Key contracts with China and India have been settled in recent months. At the end of April, a consortium of Chinese buyers agreed its first MOP contract since September 2018 with Belarusian potash marketer BPC. This was secured at a headline price of \$220/t cfr, down \$70/t on the previous level.

Sulphur: Covid-19 was unsurprisingly the talk of the market during May and June – with Opec+ production cuts coming a close second. The pandemic has forced oil refinery-based sulphur production downwards with many refiners west of Suez lowering

operational rates, if not being shuttered completely. This, together with Opec+ cuts to oil production across key parts of the FSU and Middle East, has seen sulphur prices trade on a flat-to-firm basis in most markets.

Prices held relatively steady in key markets in May, with Middle East f.o.b. prices trading at a midpoint of \$55/t. China's top-end granular price held at \$69-70/t cfr, while Brazil's cfr price varied within the low-to-mid-\$70s/t range. Stability was maintained because buyers and sellers alike had concluded business well in advance. But prices eventually started to firm as June commenced, with buyers looking to secure the few cargoes that were available. A pick-up in freight rates also played a large role, adding to the existing upwards price pressure from the tight supply balance.

The Mediterranean was the exception to this trend with prices trending flat-to-soft instead. Key regional supply and demand centres such as Italy and Turkey have been hit by the pandemic. Despite Covid-19 hitting both sides of the market, Mediterranean supply has outweighed demand, so pushing prices downwards.

OUTLOOK

Urea: Another Indian tender is taking place at the time of writing and Chinese urea is expected to figure prominently as a supplier to India from July onwards. The ability of Chinese suppliers to provide around 400,000-500,000 tonnes/month for export in the second-half of the year is expected to cap prices in the short term.

In the West, most attention is focused on Brazil, where favourable corn:fertilizer price ratios boosted demand in May and

June. Prices have recovered from a low point of \$208-210/t cfr in May to around \$245/t cfr at present. Competition for spot tonnages should continue to support prices through the third-quarter.

Phosphates: Brazilian MAP demand is set to remain strong throughout July, with more buying expected for August arrival. Purchases from Indian and Pakistani importers are likely to continue, driven by solid agricultural fundamentals, especially in India. A healthy July-September monsoon season is also forecast on the sub-continent. No downsides are anticipated for DAP and MAP prices in coming weeks, given the continued buying and OCP's reduction in availability. Prices in markets west of Suez will, however, be placed under pressure once Brazilian demand for *safra* season applications ends.

Potash: Prices have flattened, as of early June, and should stay flat in the next few months. Solid demand in key MOP-buying markets, specifically Brazil, India and the US, should see prices head upwards during the third-quarter. But the sharp economic downturn and enduring Covid-19 effects could act to temper demand and limit any price gains.

Sulphur: Third-quarter prices are expected to repeat the pattern of the previous quarter. Increases are anticipated in the first few weeks but are likely to be flat-to-soft thereafter. Initially, a tight supply/demand balance and a flurry of purchases should buoy prices in July as end-users seek to cover the June deficit. But liquidity is likely to drop off subsequently with prices set to trend flat-to-soft later in the quarter, once market appetite is filled and contract negotiations are settled.

ISRAEL

New crop nutrient advice website

ICL Group has launched an interactive online advisory forum for farmers and agronomists.

The new website (AgroPro.com) was created in response to the difficulties in obtaining agronomic advice during the Covid-19 pandemic. It will offer a simple, accessible way for farmers and advisors to ask questions and get quick responses from ICL's team of international agronomists and a global online agricultural community.

After signing up to the AgroPro community, farmers, whatever their crop or region, can search for content, post a crop nutrition question, share a resource, join a discussion thread or add a comment. Comprehensive up-to-date fertilizer information will be available on-demand and free of charge alongside nutrient management advice for field crops, orchards, plantations, ornamentals and turf.

Maya Grinfeld, head of ICL's marketing department, said: "As the crisis caused by Covid-19 unfolds, we know that farmers worldwide are still eager for concrete information to improve their crops. In response to that we consulted ICL's agronomists around the world about how we could help, and together we initiated AgroPro.com."

ICL's wants the website to become the go-to place to collaborate, network, seek advice and obtain practical crop nutrition information – whether for fertilizer, fertigation or foliar feeding.

Hillel Magen, ICL's vice president for agronomy, said: "This is the first time the extensive professional knowledge and network of ICL agronomy experts, gathered from all across the world from multiple crops and climatic regions, has been made available – directly and indefinitely – to everyone. We believe, at times like this, that knowledge is a force for good that everyone should be able to access and benefit from."

The ICL team supporting the website will be available 24/7 for interaction with farmers, advisors and agronomists. The new interactive online forum will also be available in multiple languages. ■

ICL agrees potash supply contracts with IPL and China

ICL Group has signed a contract to supply Indian Potash Limited (IPL) with 410,000 tonnes of potash during 2020. It follows an earlier agreement to supply 910,000 tonnes of potash to China this year.

The supply contract with IPL, India's largest potash importer, was announced on the 18th May. It runs until the end of December 2020 and includes the option to supply an additional 30,000 tonnes of potash, if mutually agreed.

The contract is part of the five-year supply agreement established between ICL and IPL in 2018. The latest selling price is \$50/t below the previous potash contract, according to ICL, but is reported to be in keeping with other recent contract prices in India.

Noam Goldstein, president of ICL's potash division, said: "The contract that we have signed in India, one of ICL's strategic markets, solidifies the leading position ICL has in this market. Favourable weather conditions and an increase in planted areas in several agriculture-intensive regions are contributing to a solid global demand for potash, as reflected by this

supply contract, as well as by the contracts we recently signed in China."

Mr Goldstein was referring to the signing of several contracts with ICL's customers in China announced on 8th May. This commits ICL to supplying a total of 910,000 tonnes of potash to China by the end of 2020 – with the option to supply an additional 490,000 tonnes, if mutually agreed.

These contracts are part of three-year framework agreements established between ICL and its Chinese customers in 2018. The latest selling prices are \$70/t below previous potash contracts, according to ICL, but are said to be in line with other recent contract prices in China.

INDIA

India takes first Turkish DAP delivery in a decade

India is to receive its first delivery of diammonium phosphate (DAP) from Turkey in ten years.

A Turkish fertilizer producer is scheduled to ship a 40,000 tonne DAP cargo to India in July, according to trade data. This is the first such delivery since 2010.

Argus Media is reporting that a freight

enquiry has been issued to transport this shipment from the northern Turkish port of Samsun to the Indian port of Pipavav in the western state of Gujarat.

Unusual circumstances are behind the supply of DAP from Turkey. Fertilizer traders and buyers sourcing product for India have been forced to look westwards due to a lack of availability from China. Because of this, Indian importers have instead begun sourcing DAP from Morocco, Russia, Jordan, Egypt, Saudi Arabia and Turkey – as well as from China and Australia to the east.

Only four Chinese DAP cargoes to India are scheduled for July arrival, according to Argus Media, with these accounting for just 27 percent of the total scheduled arrivals of 776,000 tonnes that month. The lack of Chinese DAP available for export in June has supported prices. Chinese suppliers have held DAP offers in the \$305-310/t f.o.b. range and above in recent weeks.

UNITED STATES

Mosaic seeks import duties on Moroccan and Russian phosphate

The Mosaic Company has asked US authorities to consider imposing import duties on phosphate fertilizers from Morocco and Russia.

The Florida-headquartered fertilizer producer has requested the launch of countervailing duty investigations into these imports, having filed petitions with the US Department of Commerce and the US International Trade Commission on 26th June.

In a statement, Mosaic, the largest phosphate fertilizer producer in North America, said it was taking this action because: "Large volumes of unfairly subsidized imports from Morocco and Russia are causing significant harm to Mosaic's operations. Mosaic's phosphate fertilizer business employs approximately 3,500 US workers and operates mines and production facilities in Florida and processing plants in Louisiana."

Mosaic says it simply wants to restore fair competition in the North American market by asking US authorities to remedy the distortions caused by foreign subsidies for phosphate fertilizers.

"Mosaic believes in free trade and vigorous competition, and we believe we should compete on a level playing field," said Joc O'Rourke, Mosaic's president and CEO. "The duties we are seeking will help ensure that North American farmers can

rely on the American phosphate industry to supply critical fertilizers for the long term.”

US authorities will firstly consider the petitions before potentially triggering extensive investigations. Mosaic says it will participate actively in any future proceedings.

Phosphate fertilizer import levels into the US have been a concern over the last 18 months due to their effect on prices and margins. Mosaic reported in February that high US import volumes in the first half of the 2019 were responsible for driving down prices throughout last year, due to a build-up of inventories for producers, distributors and retailers.

SAUDI ARABIA

MWSPC refinanced

The Saudi Arabian Mining Company (Ma'aden) completed the refinancing of the Wa'ad Al Shamal Phosphate Company (MWSPC) at the end of June.

MWSPC has signed new financing agreements for \$2.3 billion with a number of leading local and regional banks. These were named as the Alinma Bank, the National Commercial Bank, Al-Rajhi Bank, Bank Albilad, Riyadh Bank, Saudi British Bank, Bank AlJazira, Samba Bank and Saudi Fransi Bank.

The company will use the proceeds from refinancing to pay down its existing loans. MWSPC has also rescheduled and transferred a \$1.8 billion loan, previously held with Saudi Arabia's Public Investment Fund, to the country's Public Pension Agency.

According to Ma'aden, the refinancing replaces the original, more restrictive project financing terms for MWSPC with more attractive and flexible corporate loan terms.

The MWSPC is an \$8 billion joint venture between three partners – Ma'aden (60%), SABIC (15 percent), and The Mosaic Company (25%). It owns and operates the integrated phosphate fertilizer production complex at the Wa'ad Al Shamal Minerals Industrial City in Saudi Arabia – one of the world's most modern, largest and lowest cost phosphate production sites.

The refinancing arrangements, together with an extended debt repayment schedule, are “a step towards significantly strengthening the long term cash flow position for Ma'aden as part of its strategy to pursue new growth and development projects”, Ma'aden said in a statement.

“We are proud of the strong appetite from banks to lend to Ma'aden MWSPC during the current challenging market con-

ditions. This is a reflection of our financial strength and growth prospects and the durability of our assets,” said Mosaed Al Ohali, Ma'aden's CEO. “With abundant phosphate deposits in the north of Saudi Arabia, Ma'aden is well placed to build on its position as a leader in the global phosphates market and make Saudi Arabia a major contributor to global food security.”

He added: “The mining sector is the ‘Third Pillar’ of Saudi industry and is considered one of the most important sectors for achieving the goals of Vision 2030, alongside the petroleum and petrochemicals sectors, as it strongly supports economic growth and job creation in remote areas.”

EGYPT

Ammonia contract finalised

Maire Tecnimont subsidiary Tecnimont SpA has finalised a \$350 million engineering, procurement and construction (EPC) contract with Egypt Hydrocarbon Corp (EHC) for a new ammonia plant at the Ain Sokhna complex near Suez.

The contract, provisionally announced last September, will see the construction of a new 1,320 t/d capacity ammonia plant at the site, and also covers the provision of extensive utilities and off-site facilities. Output from the new plant will feed EHC's existing ammonium nitrate plant at Ain Sokhna.

The project is scheduled for completion 36 months after financial closure. Project finance is being arranged by the Italian export credit agency SACE and US EXIM Bank.

Basil El-Baz, EHC chairman, said: “This contract is another outstanding opportunity to work with Maire Tecnimont, a company we trust with best in class expertise and experience. The EHC expansion project is a vote of confidence in the Egyptian economy and the reforms that have been undertaken to date. The project will serve as a catalyst for the mining sector, attracting foreign investment and increasing employment opportunities and providing the raw materials needed for the sectors activities.”

Pierroberto Folgiero, Maire Tecnimont Group CEO, added: “With this achievement we are proving once again the great resilience of our core business in a particularly challenging period for the whole market. We are also really proud to play a strategic role in the development of the fertilizer industry in Egypt with an entrepreneurial client such as EHC.”

AFRICA

Fertilizers still reaching farmers

The Covid-19 pandemic continues to have little impact on fertilizer supply and distribution in Eastern and Southern Africa – with no shortages reported currently.

This was the conclusion of the latest edition of the *Covid-19 Fertilizer Watch* newsletter for the region published by the International Fertilizer Development Centre (IFDC). This monitors the status of fertilizer markets in Burundi, Ethiopia, Malawi, Mozambique, Rwanda, South Africa, Tanzania, Zambia and Zimbabwe.

All these countries are reporting normal movement of fertilizer products and as-usual trading conditions, according to IFDC. Yet concerns remain that renewed cross-border trade within the region could help spread the virus, says IFDC, as more countries relax their trading restrictions.

Key regional ports are still operating under modified conditions. The isolation and quarantining of returning crew are still standard, for example, as are reduced shift patterns. Road freight is also said to be moving normally, despite losses being incurred by logistics companies due to the decline in back-freight cargo. Covid-19 testing of truck drivers – with subsequent isolation, if necessary – is still mandatory at border crossings. In practice, however, this is being applied with varying degrees of rigour across the region.

Neither has Covid-19 seriously dented fertilizer imports into the region, Argus Media separately reported.

Kenya's DAP imports, for example, totalled 140,000 tonnes in the first-quarter of this year, up from 132,000 tonnes during the same periods in 2018 and 2019. Total January-May arrivals for 2020 are estimated at 220,000 tonnes, up by 58,000 tonnes year-on-year (y-o-y). Kenya's January-March urea imports of 33,000 tonnes in 2020, in contrast, were down 21,000 tonnes y-o-y, albeit up by 8,000 tonnes on the same periods in 2018 and 2017.

GERMANY

Gigawatt-scale 'green hydrogen' projects now possible

In a landmark moment, thyssenkrupp's highly-automated European production line now allows 'green hydrogen' projects to be delivered at gigawatt scale.



PHOTO: THYSSENKRUPP

thyssenkrupp electrolyser installation.

The company – together with its strategic supplier and joint venture partner De Nora – announced a significant expansion in its manufacturing capacity for water electrolysis cells in June.

thyssenkrupp confirmed its annual production capability for the manufacture of electrolysis cells has now exceeded the one gigawatt power consumption threshold. This production capability will be extended continuously in the future, the company said.

The generation of green hydrogen via water electrolysis using renewable electricity is gaining in global importance – both as a zero carbon energy carrier and a CO₂-free feedstock for the chemical industry. Green hydrogen is the starting point for the sustainable manufacture of ammonia and fertilizers, for example, as well as methanol and synthetic natural gas

“Many countries around the world are currently planning to enter the hydrogen economy. Water electrolysis is increasingly emerging as a key technology for building a sustainable, flexible energy system and carbon-free industry. This opens up new markets for us,” says Sami Pelkonen, CEO of thyssenkrupp’s chemical & process technologies business unit.

thyssenkrupp, with its expertise in chemical plant engineering and construction, is

well-placed to capitalise on large-scale green hydrogen production by coupling this front-end technology with the downstream manufacture of sustainable base chemicals such as ammonia and methanol.

“Only green hydrogen opens the way to climate neutrality – especially in energy- and resource-intensive industries, such as fuel, chemical or steel production. For this, we need water electrolysis on a gigawatt scale. We can deliver and, as the number and size of hydrogen projects increases, we will further expand our production capacities,” said Christoph Noeres, thyssenkrupp’s head of energy storage & hydrogen.

However, he also cautioned: “One thing is also clear: it won’t work without changes to regulatory conditions and fair market opportunities for green hydrogen. In addition to a further expansion in renewable energy, the focus needs to be on adjusting tax systems and crediting the CO₂-reducing effect of green hydrogen.”

thyssenkrupp’s patented water electrolysis cell design is up to 80 percent efficient and incorporates proprietary anodic and cathodic coatings developed by De Nora. To date, the company has delivered this technology to more than 600 projects and electrochemical plants worldwide, with a combined capacity rating of over 10 gigawatts.

TOGO

\$3 million Covid-19 response loan approved

The African Development Bank (AfDB) has approved the reallocation of a \$3 million loan to help Togo purchase agricultural inputs. The bank decided to redirect the funds to improve Togo’s food security in the wake of the Covid-19 pandemic.

The approval, granted on 18th June, enables a previously-approved African Development Fund (ADF) loan to be reallocated to the Togo Agro-Food Processing Project (PTA-Togo) instead. The funds will now be used to purchase fertilizers, organic pesticides and seeds for approximately 150,000 smallholder farmers.

This should help Togo’s farmers cope with the effects of Covid-19 during the upcoming cropping season. The AfDB estimates that the purchase of these inputs should boost Togo’s agricultural production by delivering an extra 12,700 tonnes of maize, 18,000 tonnes of rice, 1,700 tonnes of sesame seeds and 2,200 tonnes of market garden produce.

By disrupting food chains, the Covid-19 crisis has already affected food supply and demand, according to the AfDB. It has also caused a decline in the purchasing power

of agricultural producers and reduced their access to inputs.

Togo is thought to be particularly vulnerable to a food crisis, as happened in 2008, if the pandemic persists. Its economy is highly dependent on the agricultural sector, which accounts for more than 40 percent of GDP and employs almost 65 percent of the workforce. The government of Togo wants to avert a potential crisis by purchasing high-quality inputs for agricultural producers.

“In addition to reducing the effects of Covid-19 on food security, the planned input procurement operation will ultimately contribute to increasing production and thereby reduce food imports,” said AfDB director Martin Fregene.

The AfDB has set up a \$10 billion Covid-19 Response Facility (CRF) to help curb the effects of coronavirus in Africa. A budget support package to Togo from the bank worth \$27.44 million is currently under consideration. This will be directed towards enhancing the nation’s economic and health resilience to Covid-19, if approved.

RUSSIA

Metafrax project makes progress

The Metafrax ammonia-urea-melamine (AUM) project continues to make progress, Casale confirmed in a recent statement.

Construction of the large AUM complex is making steady progress, Casale said, despite serious hurdles caused by the Covid-19 pandemic and the need to safeguard the health and safety of all staff involved in the project, particularly Casale’s own on-site team.

Casale said in a statement that it has complied fully with anti Covid-19 measures required by Russian authorities and that none of its own staff have tested positive for the virus. It remains confident that the ammonia unit will be delivered and come

on-stream before the end of the year.

“At the onset of the pandemic, appropriate measures and strategies were quickly put in place to soften – to the maximum extent possible – the negative impact of the situation, especially as far as the schedule is concerned. All the equipment for all of the units was already delivered on-site before the pandemic struck. Piping prefabrication and installation are [also] underway,” Casale said.

Casale also confirmed separately that the 1,500 t/d nitric acid plant at Navoyazot in Uzbekistan was on schedule to start-up at the end of May, following the successful completion of a ‘turboset’ surge test.

Uralchem doubles environmental investments

Uralchem more than doubled its investment in environmental projects in 2019 to RUB 861 million (\$12 million). Projects included:

- Upgrades to industrial waste purification systems at the company’s KCKK Branch in Kirovo-Chepetsk. This included the installation of a new gas purification system for the phosphoric acid and nitrates plants.
- Effluent treatment to avoid water body contamination at the Perm Mineral Fertilizers (PMF) Branch in Perm. A waste separation and recycling scheme was also implemented.
- Various environmental upgrades at Azot Branch in Berezniki, Perm, with a major focus on reducing water and natural gas consumption. Up-to-date purification systems were installed to recycle and neutralise industrial wastes.
- Upgrades to sulphuric acid production at the Voskresensk Mineral Fertilizers (VMF) Branch in Moscow region, including the replacement of the absorption tower.

In a milestone moment for Uralchem, its PMF Branch successfully achieved ISO

14001:2015 certification in November 2019. The International Fertiliser Association (IFA) also awarded the PMF Branch its top global rating for responsible production management last year.

MOROCCO

Khemisset feasibility study published

Emmerson Plc published a feasibility study (FS) for its Khemisset potash project in northern Morocco in June.

The project is aiming for average steady-state production of 735,000 t/a and peak production of 810,000 t/a for its K60 MOP (muriate of potash) product. Khemisset will also produce one million t/a of de-icing salt.

Potash production at this scale will require pre-production capital investment of \$387 million. A plant to produce de-icing salt for the US market will require additional capital of \$24 million.

The net present value (NPV, post-tax) of the venture – a measure of its profitability – is estimated at \$1.4 billion. The project will also have an internal rate of return (IRR) of 38.5 percent over its initial 19-year mine life. Average annual earnings (EBITDA) of \$307 million are expected, with a capital payback of less than 2.6 years.

The estimated delivered cost of potash to Emmerson’s target markets (Brazil, NW Europe, Morocco, South Africa) are said to be in the industry’s lowest quartile. While the project’s projected cash margins are in the top quartile, according to an analysis by Argus FMB.

Hayden Locke, Emmerson’s outgoing CEO, said: “The feasibility study shows that Khemisset has the potential to be a world class, low capital cost, high margin potash mine, which is a very rare asset in the global fertiliser industry. The strong agricultural investment thematic remains firmly in place driven by ever increasing global population and shrinking arable land, which necessitates the need for fertiliser and, in particular, potash.”

Locke added: “We are particularly pleased that the total pre-production capital cost has come down by approximately \$19 million from the scoping study. The objectives for Emmerson for the rest of 2020 are to move the project through the various permitting requirements – including an Environmental and Social Impact Assessment – while concurrently moving forward our financing discussions for the next phase of Khemisset’s development.” ■



PHOTO: URALCHEM

UralChem fertilizer production plant, Russia.

People

ICL Group's executive vice president (EVP) **Eli Amon** has been appointed to lead its newly-created crop nutrition marketing business. He will also continue in his current role as EVP for ICL's Innovative Ag Solutions division. Mr Amon has been with ICL for 29 years, serving in several executive sales, marketing and logistics roles.

ICL announced a consolidation of its sales and marketing teams on the 22nd June. In future, sales and marketing efforts for both commodity fertilizers and speciality fertilizers will be undertaken by a single commercial unit and managed on a regional basis.

Raviv Zoller, ICL's president and CEO, said: "We believe that establishing a single commercial unit facing agricultural end-markets will allow us to better leverage ICL's region-specific knowledge, agronomic and R&D capabilities, logistical assets, and customer relationships, as well as to enhance the global operational scale of our crop nutrition business."

Gretchen Watkins, the president of Shell Oil Company, was elected to the board of directors of The Mosaic Company in May. Ms Watkins joined Royal Dutch Shell in 2018 as president of its US business arm, Shell Oil Company, and as EVP, Global Shales. She was the CEO of Maersk Oil and Gas from 2016 to 2018, and the company's chief operating officer (COO) immediately prior to that, from 2014 to 2016. Previously, Ms Watkins has held senior executive roles at BP and Marathon Oil Company, and served on the board of directors of global engineering consultancy WS Atkins. She holds a Mechanical Engineering BSc from Pennsylvania State University.

"Gretchen has built an extraordinary career in the energy industry," said Gregory Ebel, Mosaic's board chairman. "The board of directors looks forward to benefiting from her global experience, her deep understanding of commodities and her strong operations background."

Graham Clarke became the new CEO of Emmerson Plc, the developer of the Khemisset potash project in Morocco, at the beginning of July. He replaces **Hayden Locke** who is remaining as a company director to focus on financing and strategic partnerships. Mr Clarke joins Emmerson from Sirius Minerals where he has been a key member of its senior executive team since 2011, overseeing all technical aspects of the development of the Woodsmith Mine. Prior to this, Graham enjoyed a 26-year career at Cleveland Potash, the operator of the Boulby potash mine in Yorkshire. This included a stint as director of mining before finally becoming managing director of ICL UK, the owner of Cleveland Potash.

Mark Connelly, Emmerson's chairman, said: "Graham is a highly experienced potash mining executive with a clear track record of success in the industry. What is more unique is his recent experience of taking a large, highly complex, underground mine all the way from a concept through to construction. In my experience, this is a rare combination of skills in any commodity, and this is particularly true in the potash industry."

Graham Clarke, Emmerson's Incoming CEO, said: "I am delighted to be joining Emmerson at this important stage of its development. The results from the feasibility study

indicate a very compelling potash opportunity which, because of its very low expected upfront capital cost, is likely to have multiple financing options available to it."

Roeland Baan became Haldor Topsoe's new CEO in May. He was previously CEO of Finnish steel giant Outokumpu.

Welcoming Mr Baan's appointment, Jeppe Christiansen, Haldor Topsoe's chairman, said "Roeland Baan has remarkable global experience and a proven track record of driving growth, developing businesses and building cohesive organizations. I am convinced he will contribute to the continued strong performance of Haldor Topsoe. With Roeland's direction, we will continue to focus on being global leader in the markets in which we operate."

In response, Roeland Baan said: "This is a special day for me. Topsoe is an exceptional company that has made a huge difference for the refining and chemical industries for decades. I have no doubt that Topsoe has the potential to expand this strong market position and lead the way into a more sustainable and energy-efficient future. I have been looking forward to begin this journey together with the board and the leadership team as well as Topsoe's customers and dedicated employees."

Advanced conveyor technology company Gambarotta Gschwendt has appointed **Davide Gambarotta** as its new CEO and sole owner designate, replacing the former CEO with immediate effect. Mr Gambarotta will stay on in his current position as CEO and sole director of MDG Handling Solutions. Gambarotta Gschwendt and MDG both operate jointly under the Gambarotta Group. ■

Calendar 2020/21



The following events may be subject to postponement or cancellation due to the global coronavirus pandemic. Please check the status of individual events with organisers.

SEPTEMBER

14-16

TFI World Fertilizer Conference 2020, WASHINGTON, DC, USA
Contact: Valerie Sutton
Fax: (202)-962-0577
Email: vsutton@tfi.org

OCTOBER

20-22

IFA Crossroads Asia Pacific, SINGAPORE
Contact: IFA Conference Service
49, Avenue d'Iéna, 75116 Paris, France
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

NOVEMBER

2-4

Sulphur and Sulphuric Acid Conference 2020, THE HAGUE, Netherlands
Contact: CRU Events
Chancery House, 53-64 Chancery Lane, London WC2A 1QS
Tel: +44 20 7903 2167
Email: conferences@crugroup.com

16-18

IFA Strategic Forum, KIGALI, Rwanda
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

MARCH 2021

1-3

Nitrogen+Syngas 2021, ROME, Italy
Contact: CRU Events
Tel: +44 (0) 20 7903 2444
Email: conferences@crugroup.com

APRIL

7-9

88th IFA Annual Conference, NEW DELHI, India
Contact: IFA Conference Service
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

Covid-19: adjusting to the new normal

We report on how the fertilizer industry and individual companies are working to mitigate the impacts of the Covid-19 pandemic.

Fertilizers declared an essential product

As the Covid-19 pandemic has continued to spread globally, draconian control measures have been introduced to limit contagion. Some countries have forced non-essential businesses to close – resulting in the cessation of commercial and industrial activities that are not deemed strategic or vital to the economy.

The overriding need to keep food supplies running and populations fed, however, has meant that agriculture and its supply chain have been exempted from such strictures. Indeed, a growing number of countries have now recognised the fertilizer industry, and the crop nutrient products it manufactures, as essential to the functioning of their economies.

The **International Fertilizer Association (IFA)** has drawn up a list of countries that have implemented measures designed to ensure that fertilizers continue to be supplied and distributed to farmers during the lockdown. This growing list includes: Argentina, Australia (New South Wales and Victoria), Belgium, Canada (Québec Province), China, Côte d'Ivoire, France, Ghana, India, Italy, Malaysia, Morocco, New Zealand, Nigeria, Pakistan, Russia, Spain, Swaziland, the United Kingdom, United States and Vietnam. Collectively, these nations account for about 60 percent of the global market for crop nutrients.

From this analysis, it is clear that the fertilizer industry has been largely protected from the immediate impacts of the Covid-19 pandemic, thanks to the intervention of national governments, and widespread recognition of the industry's strategic role in supplying vital inputs for the production of food staples.

Behind the scenes, the industry has also made concerted efforts to maintain fertilizer production and keep distribution channels open, while safeguarding their employees at all times.

Below, we look at how the crop nutrients industry has reacted to a still unfolding and unprecedented global crisis. What is very noticeable is the extent to which fertilizer producers and their employees, while being focussed on ensuring operations continue, have also looked outwards and supported their local communities. Many companies have donated their time, expertise, personal protection equipment and, in some cases, millions of dollars to fighting Covid-19.

Information sharing holds the key

IFA was quick to react, establishing an online *Covid-19 Information Centre* during the pandemic's early stages. The association judged that having access to accurate, up-to-date information on the global impacts of Covid-19 would be vital for the industry – and help ensure the continuation of production, supply and distribution of fertilizers internationally.

The centre provides relevant global market and supply chain news, regional and national policy developments, and updates on efforts by the UN and other multilateral agencies. It is also designed to allow IFA's fertilizer industry members to exchange information on critical measures and share good practices and their learning experiences.

In launching the web-based portal, IFA commented: "During these challenging times, keeping each other informed and staying in touch is critical!"

In March, to gain a clearer picture of the scale of Covid-19 impacts in China, IFA carried out a survey of major international fertilizer producers with a presence in the country. The association also ran a webinar on *Covid-19 – Best Practices and Lessons* at the end of May. This covered China's fight against Covid-19, plant management practices, and how to support employee stress at home and work. It included

presentations from China's CNAMPGC, Yara International and OCP Group.

Regional and national updates

Fertilizers Europe, the body that represents European Union fertilizer producers, began publishing weekly *Covid-19 – implications for the EU fertilizer industry* newsletters from 20th March. It has also been publishing a regular series of *Media Reviews* in parallel. Similarly, in the United States, **The Fertilizer Institute** has been publishing Covid-19 updates since 16th March.

Other regional bodies and national fertilizer trade associations have also been active in publishing updates on fertilizer production, supply and distribution, including:

- Germany's Industrieverband Agra (IVA)
- Spain's Asociación Nacional de Fabricantes de Fertilizantes (ANFFE)
- Italy's Assofertilizzanti
- Belgium's BELFertil
- The China Phosphate and Compound Fertilizer Industry Association and the China Nitrogen Fertilizer Industry Association.

In Africa, the IFDC has regularly published an *East and Southern Africa Fertilizer Watch* newsletter. Joint weekly West African trade updates have also been issued by IFDC, WAFA, and AfricaFertilizer.org.

The people and economies of Europe, particularly those of the UK, Italy and Spain, have been hit particularly hard by Covid-19 during the spring and summer. However, the fertilizer industry's 'essential' status, drastic changes to working practices and cooperation between the sector and domestic governments have – in general – kept fertilizers rolling off production lines and ensured deliveries to farmers.

Italy was the first EU country to enter lockdown in early March. “The agri-food sector and all the activities linked to it – including fertilizers production and selling– were immediately recognised as fundamental and unstoppable, thanks to us,” commented Alice Parasecolo of **Assofertilizzanti**, Italy’s national association of fertilizer manufacturers, in April.

She continued: “[Under] restrictive measures adopted by the government at the end of March, fertilizers retailers and distributors were required to inform authorities about the continuation of their activities. However, due to the decline in the number of new cases and the severe economic consequences of the lockdown, some areas have started to work again [with] Italian fertilizer retailers and distributors re-opening after 14th April.”

Emerging from one of Europe’s strictest lockdowns, Spain’s **Asociación Nacional de Fabricantes de Fertilizantes (ANFFE)**, is reporting a return to business as usual: “Nowadays, all fertilizer production, transportation and distribution activities are working correctly in Spain, and manufacturing companies are ensuring the supply of quality fertilizers to farmers, attending to any product request. At the same time, they are taking the necessary measures to protect the health and safety of workers, avoiding health risks.”

In an update in April, Sven Hartmann of German trade body **Industrieverband Agra (IVA)** said: “So far, measures [have] helped to keep production and logistics in Germany running. There is no shortage on agrochemicals for farmers. Up to now, food production in general and fertilization, specifically, have not been impaired.”

The Netherlands, a European production and distribution hub for fertilizers, has also reported minimal fertilizer industry disruption.

“The chemical industry (including mineral fertilizers production) as well as the agricultural sector is seen as a vital sector already from the start of the Covid-19 crisis. Up to now, signals we get from our members are that both production and distribution is continuing rather uninterrupted,” Reinier Gerits, director of **Meststoffen Nederland**, the Dutch association of fertilizers manufacturers, importers and distributors, said in April.

He added: “Logistics is one of the main areas of concern, mostly regarding importing raw materials and shipping final products, but also for people living in Flanders and working in the Netherlands. Up to now fitting solutions have been implemented.”

In mid-May, Belgium’s **BELFertil** reported that: “Covid-19 did not really influence the operational activities of most of the members of BELFertil, the Belgian mineral fertilizers industry. The agro-food chain is considered to be a primary and essential sector in Belgium. This includes the mineral fertilizer industry.

The declaration of the industry as an essential sector, flexible logistics, and Belgium’s large-scale and fully operational ports, help explain the limited effects of Covid-19 so far, BELFertil suggests:

“The pandemic has a limited impact on the produced and delivered volumes of mineral fertilizers of our members. The installations were running on normal capacities. The resources kept coming in and the end products were going out almost like normal.”

Behind the scenes, this has required impressive organisational efforts to achieve, as BELFertil makes clear. Planned investments and recruitments have not stopped either, despite the uncertain situation. The main goal initially was to keep on-site staff levels as low as possible:

“The necessary measures were taken to enable safe working with day and night shifts working on minimum staffing. Technical operations were rescheduled, contractors were sent home, and administrative staff and salespeople have been working from home most of the time.”

The lifting of the lockdown has, however, allowed fertilizer industry employees in Belgium to begin returning to production sites and offices since the 11th May.

Following the imposition of the UK lockdown at the end of March, Sam Bell, commercial director of **CF Fertilisers UK Ltd**, the UK’s largest fertilizer manufacturer, confirmed that the British Government had granted the company ‘critical business status’. In an open letter to staff, Mr Bell said:

“We have re-organised our working patterns to protect against the pandemic and remain operational. As such we are able to keep producing to our normal product range and timescales.

“Safety is our number one priority. So, we are, and will, do everything we can to keep our plants working safely and to this aim our staff are either working from home or on the plants as required.

“Much of our business involves putting the supply jigsaw together with our partners, from inputs to manufacturing, through production to sales and distribution. We are working with all our partners to ensure that this keeps going and that customers get what they require from us in a safe and timely manner.”

Safety, mitigation and business planning

A number of major fertilizer manufacturers have shared the actions they have taken to ensure that production has continued to operate as normal and their staff have remained safe during the Covid-19 pandemic.

Yara International, via IFA’s *Covid-19 Information Centre*, made available its internal guidance materials for other companies to use or adapt, including support and advice for:

- Home office stress
- Managing stress at work
- Checklist for operations.

The operational checklist – a risk mitigation document aimed at site and asset managers – is split into three sections covering: people and leadership; workplace organisation; physical assets, transport and security.

Moroccan phosphate giant **OCP Group** says that its production is proceeding as normal thanks to the implementation of business continuity planning (BCP) at each of its production sites. The aims of BCP are to safeguard the health and safety of employees, both on-site and those working from home, guarantee the provision of safety equipment, and maintain normal operating rates at OCP’s production sites.

The BCP activities introduced by OCP have included:

- Remote control of production units
- A local crisis unit
- Prevention, response and communication plans
- A list of critical activities, an alert scheme and an assistance protocol
- The use of digital communication tools instead of physical meetings.

In a statement, the company said: “As a global business with more than 21,000 employees in more than 30 countries, our first response to the Covid-19 pandemic has been to ensure the safety and wellbeing of our team, our supplier partners, and the communities in which we operate. Our business resilience task force has led the transformation of our working practices, championing safety and spearheading the move to working from home for as many of our office workers as possible.”

As part of a comprehensive *Mitigation & Escalation Action Plan* issued towards the end of March, Bahrain-based **Gulf Petrochemical Industries Company (GPIC)** con-

firmed it had taken the following actions on operational management:

- Set up a coordination team to review the site continuity plan in the event of a pandemic
- Identified the minimum staff requirement to cover critical operations
- Identified critical positions to maintain on site
- Prepared a implementation plan for alternative shift coverage, if needed
- Developed integrated production slow-down and shutdown plans
- Conducted site-wide drill plans for production slowdown and shutdown
- Prepared housing facilities for shift workers
- Reviewed all Capex and projects currently under implementation
- Suspended external and internal audits
- Put non-critical activities on standby, including non-critical preventive maintenance
- Initiated a marketing contingency plan
- Coordinated with the authorities on the granting of special security passes to enable employees to commute to work if Bahrain declares a partial curfew.

Other 'actions in progress' include:

- Re-evaluation of the November 2020 turnaround date with the option to postpone this to March 2021
- Revision of planned factory acceptance test (FAT) visits outside Bahrain and the delegation of these to third parties, if necessary
- A follow-up marketing evaluation of product demand and net backs.

Emergency relief efforts

Fertilizer producers across the globe have pledged funds to support local communities facing hardship during the current crisis.

OCP Group has been particularly generous, donating \$310 million to Morocco's Covid-19 management and response fund. The company is also:

- Using 3D printing to design and produce personal protection equipment (PPE) for hospital staff
- Developing a Covid-19 track & trace app
- Producing its own hand sanitiser gel
- Donating an ambulance
- Refurbishing three regional public hospitals
- Providing resuscitation equipment and respirators
- Disinfecting public places and transport

- Caring for homeless people
- Raising awareness of hygiene measures among farmers.

"It is wonderful to see our teams making a positive impact in our society through Act4Community (OCP's community engagement association), the OCP Foundation, the Phosphocraa Foundation and our other social programs to address the needs of their communities," OCP said in a statement.

Impressively, in response to the pandemic, **Yara International** has committed \$25 million to provide food for more than one million people in Southern and Eastern Africa. The Norwegian company has launched *Action Africa: Thriving Farms, Thriving Future* – an initiative designed to secure food production and improve food security for 250,000 smallholder farmers in seven African countries. Some 40,000 tonnes of high-quality, zinc-fortified fertilizers will be provided as part of this. Yara's fertilizer contribution, combined with agronomic support, is expected to triple maize production and feed more than one million people across Kenya, Uganda, Rwanda, Tanzania, Zambia, Malawi and Mozambique for one year.

"Vulnerable communities may face the most devastating food crisis in decades. If we don't act now, millions of people will be pushed into deep poverty and hunger. This is especially worrying in Africa where lives and livelihoods are at risk. As a critical part of the food value chain, we have a responsibility to support vulnerable farming communities and help avert a hunger crisis," said Svein Tore Holsether, Yara's president and CEO.

The **Indian Farmers Fertiliser Cooperative Limited (IFFCO)** has donated \$3.4 million to the national PM-CARES Fund and \$140,000 to the Punjab chief minister's relief fund. IFFCO employees have also given one day's pay towards relief efforts for the disadvantaged. The company is also manufacturing hand sanitisers, distributing coronavirus prevention kits to farmers and key workers, giving food to the disadvantaged, and providing Covid-19 prevention awareness to agricultural labourers.

Commenting on the contributions made by IFFCO – and those from **Krishak Bharati Cooperative Limited (KRIBHCO)** and **National Fertilizers Limited** – D V Sadananda Gowda, India's fertilizer and chemicals minister said it will go a long way in helping the government combat coronavirus and mitigate the impacts of the outbreak.

In Pakistan, **Fauji Fertilizer Company (FFC)** has pledged \$100,000 to community-support initiatives. The company has so far distributed 1,000 ration packs to disadvantaged families. It has also created a 60-bed public quarantine centre at FFC's welfare complex, briefed farmers on Covid-19 safety measures, and launched a mass awareness campaign that includes the provision of hand sanitisers.

Florida-based **Mosaic** has confirmed the donation of \$1.5 million to projects in Brazil, Canada, China, India and the US. The money will go towards food banks, government emergency funds, and the procurement and distribution of hygiene kits, medical kits and PPE.

Canadian fertilizer giant **Nutrien** has allocated \$1 million in food support to local communities. The company's Covid-19 community support plan also offers volunteer support and virtual youth education, as well as providing in-kind donations such as N-95 face masks, Tyvek suits, computers and the manufacture of hand sanitisers for healthcare providers.

Illinois-based **CF Industries** has donated \$350,000 to Feeding America and nine food banks located near its US manufacturing sites. The company has also donated large quantities of PPE to local hospitals and healthcare and nursing providers in both the US and the UK. These include P-100 masks, N-95 masks, gowns, shoe covers and eye goggles.

In Indonesia, **PT Pusri Palembang** has donated PPE, hygiene kits, medical kits and vitamins to the South Sumatran government, and was designated as the coordinator of the regional disaster task force. The company is also distributing medical kits to its local hospital, hygiene kits and PPE to the local community, and food to people in need.

Also in Indonesia, **Pupuk Kaltim** has provided PPE, extra food and disinfection help to three hospitals in East Kalimantan. It has also upgraded its company hospital, purchasing four ventilators and allocating 50 percent of hospital capacity to Covid-19 patients, as well as providing isolation facilities and PPE.

The company was singled out for praise by the governor of East Kalimantan. "Pupuk Kaltim provides PPE assistance, extra food and vitamins to hospitals in Samarinda, Balikpapan and Bontang. They have supported health workers to treat patients with Covid-19," the governor said during a Covid-19 video conference call with Indonesia's president Joko Widodo. ■

Nitrogen projects and licensors

Stamicarbon urea pool reactor plant.

PHOTO: STAMICARBON

Following the publication of the 2020 nitrogen project listing by our sister magazine *Nitrogen+Syngas*, we profile a selection of leading nitrogen projects and their process licensors. Australia, Egypt, India, Nigeria and Russia have been key countries for new project developments.

AUSTRALIA

Contracts agreed for Karratha project

Haldor Topsoe entered into a technology licensing and engineering contract with Perdaman Chemicals and Fertilisers at the end of last year for a new ammonia-urea plant in Karratha, Western Australia.

Perdaman is planning to build a two million tonne capacity urea plant on the Burrup Peninsula, some 20 kilometres north-west of Karratha on the northwest coastline of Western Australia. The AUD four billion project will use local natural gas as a feedstock for fertiliser production, and incorporates innovative and low-emissions technologies.

The Karratha project's 3,500 t/d ammonia plant will be the largest single-train unit in the world, when completed. Construction is expected to start this year, although go ahead is still subject to a final investment decision.

The Karratha project, which has a guaranteed gas supply, has made significant progress over the last two years. SNC-Lavalin was named as the project's engineering, procurement and construction (EPC)

contractor in November 2018. Stamicarbon has also come on board as the project's urea technology licensor, with the company's *LAUNCH MELT™* pool condenser design being selected for urea production.

Topsoe is licensing its *SynCOR Ammonia™* technology for the project. This is company's latest technology for large-scale ammonia production. It incorporates single-step autothermal reforming and is capable of reducing steam throughput by 80 percent.

According to Topsoe, *SynCOR Ammonia™* technology will deliver major economic and operational benefits for Karratha's large-scale ammonia plant.

"This is a significant step forward for the Karratha urea project. We are now full steam ahead on this important project that will use the latest and best technologies available. We expect Haldor Topsoe's innovative technology to deliver significant economies of scale that will contribute to making this world-scale plant exceptionally competitive," said Vikas Rambal, founding chairman and managing director, Perdaman Group.

Chris Brown, SNC Lavalin's president for oil & gas, said the company was pleased to be part of this important Aus-

tralian project. "Our vast experience in delivering major projects that involve constructing state of the art technology will be vital in bringing this project to completion over the next four years," he said.

Karratha has been awarded 'Project of State Significance' status by the WA State Government. Project construction is conditional on environmental approval

EGYPT

Aswan nitrogen complex completed

The new Egyptian Chemical Industries (KIMA) nitrogen complex at Aswan has now been completed and is ready to enter production, according to the company. The new \$770 million complex has the capacity to produce 900 t/d of ammonia, 1,200 t/d of urea, and 300 t/d of ammonium nitrate (both low and high density). Full-scale commercial production was expected to start in April, following the successful completion of trial operations.

Tecnimont and tkIS secure Ain Sokhna contracts

Maire Tecnimont signed a \$550 million engineering, procurement and construc-

Nitrogen project listing 2020 for Australia, Egypt, India, Nigeria and Russia

Contractor	Licensor	Company	Location	Product	mt/d	Status	Start-up date
AUSTRALIA							
SNC Lavalin	Haldor Topsoe	Perdaman	Karratha, WA	Ammonia	3,500	CA	2024
SNC Lavalin	Stamicarbon	Perdaman	Karratha, WA	Urea	6,000	CA	2024
EGYPT							
Tecnimont	KBR	Kima	Aswan	Ammonia	1,200	C	2020
Tecnimont	Stamicarbon	Kima	Aswan	Urea	1,575	C	2020
thyssenkrupp I.S.	thyssenkrupp I.S.	NCIC	Ain Sokhna	Ammonia	1,200	UC	2022
thyssenkrupp I.S.	Stamicarbon, TKFT	NCIC	Ain Sokhna	Urea	1,050	UC	2022
thyssenkrupp I.S.	thyssenkrupp I.S.	NCIC	Ain Sokhna	Nitric acid	500	UC	2022
thyssenkrupp I.S.	thyssenkrupp I.S.	NCIC	Ain Sokhna	Ammonium nitrate	635	UC	2022
thyssenkrupp I.S.	thyssenkrupp I.S.	NCIC	Ain Sokhna	CAN	835	UC	2022
n.a.	n.a.	El Nasr Fertilizers	Ataka	Ammonia	1,200	P	n.a.
INDIA							
TEC	KBR	Chambal Fert & Chem	Gadepan	Ammonia	2,200	C	2019
TEC	TEC	Chambal Fert & Chem	Gadepan	Urea	2 x 2,000	C	2019
Engineers India Ltd	Haldor Topsoe	RCFL	Ramagundam	Ammonia	2,200	C	2020
Engineers India Ltd	Saipem	RCFL	Ramagundam	Urea	3,850	C	2020
n.a.	Casale	Zuari AgroChem	Goa	Ammonia	1,050	RE	2020
TechnipFMC/L&T	Haldor Topsoe	HURL	Sindri	Ammonia	2,200	UC	2021
TechnipFMC/L&T	Saipem	HURL	Sindri	Urea	3,850	UC	2021
TechnipFMC/L&T	Haldor Topsoe	HURL	Barauni	Ammonia	2,200	UC	2021
TechnipFMC/L&T	Saipem	HURL	Barauni	Urea	3,850	UC	2021
n.a.	KBR	HURL	Gorakhpur	Ammonia	2,420	UC	2021
n.a.	TEC	HURL	Gorakhpur	Urea	3,850	UC	2021
n.a.	Casale	Deepak Fertilizers	Paradip	Nitric acid	970	BE	2021
n.a.	KBR	Deepak Fertilizers	Taloja	Ammonia	1,500	UC	n.a.
Wuhuan Engineering	KBR	Talcher Fertilizers	Talcher	Ammonia	2,200	DE	2023
Wuhuan Engineering	Stamicarbon	Talcher Fertilizers	Talcher	Urea	3,850	DE	2023
NIGERIA							
TEC	KBR	Indorama	Port Harcourt	Ammonia	2,300	UC	2021
TEC	TEC	Indorama	Port Harcourt	Urea	4,000	UC	2021
Saipem	Haldor Topsoe	Dangote Fertilizer Ltd	Agenbode	Ammonia	2 x 2,200	UC	2020
Saipem	Saipem/TKFT	Dangote Fertilizer Ltd	Agenbode	Urea	2 x 3,850	UC	2020
n.a.	n.a.	OCP	n.a.	Ammonia	3,300	P	n.a.
RUSSIA							
Tecnimont	Stamicarbon	KuibishevAzot	Togliatti	Urea	1,500	UC	2021
GIAP	Casale	KuibishevAzot	Togliatti	Nitric acid	1,350	UC	2021
GIAP	Casale	KuibishevAzot	Togliatti	Ammonium nitrate	1,500	UC	2021
NIIK	Casale	JSC Metafrax	Gubakha	Ammonia	1,000	UC	2020
NIIK	Casale/MHI	JSC Metafrax	Gubakha	Urea	1,700	UC	2021
Casale	Casale	Togliatti Azot	Togliatti	Urea	2,200	UC	2021
Tecnimont	KBR	EuroChem	Kingisepp	Ammonia	2,700	C	2019
Tecnimont	KBR	EuroChem	Nevynnomysk	Ammonia	3,300	UC	n.a.
Tecnimont	n.a.	EuroChem	Kingisepp	Ammonia	3,000	FS	n.a.
Tecnimont	n.a.	EuroChem	Kingisepp	Urea	4,000	FS	n.a.
Uralchem	Stamicarbon	Uralchem	Perm	Urea	+900	RE	2020
n.a.	KBR	Kemerovo Azot	Kemerovo	Nitric acid	500	DE	2021
NIIK	Stamicarbon	Acron	Novgorod	Urea	2,000	UC	2020
CNCCC	Haldor Topsoe	ShchekinoAzot	Pervomaysky, Tula	Ammonia	1,500	DE	2022
CNCCC	Stamicarbon	ShchekinoAzot	Pervomaysky, Tula	Urea	2,000	DE	2022

Note: this is an extract from the full global 2020 nitrogen project listing published in our sister magazine Nitrogen+Syngas in March this year (Nitrogen+Syngas 364, p 28).

KEY

BE: Basic engineering DE: Design engineering P: Planned/proposed Conversion:
 C: Completed/commissioning FS: Feasibility study RE: Revamp 1 t/d of hydrogen = 464 Nm³/h
 CA: Contract awarded n.a.: Information not available UC: Under construction 1 t/d of natural gas = 1,400 Nm³/d

tion (EPC) contract with Egypt Hydrocarbon Corporation (EHC) at the end of last year for a new ammonia plant at Ain Sokhna, near Suez.

The 1,320 t/d ammonia plant will feed an existing ammonium nitrate plant at the site. It will operate using KBR-licensed technology and should be completed within three years, once formal go ahead is given.

Pierroberto Folgiero, Maire Tecnimont Group CEO, said: "We are very happy to expand our footprint in Egypt in our fertilizers core business, leveraging our long-term relationships with the Egypt Hydrocarbon Corporation."

Germany's thyssenkrupp Industrial Solutions (tkIS) secured a separate contract to construct a new nitrogen fertilizer complex at Ain Sokhna for Egypt's Nasr Company for Intermediate Chemicals (NCIC) earlier in 2019.

The two companies signed the engineering, procurement and construction (EPC) contract in Cairo in March last year. The major order is said to be valued in the "mid-three digit million euro range".

The new complex is located at Ain El Sokhna, around 100 km southeast of Cairo, close to NCIC's existing phosphate and compound fertilizer complex. It will produce up to 440,000 t/a of ammonia, 380,000 t/a of urea and 300,000 t/a of calcium ammonium nitrate (CAN).

The new Ain El Sokhna complex is part of a plan by NCIC to expand its current product portfolio to include high-quality nitrogen fertilizers – and manufacture these for both domestic consumption and the export market. The complex will be completed and enter production in 2022 under current plans.

"We have a particularly successful partnership with Egypt stretching back more than 160 years which offers great potential for the future. Our longstanding experience in plant construction, our strong local presence and close collaboration with our customers form the basis for our success and strong market position in the region," said Marcel Fasswald, the CEO of tkIS.

"To date, we have planned and built 16 of the 17 existing nitrogen fertilizer plants in the country and are delighted that another state-of-the-art plant will now be added," added Ralf Richmann, CEO of the company's fertilizer & syngas technologies business unit.

thyssenkrupp will deliver the project as part of a consortium with the Egyptian company Petrojet. Stamicarbon is the project's urea process licensor.

INDIA

KBR supplies technology to Talcher project

KBR is supplying ammonia synthesis technology to the Talcher ammonia-urea project in India.

It secured the Talcher contract from Wuhuan Engineering Co, the project's EPC contractor at the beginning of the year. KBR will provide the technology license, basic engineering design, catalyst, and proprietary process equipment for the project's ammonia plant. Stamicarbon has also been selected as the technology provider for the project's urea plant

Talcher is a flagship coal-to-urea project for India. It is a central part of government efforts to reduce the country's import reliance by increasing domestic urea capacity. The project is owned by Talcher Fertilizer Limited (TFL), a joint venture between a number of Indian public sector companies.

The Talcher project is a particularly pioneering venture as no other operational urea plants in India are based on coal gasification technology at present.

"We are proud to be part of this significant project in India," said Doug Kelly, KBR president, technology solutions. "KBR's ammonia synthesis process will deliver flexibility, reliability, and cost competitiveness to Talcher for years to come."

China's Wuhuan Engineering Co was awarded the contract to build a coal-based urea plant at Talcher in Odisha state in 2019. The lump sum turnkey contract commits the company to building the \$1.85 billion urea plant by September 2023.

The Talcher plant will convert 2.5 million t/a of coal and 0.35 million t/a of petcoke into syngas. This intermediary will then be used to manufacture ammonia and ultimately 1.27 million t/a of urea.

Attending the contract signing ceremony, oil minister Dharmendra Pradhan said: "The Talcher fertilizer plant was shut down in 1999 due to financial losses. Twenty years later, we have handed over work order for revival of the same."

The Talcher project is essentially a plant re-opening rather than a completely new venture. The Indian government wants to boost domestic urea capacity by reviving the previously-closed fertilizer operations of Fertilizer Corporation of India Ltd (FCIL). It has placed joint venture company TFL in charge of delivering the project.

TFL has been allotted the northern part of North Arkhpal mine as a captive source of coal for the project. Petcoke will be sourced from the Indian Oil Corporation's Paradip refinery.

The successful implementation of coal-based urea technology at Talcher should have benefits for the Indian coal industry by demonstrating the suitability of high-ash Indian coal in areas other than conventional power production.

Ramagundam plant enters production

The Ramagundam urea plant was expected to complete commissioning and begin commercial urea production by the end of March, according to its owners Ramagundam Fertilizers and Chemicals Ltd (RFCL).

The plant's gas supply pipeline from Kakinada is now operational and its flare stack was also recently commissioned.

The plant will be the first of the previously closed state-owned fertilizer plants in India to be brought back on-line. A number of plants are being revamped and upgraded as part of the Indian government's ambitions for self-sufficiency in urea production.

RFCL was formed as a joint venture between six partners in 2015. National Fertilizers Ltd (NFL) and Engineers India Ltd both have a 26 percent stake. Other partners include the Gas Association of India Ltd (14.3%), HTAS Consortium (11.7%), the Fertilizer Corporation of India Ltd (11%) and the government of Telangana (11%).

The new plant's foundation stone was laid by India's prime minister Narendra Modi in August 2016.

Casale secures major nitrate order

Casale is the contractor for a major new technical ammonium nitrate complex in India.

The contract was awarded by Smartchem Technologies Limited (STL) in 2019, a fully-owned subsidiary of Deepak Fertilisers and Petrochemicals Corporation Limited (DFPCL). Under the terms of the contract, Casale will supply process licenses, know-how, basic design and proprietary equipment to the complex, together with on-site assistance.

The planned complex includes the following three production units:

- 900 t/d nitric acid plant based on Casale's proprietary NA2000 dual-pressure process
- 1,143 t/d ammonium nitrate solution plant incorporating Casale's AN2000 pipe reactor technology

Stamicarbon's future-proof fertilizer plants

Stamicarbon – the innovation and license company of Maire Tecnimont Group – has been designing and bringing innovative fertilizer technologies to market for over 70 years now. Stamicarbon holds the largest number of references in the urea business, having licensed more than 250 urea plants worldwide and delivered more than 100 urea revamp projects.

Stamicarbon's ambition is to contribute to a world in which sustainable, environmentally-friendly and safe technologies can thrive. It is seeking to develop solutions that are not just profitable, but also benefit both people and planet.

Stamicarbon made a commitment to invest in a sustainable future by launching its innovation agenda in 2019. This focuses on three key areas:

- **Specialty fertilizers:** including controlled release fertilizers, seed cores and (micro)nutrients.
- **Renewable production of fertilizers:** using wind or solar energy to produce fertilizers.
- **Digitalisation:** optimising plant operations by harnessing the power of real-time data.

To pave the way to achieving these innovation goals, Stamicarbon has invested in controlled-release fertilizer (CRF) technology developed in partnership with Pursell Agri-Tech. This technology enables the production of 'smart' fertilizers able to provide crops with the required nutrients at the right time and rate, resulting in more efficient nutrient use. This innovation is highly valuable for agriculture as it helps farmers optimise crop production and improve their yields.

Stamicarbon also took a step forward in digital transformation through the acquisition of Protomation. This Dutch specialist IT company is dedicated to developing software applications and operator training simulators (OTS) for the chemical process industry – and has a track record of collaboration with fertilizer producers.

Stamicarbon is investing in these future-proof business opportunities, while at the same time remaining strongly focused on its core business: the licensing of fertilizer technology.

During 2019, Stamicarbon signed a contract with Talcher Fertilizers Limited in India for the licensing of a greenfield urea plant, and another contract with Gemlik Gübre in Turkey for the licensing of a greenfield urea and urea ammonium nitrate (UAN) plant.

Stamicarbon also began a revamp project for a US client. This will increase the urea production capacity of the original plant, designed in 1975, from 1,200 short tons/day (1,090 t/d) to 2,000 short tons/day (1,815 t/d), once completed.

The urea plant of KIMA, a Stamicarbon client, went into operation in Egypt in March. This joint project was delivered by two Maire Tecnimont Group sister companies: Tecnimont as EPC contractor and Stamicarbon as urea technology licensor. Stamicarbon engineers provided excellent support to KIMA, even through the challenging work conditions that arrived with the Covid-19 pandemic, enabling the operator to run the plant properly and meet the guarantee figures. The new facility is now in production, thanks to the joint effort of both Stamicarbon and Tecnimont teams, and is fully operational far above its nameplate capacity of 1,200 t/d for ammonia, 1,575 t/d for urea and 300 t/d for ammonium nitrate. ■

- 970 t/d prilling unit able to produce either high density ammonium nitrate (HDAN), based on Casale technology, or low density ammonium nitrate (LDAN), based on newly-acquired ORICA technology.

The project will fully-utilise equipment mothballed, but never used, from another project in a different region.

NIGERIA

Dangote plant in pre-commissioning

Dangote's large-scale urea-ammonia complex near Lagos, Nigeria, has finally entered pre-commissioning, the company has confirmed.

The giant fertilizer complex is located in the Lekki Free Zone close to Nigeria's Atlantic seaboard, and has the capacity to produce 2.6 million tonnes of granulated urea annually.

The project to complete the \$2 billion complex is now in its final stages and approaching completion. Italy's Saipem is constructing the plant, being the project's

engineering, procurement and supervision contractor. Tata Consulting Engineers of India are acting as project management consultants.

Virtually every section of the urea production complex – including the central control room, ammonia and urea bulk storage, cooling tower, power generation plant and granulation plant – is now complete and are going through pre-testing.

The project is also receiving its gas feedstock. The fertilizer plant is being supplied with 70 MMscf/d of natural gas from the Nigerian Gas Company and Chevron Nigeria Ltd under a gas sale and purchase agreement.

Products from the fertilizer plant will save Nigeria \$500 million by import substitution and generate \$400 million in exports, according to Dangote Group executive director Devakumar Edwin.

"By the time our plant is fully commissioned, the country will become self-sufficient in fertilizer production – and even have the capacity to export to other African countries," Edwin said, adding: "Around

five million tonnes of fertilizers are required per year in Nigeria in the next five to seven years – 3.5 million t/a of urea and 1.5 million t/a of NPK – while current production levels in Nigeria [prior to the opening of the new Dangote plant] are 1.6 million t/a."

The dual-train plant will be the largest fertilizer production plant in Africa, having the capacity to produce 2.6 million t/a of urea and 1.5 million t/a of ammonia.

The Lekki fertilizer plant is just one part of Dangote's massive Lekki integrated petrochemical complex. The company is investing \$12 billion overall constructing a 650,000 barrel per day crude distillation unit, a 3.6 million t/a polypropylene plant, and installations able to process three billion cubic feet per day of natural gas.

The plant, which was originally targeting completion in the first quarter of 2018, is being built to the following specification:

- Ammonia plants: 2 x 2,200 t/d based on Haldor Topsoe technology
- Urea melt plants: 2 x 3,850 t/d based on Saipem's Snamprogetti technology



Saipem: flexible urea plant technology

Saipem's *Snamprogetti*[™] Urea Technology is today licensed to almost 140 urea plants worldwide. This urea plant technology provides added-value, both in terms of the time savings it offers operators, and its ease of integration with other production units – either within a new complex or in the expansion of an existing one.

Operational flexibility valued

Snamprogetti[™] technology provides operational flexibility and the ability to isolate the urea reactor, two qualities that are particularly prized by Saipem customers. Urea plant flexibility, particularly the ability to operate at both high and low loads, means it is possible to adjust plant load in response to market demand or feedstock variations – without the need for time wasting, costly and energy-consuming shut-downs. In the eventuality of a shut-down, the option to contain the urea and carbamate solution within the urea reactor for a number of days also helps, as this limits economic losses by permitting a fast restart of the plant.

Coping with start-up problems

The ability of the *Snamprogetti*[™] process to adapt promptly to variations in operating conditions, without affecting the overall performances and safety of the plant, allows urea plants to remain in operation even when all the vessels and tanks are almost full with carbamate solution, in excess of specification.

These features of Saipem's urea technology proved to be of fundamental importance and value in the first days of operation during the start-up of a new fertilizer complex. As the operators were familiarising themselves with the plant's behaviour, an improper response to changes in operating parameters led to the 'popping' of a pressure safety valve (PSV).

Operating satisfactorily

The urea plant was able to continue operating satisfactorily after the popping of the PSV. The plant was repeatedly shut-down shortly after the PSV popping incident due to complex external factors linked to utilities and the upstream and downstream sections. Nevertheless, thanks to the flexibility of *Snamprogetti*[™] technology, the production of finished urea continued, recovering carbamate solutions that had previously accumulated in various vessels.

The above scenario demonstrates the value of operational flexibility, and the ability to self-contain the urea reactor, as the *Snamprogetti*[™] process enabled low load runs and fast start-ups, while at the same time returning operating conditions and vessel inventories to normal. ■

- Urea granulation plants: 2 x 3,850 t/d based on Uhde Fertilizer Technology
- Dedicated power plant: 3 x 40 MW steam turbine generators
- Auxiliary boilers: 3 x 200 t/h steam generation
- EPC contractor: Saipem, Italy, and Saipem Construction Nigeria
- PMC contractor: Tata Consulting Engineers, India

Dangote Group is a diverse industrial conglomerate operating across 10 African countries, generating annual revenues of around \$3 billion from its major interests in the cement, agriculture, food processing, oil & gas and power sectors. Dangote has invested \$7 billion in Nigerian industry in the last five years, equivalent to around 10 percent of the country's total direct foreign investment. Its current investment pipeline, for various Nigerian projects at different stages, totals more than \$23 billion.

Part of the output from Dangote's new urea plant will be dedicated to its growing farming business. The Group is planning to expand sugar cane and rice cultivation in Nigeria to around 300,000 hectares, raising its annual fertilizer requirement to 150,000 tonnes.

Although current domestic consumption represents a relatively small fraction of Nigeria's installed urea capacity, there is potential for this to grow significantly, in Dangote's view. The company suggests that Nigeria's total domestic fertilizer consumption could eventually grow to 1.7-2.9 million tonnes annually under some scenarios, up from around one million tonnes currently. Such an eventuality could see Nigeria's urea consumption rise from under 400,000 tonnes annually currently to 0.9-1.4 million tonnes.

Port Harcourt expansion targets 2021 competition

Indorama Eleme Fertiliser and Chemicals Ltd is aiming to complete construction on its second world-scale ammonia-urea production line next year. The second line will effectively double Indorama's urea capacity to 2.8 million t/a at its Port Harcourt complex by duplicating the 1.4 million t/a capacity of the existing line production line.

Indorama secured the \$1 billion finance package for the 'Eleme II' project in 2018 from a consortium of banks led by the International Finance Corporation (IFC). The IFC will directly lend Indorama \$100

million and mobilise additional loans worth \$850 million from other financial institutions and commercial banks. A further \$50 million in financing will be provided by IFC's Managed Co-Lending Portfolio Program (*Fertilizer International* 485, p10).

The Eleme II project has been under construction for two years. Bukola Saraki, the president of Nigeria's senate, laid the foundation stone at an official ground-breaking ceremony in July 2018.

Toyo (TEC) was awarded the contract to build the second urea-ammonia line at Port Harcourt, replicating its work on the original production line. Toyo is also the urea technology licensor (ACES21[®]) for Eleme II, as well as being responsible for the project's basic design, detail engineering, procurement and commissioning services. KBR will provide the technology licensing, basic engineering design, proprietary equipment and the catalyst for Port Harcourt's second ammonia plant.

"Nigeria has become a major hub for urea exports. With Line 2, we aim to further expand our ability to provide competitively-priced and high-quality fertilizer to farmers in West Africa and across the globe," said Manish Mundra, CEO, Indorama Africa.

"This project will increase... the domestic supply of urea fertilizer in Nigeria, making it easily available and leading to cheaper prices for the Nigerian farmer," said Abdu Mukhtar, industrial and trade development director at the African Development Bank. "It will also... create high paying technical jobs and will count towards climate change abatement by reducing amounts of flared gas."

Large volumes of natural gas are wasted in Nigeria due to gas flaring. Nigeria has flared 750 million cubic feet per day of associated gas over the past three years, according to the World Bank. Downstream use of this gas for basic chemicals and fertilizer production will reduce flaring, a significant contributor to greenhouse gas emissions and climate change.

RUSSIA

New Kingisepp plant contract

Maire Tecnimont signed a memorandum of intent with EuroChem Group for a new Russian nitrogen plant late last year.

The two companies signed an early works contract for a potential new urea and ammonia plant in October. This will be located next to EuroChem's existing Kingisepp nitrogen complex in northwest Russia, close to the Baltic Sea.

Under the terms of the agreement, Tecnimont will carry out preliminary engineering and surveying work at the industrial site. But a definite go-ahead for the plant still awaits a final investment decision by EuroChem.

"We are pleased to take the next step toward considering building this world scale plant, with Maire Tecnimont, a company that we have worked with closely for many years," said Petter Ostbo, EuroChem's CEO. "Expansion of production facilities is a strategic goal for us and part of the next chapter in our growth story."

"We are eager to keep on supporting a prestigious client such as EuroChem in its long-term expansion plan," said Pierroberto Folgiero, Maire Tecnimont's CEO. "This important project reinforces our position in the fertilizer business, and confirms further our long-lasting industrial footprint in Russia."

EuroChem officially opened EuroChem Northwest, its new ammonia plant at Kingisepp, in June last year. EuroChem Northwest took three years to develop and was constructed by two Maire Tecnimont subsidiaries, Tecnimont SpA and Tecnimont Russia. It produces ammonia using KBR's proprietary *Purifier*[™] process.

The \$1 billion plant is Europe's largest single ammonia production unit, with an annual capacity of just under one million tonnes (*Fertilizer International* 489, p15). Around three-quarters of its output will supply EuroChem fertilizer production plants in Antwerp, Belgium, Lifosa in Lithuania, and Phosphorit, the Group's adjacent phosphate fertilizer complex at Kingisepp. The remaining 25 percent will be sold to third parties.

Construction of the world-scale plant required more than 12,000 tonnes of steel and the installation of more than 64 kilometres of piling. Over 5,000 on-site workers were involved in the plant's construction at its peak. EuroChem Northwest will permanently employ 300 local people now that it has opened.

ShchekinoAzot urea plant contract

Netherlands-based Stamicarbon entered into a urea plant contract with Russian producer ShchekinoAzot last year.

The contract covers technology licensing, the process design package (PDP) and the supply of proprietary equipment for a new urea melt and granulation plant at Pervomayskiy in Russia's Tula region.

The 2,000 t/d capacity plant will use Stamicarbon's *Pool Reactor Design* and *Flash Design*. The plant's *Safurex*[®] high-

pressure stripper and pool reactor will also be equipped with a radar-level measurement system. The granulation plant at the site will use Stamicarbon's *Optimized Granulation Design* and the *MicroMist*[™] Venturi Scrubber technology.

Casale builds third urea plant for TOAZ

TogliattiAzot (TOAZ) has selected Casale to build a new 2,200 t/d urea plant.

This will be the third urea line at TOAZ's Togliatti site in Russia's Samara region. Casale is providing TOAZ with proprietary know-how, all of the project engineering, and the supply of offshore equipment and materials.

The ground-breaking ceremony for the plant's construction was held in October last year. The new line will be constructed alongside the two existing plants and will increase total urea production at the site by 70 percent. Casale's sister company, Prague-based Casale Project AS, will supply all the onshore equipment and be responsible for on-site construction.

Completion of the new urea line for TOAZ is expected in the second quarter of 2021. It is Casale's third Russian plant order in two years.

Tecnimont constructs KuibyshevAzot urea plant

Tecnimont is the engineering, procurement and construction (EPC) contractor for the Volgafert granulated urea plant.

The new 540,000 t/a capacity urea plant, sited at the KuibyshevAzot industrial complex, Tolyatti, in Russia's Samara region, will use Stamicarbon technology.

Under the terms of the €200 million contract, Tecnimont is providing engineering services, equipment and materials, and construction services to the project. It will be responsible for all project activities up to commissioning and start-up, and will also perform a final test run at the granulated urea plant.

Volgafert will produce and market high-quality urea for the domestic and export market. The company is mainly owned by Russian fertilizer producer Kuibyshevazot. METDEV1, a company owned by Maire Tecnimont, also has a minority stake in Volgafert. Simest S.p.A., part of Italian investment bank CDP Group, is another participant.

To finance the whole project, a credit line of €160 million from international banks is currently being finalised. This will be guaranteed by Italian export credit agency SACE, also part of CDP Group.

Pierroberto Folgiero, Maire Tecnimont Group's CEO said: "We are eager to strategically cooperate with a prestigious industry leader such as KuibyshevAzot in one of our core business areas, fertilizers. With this new collaboration we confirm the reliability of our Group's value proposition covering the whole value chain, from project development, to licensing to complete EPC execution."

Acron opens new urea unit

Acron Group commissioned a new 600 t/d urea unit at its Veliky Novgorod site in November.

Known as Urea-600, this is Acron's sixth urea production unit at the site. Acron upgraded its five other production units in parallel with the construction of Urea-600.

An advanced integrated wastewater treatment plant was also successfully commissioned at the Novgorod site as part of the Urea-600 project.

The successful commissioning of Urea-600 increases urea production capacity at Veliky Novgorod to 3,800 t/d, equivalent to an annual production capacity of 1.3 million tonnes.

The new two billion rouble production unit is based on NIIK's patented *URECON[®]2006* technology. This is the first time a new urea unit has been commissioned based on this technology, according to NIIK.

The *URECON[®]2006* process incorporates improved liquid recycle technology. It has been successfully used for revamping low capacity units previously. The process

offers highly efficient heat and mass transfer. One of the most important features of the technology, according to NIIK, is the single high-pressure vessel used as a urea synthesis reactor.

In November, Acron also awarded Stamicarbon a licensing and equipment supply contracts for a new 2,000 t/d urea granulation plant at Velikiy Novgorod. The plant will use the latest proprietary granulation technology offered by Stamicarbon.

"Acron has decided to expand its product portfolio by including granulated urea which is popular among clients. Cooperation with Stamicarbon, the technology leader in the industry, ensures us advanced technologies for manufacturing top-quality product," said Acron's chairman, Alexander Popov. ■

Casale case study: revamping & integration

As part of a long-term collaboration with a key customer, Casale was given the opportunity to implement a project to revamp a methanol plant. Advantageously, low-value process streams generated by the plant are being used as feedstocks to obtain high-value products. This will diversify the customer's product portfolio, extending this to include the output from ammonia, urea and melamine production.

Casale developed an integrated and optimised process solution for the two-phase project featuring a 1,000 t/d ammonia synthesis unit, a 1,750 t/d urea plant and a 120 t/d melamine plant.

The project involves the design and installation of new partial oxidation, air separation and carbon dioxide recovery units, along with completely new ammonia, urea and melamine plants. The customer also specified new storage facilities for ammonia, urea and melamine of 3,000 tonnes, 10,000 tonnes and 1,000 tonnes, respectively.

Ensuring that the operation of these newly-installed downstream units did not affect methanol production was a key project objective.

Scope of work

Casale was awarded the project under an engineering, procurement and construction management (EPCM) contract. With this contract came responsibility for overall process performance guarantees. Casale's scope of work includes:

- Licenses
- Basic and detail engineering
- Supply of equipment and bulk material
- Supervision of construction up to mechanical completion
- Site services, including commissioning and start-up supervision, plant optimisation and operator training.

Casale's additional responsibilities for the utilities area cover:

- Basic engineering

- Detail engineering supervision
- Supervision of construction up to mechanical completion.

Urea unit

The project involves the production of both urea and melamine downstream from the ammonia plant.

The urea plant is based on Casale's *Split Flow[™]* loop and *Full Condenser[™]* technology. This technological solution from Casale incorporates the most advanced CO₂ stripping technology currently available on the market.

The plant is designed for a nominal capacity of 1,750 t/d of urea. This is generated as molten urea (99.7%) to feed both the melamine unit (370 t/d) and the plant's urea prilling tower (1,380 t/d).

The synthesis loop comprises a high-pressure stripper, high-pressure carbamate condenser, urea reactor and high-pressure scrubber. This high pressure (HP) loop is configured to minimise the amount of inert gases present in the reactor, maximising the conversion of CO₂ to urea. The urea reactor comes equipped with Casale-Dente high efficiency trays which also guarantee a very high conversion rate of carbon dioxide to urea.

Conclusion

Casale is pleased to report that the project is now at an advanced stage with most site activities concentrating on erection work and commissioning.

This project demonstrates that Casale has the process, engineering and management tools to drive projects to completion and provide client satisfaction. Casale anticipates that other clients who also wish to expand their product ranges will be embarking on similar projects in future. With that in mind, the phrase 'revamping and integration' is going to become a frequent Casale motto in the years ahead! ■

PHOSPHATE PRODUCTION PROCESS



**LOW-GRADE
RAW-MATERIALS**



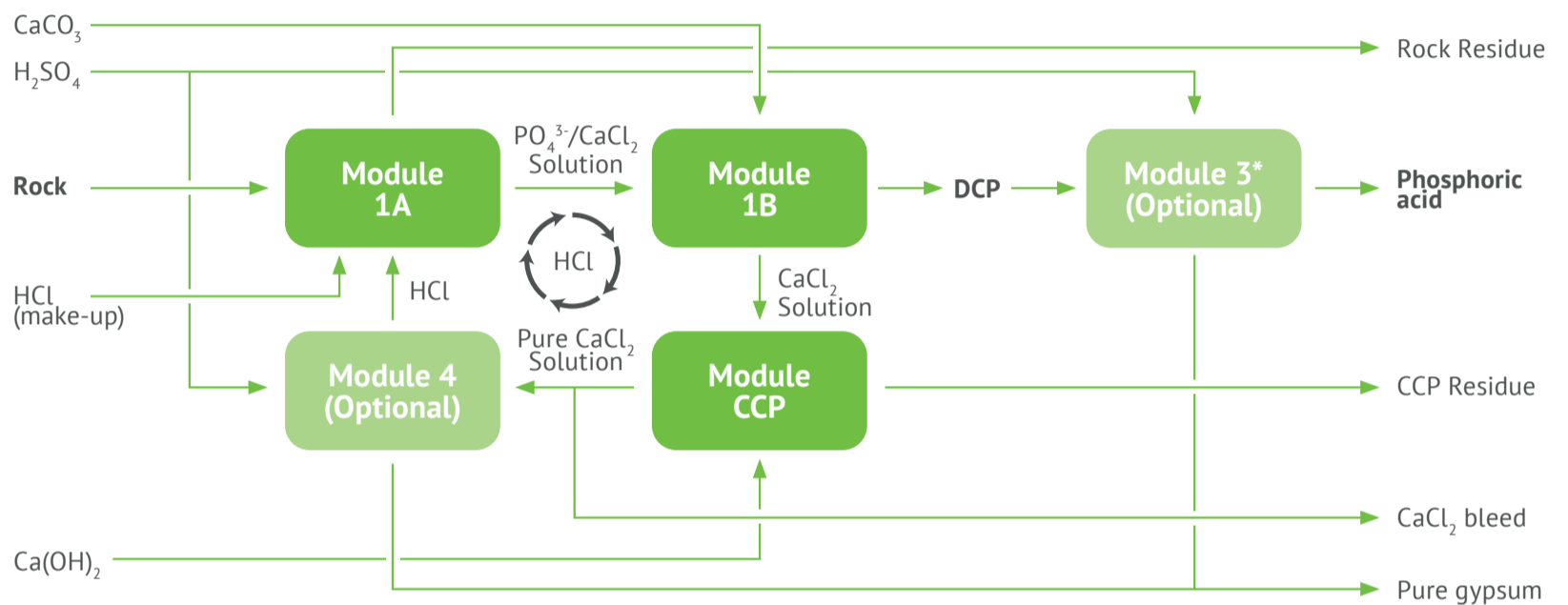
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PRODUCTS**



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FRIENDLY PROCESS**



**MODULAR
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* Prayon phosphoric acid technology

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High heavy metals
content
High Al/Fe content

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Sulphur: the fourth crop nutrient

Oilseed rape is a broad acre crop with a major requirement for sulphur.

Sulphur is becoming an increasingly important crop nutrient – due to a combination of lower sulphur emissions, the increasing prevalence of high-analysis fertilizers and higher cropping intensity.

Sulphur is present in all crops and plays an important metabolic role. It is essential for the formation of proteins, amino acids, vitamins and enzymes, and vital for photosynthesis, energy metabolism and carbohydrate production. Sulphur also contributes to the flavour and aroma of crops such as onions and can therefore influence the quality of farm produce.

Back in its rightful place

Importantly, sulphur does not act alone as a plant nutrient, as it works in tandem with nitrogen to enable the formation of amino acids during protein synthesis. Sulphur is also part of the plant enzyme required for nitrogen uptake. Sulphur and nitrogen are inseparable nutrients because of this, according to, fertilizer producer Yara International:

“Many agronomists now consider sulphur to be the second most important nutrient after nitrogen. Certainly, sulphur is an essential nutrient, closely linked with nitrogen in biological processes with both elements forming an inseparable team. Previously, crop requirements were generally met from atmospheric deposition, so sulphur was confined to a secondary role. However, today it is back in its rightful place as an essential component of optimum nitrogen management.”

In crop nutrition, sulphur plays a critical role in early crop establishment and improves resistance to environmental stress. Deficiency stunts early plant growth, leading to yield losses later on, and is exacerbated by the following conditions:

- Light and sandy soils with low soil organic matter

- Sulphur leaching during high winter rainfall
- Low sulphate mobility during dry spring conditions
- Slower mineralisation at low temperatures
- Low input of organic matter and mineral sulphur
- Low atmospheric deposition of sulphur to soils.

Crops can typically remove between 15 to 30 kilograms of sulphur per hectare from soil. Root vegetables, onions and brassica, especially oilseed rape (canola), have a particularly high demand for sulphur. Pasture and other widely-grown crops such as coffee, corn, cotton, rice, soybean, sugarcane and wheat also require moderately high sulphur applications (Figure 1). For these crop types, sulphur requirements can match or even exceed demand for phosphorus.

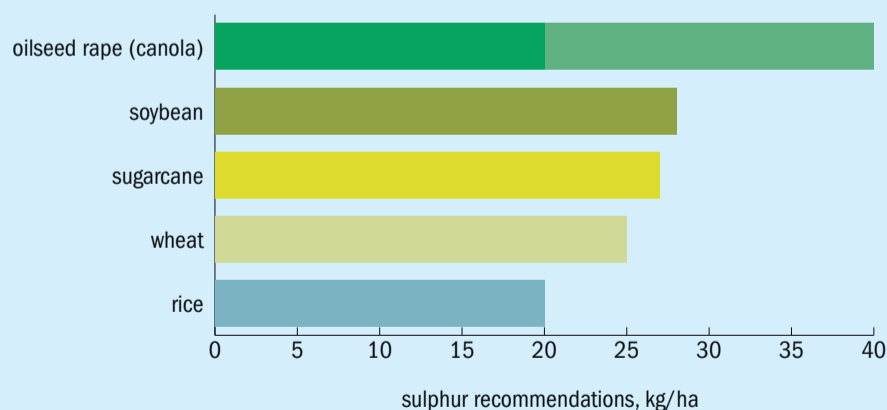
Increasing agricultural value

Sulphur is becoming an increasingly important crop nutrient due to three main factors:

- **Falling atmospheric deposition.** Soil sulphur deficiency, a relative rarity 20 years ago, is becoming more common. The deposition of sulphur dioxide emissions from the atmosphere used to guarantee that soils in many regions were automatically enriched and replenished with sulphur. This is no longer the case, however, as increasingly stringent environmental regulations and the introduction of low-sulphur fuels have sharply cut emissions
- **The prevalence of high-analysis fertilizers.** Farmers are continuing to switch to high-analysis products, containing little or no sulphur, at the expense of sulphur-rich, lower analysis products (Figure 2), a long-term consumption trend that has also put sulphur replenishment on a downward path.
- **Rising cropping intensity.** Improving crop yields are withdrawing ever larger amounts of sulphur from the field.

These three factors combined are opening up opportunities for fertilizer manufacturers to capitalise on the value of sulphur by broadening their portfolios and supplying sulphur-enhanced fertilizers as premium products to meet growing demand. Sulphur has certainly become increasingly valued by the farm sector in recent years, to the extent that some have even started to call sulphur ‘the fourth crop nutrient’.

Fig. 1: General sulphur recommendations for crops (kg S /ha)



Source: TSI and others

Fig. 2: Growing consumption of high-analysis fertilizers (Urea, DAP/MAP, MOP) over the last two decades has outstripped demand for traditional sulphate fertilizer alternatives (SSP, AS, SOP)

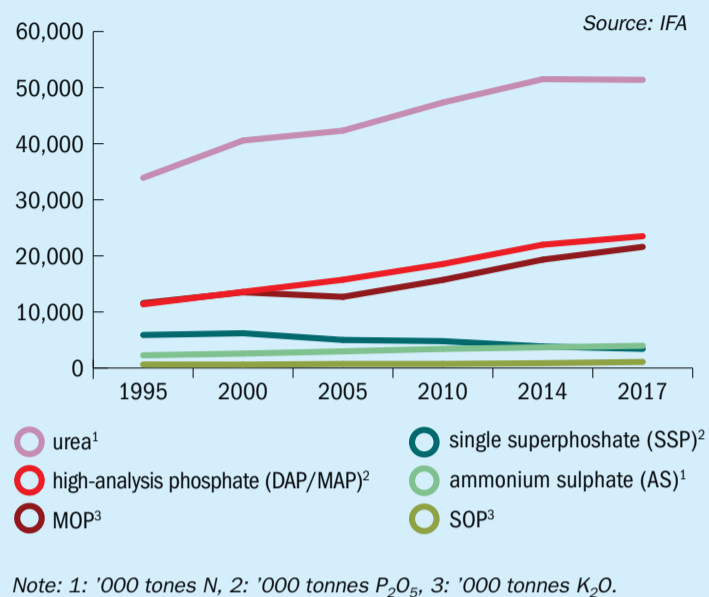
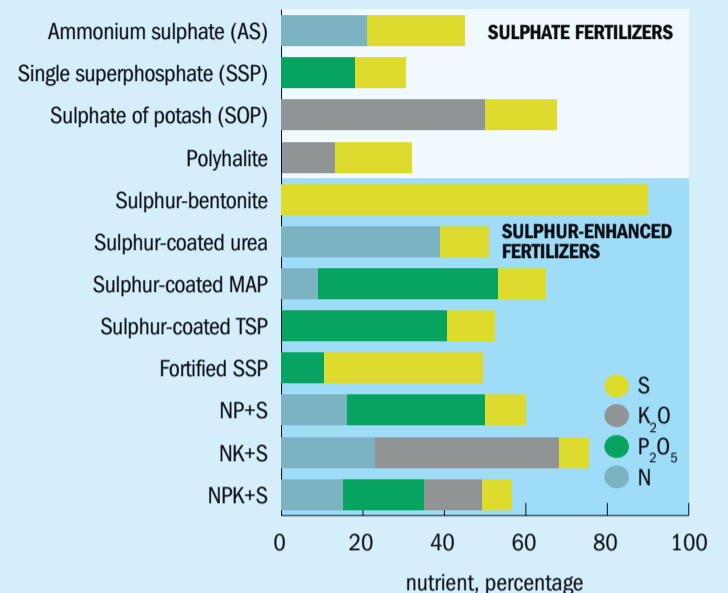


Fig. 3: Nutrient content of selected sulphate and sulphur-enhanced fertilizers



Higher-analysis, lower sulphur

Worldwide, the amount of sulphur added to soils through the application of fertilizers has diminished in recent decades. This is partly because the use of sulphate fertilizers, mainly single superphosphate (SSP), ammonium sulphate (AS) and sulphate of potash (SOP), has either fallen or been outpaced by the rising consumption of higher-analysis alternatives such as urea, diammonium phosphate (DAP), monoammonium phosphate (MAP) and muriate of potash (MOP), which are largely sulphur-free. (Figure 2).

Traditional sulphate fertilizers

Total world demand for sulphur-containing fertilizers is more than 66 million tonnes. Consumption is greatest in Latin America (15.2 million tonnes), East Asia (14.3 million tonnes) and Southeast Asia and Oceania (10.3 million tonnes), with these three regions accounting for 60 percent of global demand for these products¹.

On a nutrient basis, global agricultural consumption of sulphur is estimated at 13.3 million tonnes, according to a first-of-its-kind assessment by the International Fertilizer Association (IFA)². This value is much higher than the frequently quoted estimate of 10-11 million tonnes¹. However, this latest value is probably still an underestimate, suggests IFA, as it excludes data for some NPK+S products².

The sulphur fertilizer market divides into two main categories – traditional sulphate fertilizers and sulphur-enhanced fertilizers. These have a range of nutrient compositions (Figure 3). Liquid sulphur products – thiosulphates – are also favoured in some countries and regions.

Traditional sulphate fertilizers have long dominated global demand (*Fertilizer International* 476, p19). They include:

- **Single superphosphate (SSP)** is the second largest-selling phosphate fertilizer on the market after diammonium phosphate (DAP). Consumption is concentrated in four main markets, China, Brazil, India and Australia, which collectively account for around 85 percent of total global demand. SSP is a low-analysis fertilizer with a nutrient content of around one-fifth (18-22% P₂O₅). Because of this, it tends to be consumed in the country of origin, and export volumes have declined due to increasing competition from more economic high-analysis phosphates. SSP consumption has contracted by almost a third in the past twenty years.
- **Ammonium sulphate (AS)** consumption, in contrast, is on the rise even though its nitrogen content is much lower than urea and ammonium nitrate. World supply (26.4 million tonnes) has been boosted by the massive growth of 'involuntary' production capacity in China. Consumption of AS is concentrated in the Americas (the US, Brazil, Mexico and Canada) and East and Southeast Asia (China, Indone-

sia, Vietnam and Malaysia). Turkey and Germany also offer sizeable markets for AS (*Fertilizer International* 469, p20). The use of AS in NPK blends has become increasingly popular as awareness of sulphur deficiency in soils has become more widespread. Rapid growth in world oilseed rape (canola) production has been a notable factor behind the rise in AS demand.

- **Sulphate of potash (SOP)** is valued as a chloride-free source of potash for lucrative cash crops such as tobacco, tree nuts and citrus fruits. World demand is 7-8 million tonnes currently. China accounts for more than half of global consumption and has been responsible for much of the expansion in SOP demand globally in recent years. North America and Europe are also sizable markets accounting for some 60 percent of demand outside of China (*Fertilizer International* 475, p49).
- Global demand for **sulphate of potash magnesia (SOPM)** has grown strongly in recent years. The market for SOPM, similar to SOP and SSP, is highly concentrated with just four countries, China, the US, Canada and Germany, accounting for the lion's share of consumption. Production is also mainly located in three countries, China, the US and Germany.
- **Ammonium phosphate sulphate**, a fertilizer with a 60 percent ammonium sulphate and 40 percent MAP composition, is a commonly produced grade of NP+S fertilizer (16-20-0-14S). It is directly applied to forage crops in many

countries, particularly legumes, and is also a popular choice of fertilizer for small grains and oilseed rape (canola).

The global sulphur fertilizer market is still dominated by AS, SSP and SOP, with these three products combined being responsible for 70 percent of agricultural sulphur consumption (Figure 4).

Sulphur-enhanced fertilizers

Crop requirements for sulphur are projected to exceed 24 million tonnes by 2020. Fertilizer producers have reacted to the widening demand gap by developing sulphur-enhanced fertilizers (Figure 3). Many of these premium products are manufactured by incorporating elemental sulphur into high-analysis fertilizers, either within granules or as an external coating. Introducing a liquid sulphur spray to Urea, TSP, MAP or DAP during drum or pan granulation, for example, results in N and P products with a 5-20 percent elemental sulphur content.

Sulphur-enhanced fertilizers combine nutrient availability with high use-efficiency, and also have good storage and handling properties. Examples include:

- Sulphur-bentonite
- Sulphur-coated urea, MAP or TSP
- Fortified SSP
- Sulphur-enhanced DAP
- Sulphur-enhanced MAP enriched with sulphate

The market for sulphur-enhanced NP+S products is developing particularly quickly in the US, Brazil and Africa¹.

Sulphur-enriched SSP is popular in countries such as New Zealand and can contain twice as much sulphur as ordinary SSP. Added elemental sulphur complements SSP's existing sulphate content and helps meet crop needs during the whole growing season by providing both immediate and reserve stores of sulphur. This makes it particularly suitable for applications in areas with high leaching losses.

Controlled release fertilizers (CRFs) can be produced by coating highly-soluble nutrients with relatively insoluble elemental sulphur.

Sulphur-coated urea (SCU), for example, combines 77-82% urea (36-38% N) with a 14-20% sulphur coating. SCU is suitable for multiple nitrogen applications on sandy soils under high rainfall or irrigation conditions. It is marketed as a CRF for grass forage, turf, sugarcane, pineapple, cranberries, strawberries and intermittently-flooded rice.

Sulphur-bentonite

To be of value to crops as a nutrient, the elemental sulphur (S₈) present in sulphur-enhanced fertilizers firstly needs to be oxidised into plant-available sulphate by *thiobacillus* soil bacteria. This process requires the availability of oxygen and moisture and only occurs within a certain temperature range.

Fine elemental sulphur (40-150 microns) can be combined with 5-10 percent swelling clay to form **sulphur-bentonite** pastilles. The minor clay component promotes microbial conversion into sulphate early in the growing season by dispersing and releasing sulphur particles into the soil. This helps guarantee the supply of sulphur throughout the season and minimises leaching losses. Sulphur-bentonite is widely-used to treat sulphur deficiency in the US and India¹ and is suitable for blending as well as direct application.

Tiger-Sul Products, a Canadian subsidiary of Connecticut-based **HJ Baker & Bro, Inc**, is a leading and long-standing global sulphur-bentonite supplier. The firm is the world's largest producer of 90% sulphur pastille fertilizer, *Tiger 90CR*, a product that has been exported throughout South America, New Zealand, Australia, Europe, and China for more than 20 years.

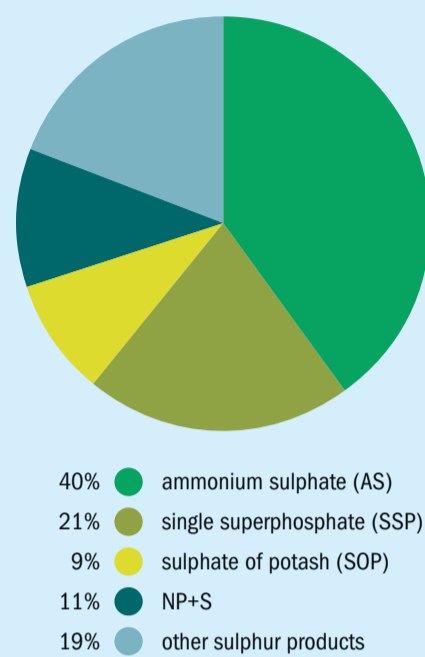
Additionally, Tiger-Sul sells the granular sulphate/sulphur fertilizer *Tiger 50CR* (50% S + 12% N) which combines 36% elemental sulphur and 60% ammonium sulphate with 4% bentonite. The combination of immediately available sulphate and the slow-release sulphur make it an ideal product for colder Northern climates, according to Tiger-Sul.

The company also manufactures and markets *Tiger Micronutrients*, a range of premium sulphur-enhanced fertilizers. These combine *Tiger 90 CR* sulphur-bentonite with micronutrients using proprietary *Microsite Enhanced* technology.

HJ Baker expanded into the Chinese market in 2014 by opening a sulphur-bentonite plant in Lianyungang, China. This manufactures *Tiger 90CR* and a zinc-enhanced micronutrient product to meet the country's growing demand for sulphur fertilizers. The company also opened a new Canadian Tiger-Sul sulphur-bentonite production plant at Irricana, Alberta, 46 miles north of its existing Calgary manufacturing plant, at the end of 2014.

In 2015, HJ Baker launched *Tiger XP*, a new sulphur-bentonite product with a higher release rate to target early-season

Fig. 4: Agricultural sulphur consumption by product, 2015



Source: IFA

sulphur deficiency in crops. This makes sulphur available to plants more rapidly by using a proprietary activator to speed up oxidation to sulphate.

Water-dispersible granules

A new sales agreement between Tiger-Sul, the world's largest sulphur-bentonite producer, and **Sulphur Mills Limited (SML)**, the world's largest manufacturer of water-dispersible granules (WDGs), was announced in August last year. This provides Tiger-Sul with exclusive North American rights to distribute and sell Sulphur Mills' *Techno-S*[®] and *Techno-Z*[®] sulphur- and zinc-based products.

SML uses a patented process to manufacture 2-4 micron-size sulphur and zinc granules with excellent water dispersion properties. Its WDG products are used to supply sulphur and zinc to deficient crops via low-dose fertigation. *Techno-S*[®] is a 90 percent sulphur fertilizer, while *Techno Z*[®] combines 15 percent zinc with 70 percent sulphur. Both products undergo extremely quick oxidation, rapidly providing S and Zn in plant-available form.

Mumbai-based SML currently supplies products to over 80 countries. Its chief operating officer, Bimal Shah, said: "This venture to work together in the US and Canadian market brings a great value proposition of these two important nutrients, sulphur and zinc, to the farming community."

Murat Kamisli, the general manager of SML's international crop nutrition business, added, "The same technology and delivery system of these two patented nutrition products have been great successes in many other countries and we are looking forward to even greater successes in the US and Canada, with this partnership with Tiger-Sul Products."

Thiosulfate products

Fertigation, the application of nutrients via an irrigation system, is a niche but high-value agricultural market for sulphur. Thio-sulphates, in particular, are widely-used as liquid sulphur fertilizers in the broad acre and speciality crop market in North America and Europe. Their use is also on the increase in Latin America.

Tessenderlo Group is a global leader in speciality liquid fertilizers and manufactures four main thiosulphate products:

- Ammonium thiosulfate, *Thio-Sul* (12% N + 26% S)
- Potassium thiosulphate, *KTS* (25% K + 17% S)
- Calcium thiosulfate, *CaTs* (6% Ca + 10% S)
- Magnesium thiosulfate, *MagThio* (4% Mg + 10% S)

Thio-Sul is suitable for most irrigation systems and, alongside nitrogen, delivers sulphur in both elemental and sulphate form. It also improves phosphorus uptake, and can be added to urea ammonium nitrate (UAN) as a nitrification inhibitor to reduce nitrogen losses. *KTS*, another of Tessenderlo's leading thiosulphate products, is marketed as a high-analysis potassium and sulphur fertilizer for fertigation. It is suitable for booster or starter formulations and can also be applied as a foliar fertilizer when crop demand for potassium is high.

Thiosulphates offer sulphur in both immediately plant-available form and in slower-release form available to plants over a longer period of time. Thiosulfates also have a modest acidification effect, benefitting crops growing on alkaline (calcareous) soils.

Providing sulphur to crops by applying thiosulphates offers a number of specific benefits:

- Enhances crop protein and chlorophyll content
- Assists the synthesis and functioning of enzymes in the plant
- Optimises fertilizer efficiency by stabilising nitrogen
- Improves availability of nutrients in the soil, particularly phosphorus and micronutrients and their uptake by the crop

- Energy efficient assimilation in the plant
- Beneficial soil microorganism interaction
- Provides prolonged sulphur nutrition
- A controlled and localised pH adjustment effect in the soil.

Thio-Sul has the most powerful acidification effect because it combines the ammonium cation with thiosulfate. *Thio-Sul* can be combined with UAN solutions to provide two main benefits:

- It brings sulphur as a nutrient into the mix – the correct N/S ratio being very important for most crops
- It acts as nitrogen stabiliser improving nitrogen use efficiency.

Thio-Sul and *CaTs* both have the ability to inhibit the urease reaction, thereby reducing nitrogen loss through ammonia volatilisation, as well as slowing down nitrification by reducing the loss of nitrogen through nitrate leaching.

CaTs, as well as offering a nitrate- and chloride-free source of calcium, and providing thiosulfate sulphur, also acts as a soil conditioner. Being a highly-soluble liquid form of calcium – unlike gypsum – *CaTs* is effective at penetrating the soil profile where it acts as a flocculant, opening up soil pores and improving soil structure and drainage. It can also help displace undesirably high levels of sodium in soils.

KTS is perhaps one of the most concentrated forms of liquid potassium and sulphur available in the market. When combined with liquid ammonium polyphosphate (APP), it can be applied as a very effective starter fertilizer early in the plant's growth cycle. The presence of *KTS* improves phosphorus use efficiency by effectively regulating the rate at which polyphosphates turn into orthophosphates and becomes plant-available. (Note: *Thio-Sul*, *CaTs*, *MagThio* and *KTS* are registered trademarks of Tessenderlo Group NV/SA.)

Product and process innovation

The last five to six years has seen the emergence of speciality NP+S products. These have established a strong market presence in India, Brazil and the US during the last decade. Demand from Australia and Ethiopia is also on the increase.

The North American market for **The Mosaic Company's** successful and pioneering sulphur-enhanced MAP product range, *MicroEssentials*, broke through the one million t/a barrier at the end of 2013. Mosaic's sales of 8.2 million tonnes of finished phosphates last year included 3.2 million tonnes

of its *MicroEssentials* speciality product. These versatile premium fertilizers are now applied to more than 10 percent of US farmland. They are suitable for both direct application and bulk blending and their increasing use is backed by more than a decade of field data and over 1,200 crop trials globally.

The proprietary *Fusion* process used in the manufacture of *MicroEssentials* joins together nitrogen, phosphorus, sulphur and zinc to create a nutritionally-balanced granule capable of boosting crop yields by 3-7 percent, compared to conventional MAP or DAP. Mosaic's innovative fertilizer technology also provides nutrient use efficiency gains. *MicroEssentials* SZ formulations, for example, improve plant uptake of P by up to 30 percent and Zn uptake by up to 45 percent compared to a typical blend.

The company offers three main formulations:

- *MicroEssentials* SZ with 12% N, 40% P, 10% S and 1% Zn (12-40-0 10S 1Zn)
- *MicroEssentials* S15 with 13% N, 33% P and 15% S (13-33-0 15S)
- *MicroEssentials* S10 with 12% N, 40% P and 10% S (12-40-0 10S)

The sulphur content in all three formulations is a 50:50 mix of elemental sulphur and sulphate.

Shell Sulphur Solutions has developed its own micronised sulphur product, Thiogro, which it licenses to key fertilizer producers around the world. The company successfully commercialised and patented sulphur technology for incorporating sulphur into ammonium phosphates in the early 2000s. Sulphur-enhanced phosphate lines have subsequently been licensed and installed at fertilizer plants in Asia, North America and Australia. This includes a major collaboration with **SinoChem** in China (*Sulphur* 381, p24).

Shell also landed a major licensing deal with **OCP Group** in 2016. This allows the Moroccan phosphate giant to produce its own range of highly-concentrated sulphur-enhanced fertilizers by using Thiogro technology to incorporate elemental sulphur into ammonium phosphates, NPKs and other products manufactured at its Jorf Lasfar site. By adding new and potentially highly-lucrative premium products to its existing fertilizer range, the licensing deal with Shell is an important long-term strategic move by OCP.

A more recent breakthrough was Shell's development of *Urea-ES* (enhanced sulphur), a dispersion of micronised sulphur in urea. This innovative technology – introduced to the market by Shell in 2016 – suspends 7-20 percent elemental sulphur in a urea matrix with

a nitrogen content of 43-37 percent. Shell subsequently introduced *Special-S*, a further refinement of the technology, in 2017. This produces a co-granulated high sulphur content (11-0-0-75ES) urea product (*Fertilizer International* 492, p44).

Shell has successfully collaborated with both thyssenkrupp (Uhde Fertilizer Technologies) and IPCO, leading providers of fluid bed granulation and Rotoform finishing technology (see box), respectively. These partnerships mean *Urea-ES* and *Special-S* technologies are now widely available to producers wishing to expand their portfolios to include sulphur-enhanced fertilizers.

H Sulphur Corp, one of Asia's leading sulphur suppliers and sulphur-bentonite producers, has licensed Shell's *Special-S* technology, commissioning the first ever production plant in South Korea in February last year. H Sulphur subsequently begun manufacturing and selling *Special-S* under its own *Super S* brand name. This product has been successfully sold and shipped to customers in Canada, Australia and Brazil (*Fertilizer International* 492, p44).

Russia's **PhosAgro** increased its sulphur fertilizer production capabilities by launching a new 100,000 t/a capacity production line at its Metachem site in 2015. This will manufacture sulphur-containing phosphate-potash fertilizers specifically formulated for priority markets such as Brazil.

EuroChem began production at Russia's first urea ammonium sulphate (UAS) unit two years ago. The RUB 5.4 billion (\$84 million) unit is located at EuroChem's Novomoskovskiy Azot complex, about 200 kilometres south of Moscow. The 600 t/d unit was designed and built in partnership with Stamicarbon. Stamicarbon's UAS process allows a very wide range of ammonium sulphate concentrations (0-50 weight percent) to be handled, without modifying the granulation plant, or affecting the quality of UAS granules produced.

EuroChem started UAS production at the end of 2018 following the commissioning of granulation equipment. The ability to manufacture UAS will add to EuroChem's existing sulphur fertilizer portfolio, which already includes ammonium sulphate and ammonium sulphate-nitrate. ■

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2. IFA, 2017. *Assessment of Global Sulphur-Nutrient Consumption*. International Fertilizer Association, Paris.

IPCO's Rotoform process

Sulphur-bentonite pastilles

Sulphur-bentonite pastilles combine elemental sulphur with 10 percent bentonite. This special clay swells in wet soil, breaking apart the pastilles and releasing dust-size particles of elemental sulphur. These can then be easily oxidised into plant-available sulphate by soil microbes.

Rotoform pastillation

IPCO's Rotoform pastillation process is ideal for the production of sulphur fertilizer products. It is simple and versatile, with low investment and operating costs, and minimal environmental impacts.

Multi-nutrient fertilizers can be created by combining sulphur with macronutrients (such as nitrogen from urea) or micronutrients, opening up new opportunities for producers in the speciality fertilizer market. The range of suitable speciality products includes:

- Sulphur-bentonite + micronutrients, e.g. zinc, iron, boron
- Urea + sulphur
- Urea + ammonium sulphate.

The Rotoform process, in partnership with Shell Thiogro, has been used to successfully mix sulphur with urea to produce *Special S* and *Urea-ES* products (see main article).

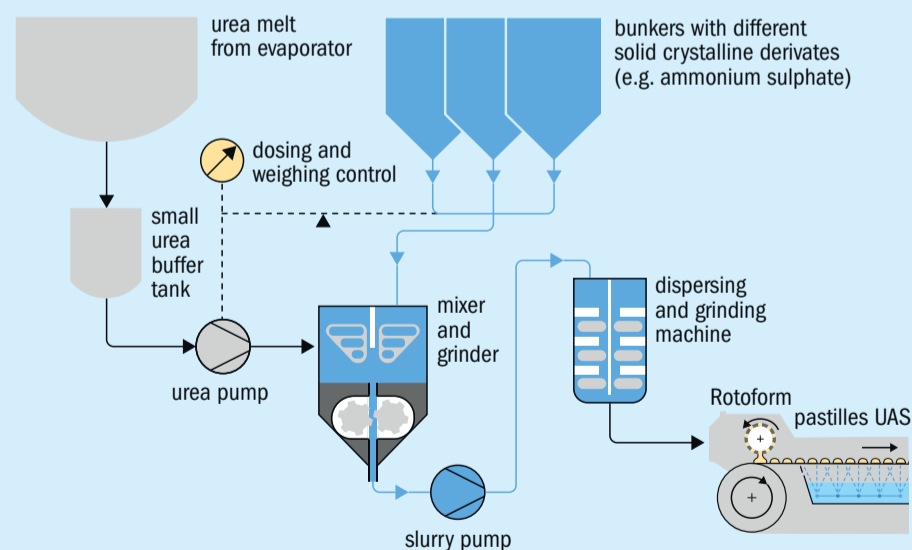
The Rotoform process, when linked to an upstream dosing and mixing plant, can be delivered as an automated continuous process for fertilizer production. An example of an IPCO plant for blending and mixing urea with sulphur is shown in Figure 5.

Additional benefits provided by the IPCO Rotoform process include:

- High-quality uniform and free-flowing pastilles with high crushing strength
- Very low dust, vapour and gas emissions
- Low power consumption.

The superior performance and operational flexibility offered by IPCO's Rotoform process allows fertilizer producers to develop and launch innovative new sulphur-enhanced fertilizers. These can boost profit margins by adding value to existing commodity products, while at the same time helping farmers to achieve the higher crop yields they need. ■

Fig. 5: IPCO mixing and blending plant – for efficient dosing, weighing, mixing and grinding with accurate control and easy maintenance



Source: IPCO

Micronutrients make major impacts

The widespread problem of soil micronutrient deficiency has come under the spotlight in recent years. We look at the range of specialist fertilizer products able to tackle micronutrient deficits in crops and soils.

Micronutrients are essential for plant growth and a necessary part of balanced crop nutrition. They include boron, copper, iron, manganese, molybdenum and zinc. Although required in much smaller amounts, micronutrient availability is arguably as important to plant nutrition as primary and secondary macronutrients. A lack of one or more micronutrients in soil can still limit plant growth, even when adequate levels of other nutrients are present (*Fertilizer International* 492, p22).

Non-chelated and chelated forms

Micronutrient fertilizers can be split into two main categories: non-chelated and chelated products. Demand for **non-chelated micronutrient products** is rising rapidly, making these products the fastest growing segment of the speciality fertilizer market globally. Large producers include Yara, Borax (Rio Tinto), Eti Maden, Agrichem, Cheminova, Brandt Consolidated, COMPO and Valagro¹.

Non-chelated products are formulated using inorganic micronutrient sources, typically oxides, carbonates and sulphates, borates and molybdates. They are able to be applied flexibly and can be incorporated into both compound fertilizers and foliar treatments. Co-formulants are generally incorporated to ensure stability and optimise performance during foliar application and seed coating. Complexing agents are used in concentrated liquid micronutrient fertilizers to produce the desired mixing behaviour.

Chelated micronutrient products, as the name suggests, benefit from the incorporation of a chelating agent. Because they are a popular choice in fertigation, growth in demand has tracked

the rise in the global market for water-soluble fertilizers and drip irrigation (*Fertilizer International* 495, p22). AkzoNobel, the current world leader in chelated micronutrients, markets and distributes eight trademarks globally. AkzoNobel's *Rexolin* brand is distributed worldwide by Yara International and its *Rexene* brand is distributed by SQM. France's Angibaud & Spécialités also distributes AkzoNobel's *Ferica* brand. Compass Minerals, SQM and Mosaic also have a strong presence in this market¹.

An attractive growing market

Boron dominates the global agricultural market for micronutrients. The application of boron in agriculture reached 300,000 tonnes (B₂O₃) in 2018, equivalent to around 15 percent of global B consumption. That compares to total global sales volume of around 65,000 tonnes for chelated micronutrients².

The main boron-consuming regions are East Asia, Latin America and Europe (Figure 1). About 35 percent of Chinese soils are thought to be boron deficient. Brazil's acid soils also tend to be deficient in Boron as do the acid and sandy soils of Northern Europe.

World consumption of chelated micronutrient products in agriculture was in the region of 63,000-68,000 tonnes in 2018. Europe is the pre-eminent regional market with a global market share of around 35-38 percent (Figure 1). Iron products are the most widely consumed type of chelated micronutrient followed by manganese, zinc and copper (Figure 2).

Historically, chelated micronutrients were developed in Europe for application to vegetables. Because of their use in fertigation, demand generally tracks the

water-soluble fertilizer (WSF) market. High premiums have, to date, limited market penetration in both India and China².

Selected products and producers

US Borax, part of Rio Tinto, is a global leader in borate fertilization. The company's world-class mine in Boron, California, about 100 miles northeast of Los Angeles, provides around 30 percent of the world's supply of refined borates.

Adequate boron is a crucial factor in high crop yields and quality, with research showing that boron plays a significant role in:

- Strength of plant cell walls
- Membrane function and cell division
- Stimulation/inhibition of metabolic pathways
- Development of flowers and fruit
- Both new and reproductive plant growth.

Boron can be applied directly to soil, through fertigation, or as a foliar spray. Because boron application rates are quite low, making uniform coverage difficult, combining boron with other fertilizers is usually the best option. This helps to decrease application costs as well as providing more even coverage. Boron application rates vary depending on crop, soil type, irrigation and yield goals.

US Borax manufactures and markets the following fertilizer products:

- *Fertibor*[®] is a free-flowing, highly soluble granular product that contains 15 percent boron and leaves little or zero residue. *Fertibor* is a versatile source of elemental boron that makes a valuable addition to solid, liquid or suspension fertilizers.
- *Granubor*[®] is a compacted form of refined boron that is ideal for bulk blending or direct application. *Granubor* con-

Fig. 1: Agricultural consumption of boron and chelated minerals, by region, 2018

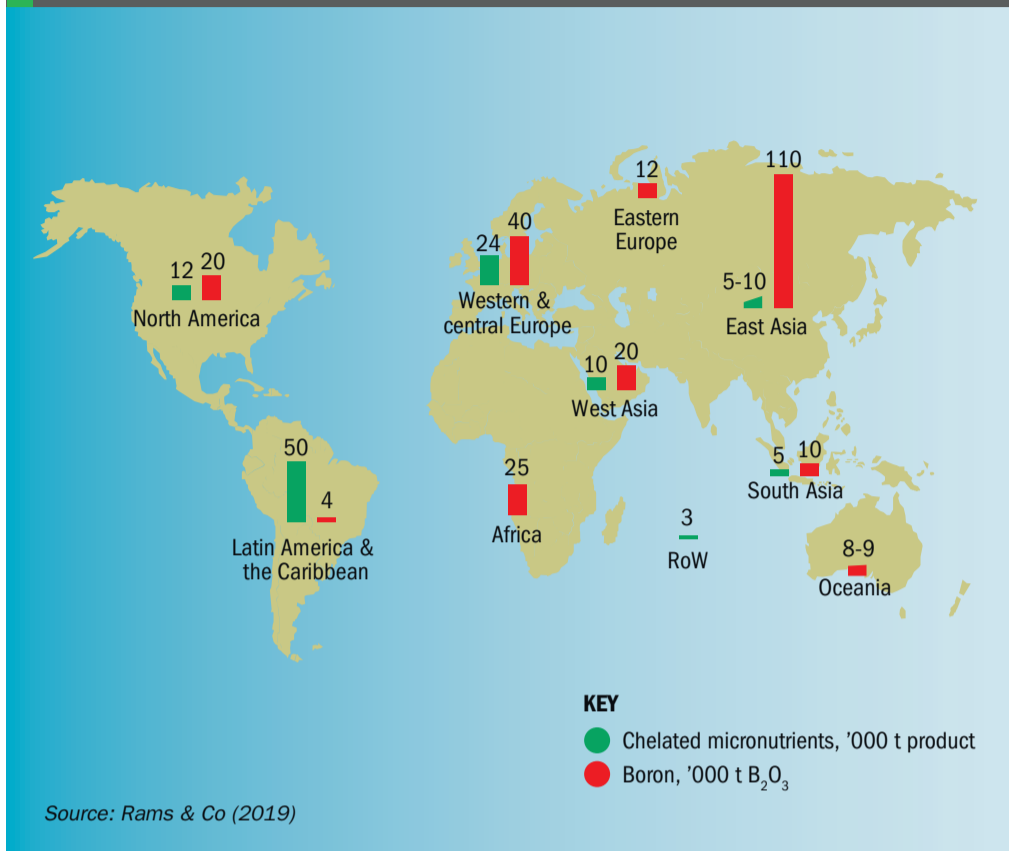
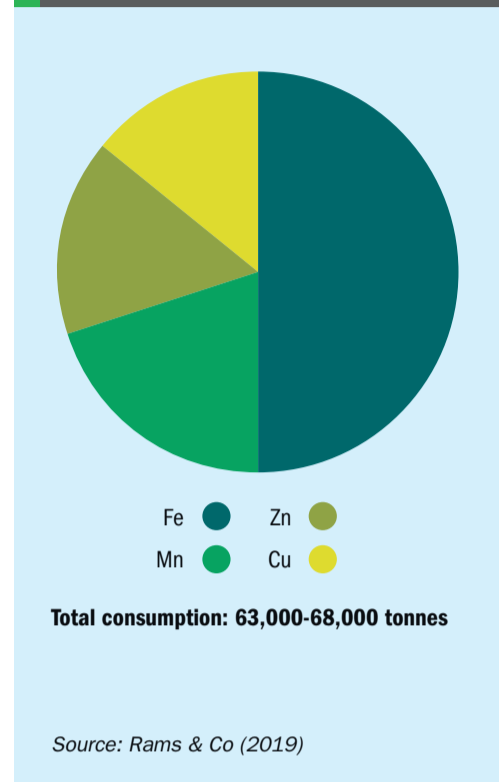


Fig. 2: Agricultural consumption of chelated micronutrients by product type, 2018



- tains 15 percent boron and – being a pure and fully water-soluble granular product – is able to meet crop boron demand throughout the growing season.
- *Solubor*[®] is an economical source of boron formulated to disperse quickly in liquid leaving a minimal residue. *Solubor* is compatible with most crop protection chemicals making it ideal for tank-mix.
 - *Solubor*[®] Flow is a liquid suspension fertilizer with a boron content of 9.9 percent (w/w). Having a near neutral pH, use of *Solubor* Flow ensures minimal degradation of crop protection chemicals in tank-mix.

US Borax products are fully refined to remove impurities. This process results in pure, natural products able to maximise plant uptake of boron throughout the growing season. Borax fertilizers are all suitable for organic farming, being listed as appropriate by the Organic Materials Review Institute (OMRI). This guarantees they are suitable for application on certified organic crops under the USDA National Organic Program and Canadian Organic Standards.

In global field studies, US Borax products have been shown to increase yield in a variety of crops. For example:

- In a one year study of cotton in Brazil, the application of *Granubor*, starting at

1 kg B/ha, increased seed cotton yield compared to the control.

- In a two year study of rice in Vietnam, the application of *Granubor* at 10 kg/ha (1.5 kg B/ha) gave the highest rice grain yield compared to the control.
- Numerous studies of soy crops treated with *Granubor* or *Solubor* have shown increased yields.

Eti Maden IGM is Turkey's biggest national mining company. It was established in 1935 to take advantage of the country's vast boron deposits, these holding almost three-quarters of world reserves. The company has since become the world's leading boron minerals and chemicals producer – and the largest exporter of refined boron products and minerals globally.

Eti Maden set up a joint venture (JV) company with the Finnish mining conglomerate Outokumpu Group in 1982. Known as Ab Etiproducts Oy, this Finland-based JV is responsible for the international marketing and sales of the boron products produced by Eti Maden. The company initially sold into the Scandinavian market, although its marketing and sales activities have expanded greatly over time. Currently, Ab Etiproducts Oy's exclusive sales area covers the Scandinavian and Baltic countries, Germany, Poland, Ukraine, Moldova and the whole of the African continent.

To meet different crop requirements, Eti Maden offers boron products in several different types as part of its agricultural portfolio. Boron can be applied to soils in solid, granular form or in liquid form directly onto plant leaves. Eti Maden's agricultural products include both quickly dissolving sources of boron, such as *Etidot-67* and *Boric Acid*, and slow-release granular products (2-4mm size) such as *Colemanite* and *Ulexite*. Application methods and product selection depend on several external factors, such as soil conditions, rainfall and the target crop.

North America has a healthy micronutrient market. These are often supplied in products alongside sulphur (*Fertilizer International* 476, p19). **The Mosaic Company** has led the way with its pioneering sulphur-enhanced mono-ammonium phosphate (MAP) product range, *MicroEssentials*. One of the main formulations offered is the zinc-fortified *MicroEssentials* SZ (12-40-0 10S 1Zn). This combines 12 percent nitrogen, 40 percent phosphorus and 10 percent sulphur with one percent zinc.

The proprietary *Fusion* process used in the manufacture of *MicroEssentials* joins together nitrogen, phosphorus, sulphur and zinc to create a nutritionally-balanced granule capable of boosting crop yields by 3-7 percent, compared to conventional MAP or DAP.

In 2014, Mosaic also launched a new micronutrient product, *Aspire*, a boron-enhanced potash fertilizer. This first-of-its-kind premium potash fertilizer (0-0-58-0.5B) combines potassium chloride (58% K₂O) with boron (0.5%). This is uniformly distributed within granules using proprietary *Nutriform* technology. *Aspire* is being targeted at the growing micronutrient needs of crops like corn, soybeans, alfalfa and cotton.

US-based **Cameron Chemicals** has expanded and made significant investments in micronutrients production since its founding in 1986. The company's original micronutrients plant in Suffolk, Virginia, produces granular micronutrients for the North America market. Its convenient location close to the Port of Virginia also enables it to supply a growing contingent of offshore customers as well.

Cameron expanded its capabilities in 2015 with the purchase of the Reese, Michigan, operations of **Advanced Micronutrient Products (AMP)**. This plant manufactures granular oxy-sulphate micronutrients as well as micronutrient-enriched compound NPK fertilizers. Both these production lines have the flexibility to make single-element, multi-element and proprietary mixes for customers.

Cameron's investment continued in 2017 with the addition of the **Ultra Yield Micronutrients** zinc sulphate plant located in Moxee, Washington. The plant produces several grades of zinc sulphate including liquid, granular and powder products.

Together, Cameron, AMP and Ultra Yield Micronutrients, are the largest producer of granular micronutrients in North America. Cameron Chemicals is currently in the process of patenting a new technology – one that it says promises to be a game changer in the US mid-west and beyond.

Nachurs Alpine Solutions (Nachurs) is an industry leader in low salt, high-quality, liquid orthophosphate fertilizer solutions. These can be applied in a variety of ways: in-furrow at planting; in-season foliar application; and via pivot/drip fertigation. In recent years, Nachurs has expanded its product offering to include liquid potassium solutions. These can be used in the same way as liquid orthophosphates, or applied as a side-dressing with nitrogen solutions, in strip tillage or by deep placement.

Nachurs also offers orthophosphate products enriched with EDTA-chelated

micronutrients. These need to be compatible with orthophosphate and meet the company's long-term quality and storage criteria.

Nachurs recommends applying micronutrients with NPK orthophosphates, in-furrow at planting, to promote early root growth and development. This is followed up with a balanced, tank-mixed NPK plus micronutrients formulation, with herbicides/insecticides, in early stages of plant growth.

Nachurs largest volume micronutrient is zinc, followed by manganese, iron, copper, calcium, and magnesium. The company has seen greater interest in boron, molybdenum, and cobalt in recent years due to their effects on plant reproduction, nitrogen efficiency and/or sugar movement.

Since its formation in 1946, Nachurs has pioneered the precision-placed liquid fertilizer market in the US and Canada. It currently owns seven strategically-located and highly-automated manufacturing plants, together with 85-plus distribution terminals across North America.

Nachurs was purchased by Wilbur-Ellis, a leading international distributor of agricultural products, animal nutrients and speciality chemicals, in November 2019. Nachurs will operate as a division within the company and continue to sell its products in the US and Canada under the **NACHURS®** and **ALPINE®** liquid fertilizers brands.

Compass Minerals manufactures micronutrient products in dry dispersible powder (DDP) form as part of its popular *Wolf Trax DDP Nutrients* range. These high-analysis micronutrient products coat NPK granules during blending, and include formulations for boron, calcium, copper, iron, magnesium, manganese and zinc.

Wolf Trax DDP Nutrients incorporate four proprietary innovations. They use *EvenCoat* technology to coat every NPK granule in a fertilizer blend with micronutrients. Once applied, this coating does not come off during subsequent handling and transport. This ensures micronutrients are evenly distributed across the field and are available in close proximity to plant roots for early plant uptake.

The patented *PlantActiv* formulation further improves micronutrient availability by avoiding soil fixation and ensuring that particle size is the optimum for plant uptake. *Wolf Trax DDP* products also contain micronutrients in multiple forms, ensuring both immediate and longer-term availability, a property Compass Minerals calls *DUAL*

ACTION availability. Finally, *Wolf Trax DDP* can be used flexibly (*FlexUse*) and applied in three different ways: as a dry fertilizer coating, mixed with liquid fertilizers, or as a foliar spray.

Compass Minerals also offers *Nu-Trax P+*. This innovative phosphate-based micronutrient fertilizer contains a custom blend of phosphorus, zinc, manganese and nitrogen and is designed to improve early-season nutrition to crops. *Nu-Trax P+* helps plants develop a more fibrous root system, improving their ability to handle environmental stress and helping to maximize yields. Corn Belt growers are using *Nu-Trax P+* as a substitute for liquid starter fertilizers.

In North America, cool, wet weather during early plant development can cause zinc deficiencies in corn and other row crops. To combat this, Compass Minerals offers two water-soluble products for in-season zinc deficiencies, *ProAcqua® Zn EDTA* and *ProAcqua® Nourish Zn*. The *ProAcqua®* product range is designed to support plants under stressful conditions, being formulated with high-quality ingredients and a blend of proprietary adjuvants. Both *ProAcqua Zn EDTA* and *Nourish Zn* can be used for in-furrow and foliar applications. Their EDTA chemistry protects the zinc from tie-up – both in the soil and in the mix tank.

In 2019, Compass Minerals launched *Rocket Seeds™*, a portfolio of dry and liquid nutrient products for seeds. This new portfolio is designed to increase early root growth and accelerate plant vigour. *Rocket Seeds™*, by providing proper nutrition to the seed, helps plants withstand early season cold and water stress while they progress through the vegetative growth stage.

Rocket Seeds™ products can be used on corn, soybeans, wheat and other major row crops. Two *Rocket Seeds™* products, *PMZ Dry* and *Moly Dry*, both address zinc deficiencies in plants. The patent-pending formulation of *PMZ Dry* (1-10-0; 8% Zn, 2% Mn) helps create more extensive and well-developed root systems. While *Moly Dry* (1-5-0; 1.5% Fe, 3% Mn, 3% Mo, 10.5% Zn), in contrast, is an ideal formulation for early soybean and legume growth.

Norway's **Yara International** occupies a leading position in the overlapping water soluble fertilizer, fertigation and micronutrient product markets. Its *YaraTera KRISTALON* water-soluble NPK product range contains a full spectrum of micronutrients in chelated form. These are suitable

for drip, tape, sprinkler or pivot irrigation systems. The company's *YaraTera REXO-LIN* product range also incorporates fully water-soluble chelated micronutrients. These are suited for soil, foliar and hydroponic applications, and ensure micronutrients remain available to crops, without the risk of precipitation or fixation. A third chelated micronutrient product, *YaraTera TENSO COCKTAIL* is a wettable powder that can be tank mixed with other water-soluble fertilizers to address micronutrient deficiencies in hydroponic and fertigation applications.

A range of micronutrient formulations are also offered as part of the company's *YaraVita* product range. The foliar fertilizer *YaraVita BEETRAC*, for example, is designed to prevent micronutrient deficiencies in sugar beet (*Fertilizer International* 467, p24) and contains manganese, sulphur, boron, copper and zinc. *YaraVita BRASSITREL PRO*, a liquid suspension for foliar application to oilseed rape (*Fertilizer International* 477, p15), brassicas (*Fertilizer International* 472, p40) and legumes, contains manganese, magnesium, boron and molybdenum.

Two other foliar liquid suspension products, *YaraVita BUD BUILDER FL* (Mg, Zn, N, B and P) and *YaraVita GRAMITREL* (N, Mn, Mg, Cu and Zn) are targeted at soft fruit flowering and cereal yields, respectively. A formulation of the *YaraMila* NPKS fertilizer incorporating magnesium, sulphur, boron, iron, manganese and molybdenum is also available in either prill or granule form.

UK headquartered **OMEX Agrifluids Limited** is a large international liquid fertilizer producer, with manufacturing sites in the UK, the US and Canada. The company offers a comprehensive and market-leading range of high-performance fertilizer coatings and liquid foliar fertilizers. These are designed to deliver essential micronutrients in a timely, accurate and efficient manner.

Products are delivered domestically and exported globally to over 60 countries including China, India, Sri Lanka, Vietnam, Brazil, Mexico, Guatemala, Nigeria, Zambia, Ghana, Netherlands, Belgium and Germany.

The availability of micronutrients in the soil during the first 30 days can play a critical role in preserving a crop's final yield potential, according to OMEX. Therefore, getting the growing season off to a strong start, with a better distribution of micronutrients in the field, will ensure benefits at harvest.

OMEX offers the *MDS* range of concentrated liquid suspensions. These are designed to coat dry fertilizers, including NPKS blends and single products – such as urea and DAP/MAP – for an even distribution of micronutrients across the field. Incorporating *Micronutrient Delivery System (MDS) Technology™*, *MDS* suspension coats each fertilizer granule, helping to reduce dust during mixing and drying quickly, leaving the blender clean.

MDS products offer a cost-effective, efficient option for applying micronutrients to problematic soil types – such as high pH soils, soils with high concentrations of organic matter and sandy soils – and for other conditions which can restrict the availability of nutrients. Various grades of single element micronutrients and micronutrient mixtures are available to meet the specific needs of the crop and local conditions – with applications depending on the crop, soil deficiencies and fertilizer application rate.

Following the early stages of development, any nutrient deficiencies that occur in the crop can be identified using OMEX's Scientific Agricultural Partnership (*SAP®*) laboratories in King's Lynn, and then addressed using OMEX's extensive range of foliar fertilizers. Many of these have been reformulated to incorporate *Enhanced Bio-Availability (EBA)* technology to optimise foliar uptake and nutrient assimilation. A silicon based non-ionic wetting and spreading agent, *SW7*, can also be used to improve the foliar uptake of nutrients, particularly for those crops where it is difficult to achieve good coverage because of waxy or tight layers of leaves or dense canopies.

Examples of OMEX's foliar range include:

- *Bio 20* is a seaweed-based bio-stimulant containing macro- and micro-nutrients. These combine to provide excellent root growth, and later top growth, leading to improved flower/fruit set and higher tolerance to environmental stress.
- *CalMax* contains calcium together with nitrogen, magnesium and micronutrients plus amino acids. It corrects calcium deficiency, improves fruit set, increases yield and help improves firmness, storability, colour and finish in a range of fruits and vegetables.
- *Foliar Boron* containing 15 percent boron alongside nitrogen and is used to increase pollen development and maximise fruit set.

- *Kingfol* is a range of single-element micronutrient formulations designed to correct specific deficiencies, including Mg, S, Zn, Cu and Mn.
- *Micromax* is a water-soluble suspension with a balanced combination of micronutrients, magnesium and sulphur that promotes crop yield and quality in most agricultural and horticultural crops. Applications provide the crop with a balanced range of micronutrients which can be readily absorbed through the leaves or the roots.

An attractive global market

Although relatively small in volume terms, higher value and better margins are providing micronutrient products with a very attractive global market – one which looks set to grow at a fast rate for the foreseeable future.

The higher performance of chelated micronutrients, relative to their non-chelated counterparts, means they can be sold at a higher price in the market. The nutrient and water efficiency of fertigation – a key market for chelated micronutrients – also generates enough cost savings to support this price differential.

In North America, there is a view that any softening in the pricing of N, P and K macronutrients should leave more farm dollars available for spending on micronutrients. If true, higher zinc and sulphur applications to corn and manganese applications to soybeans are likely to be the main beneficiaries. ■

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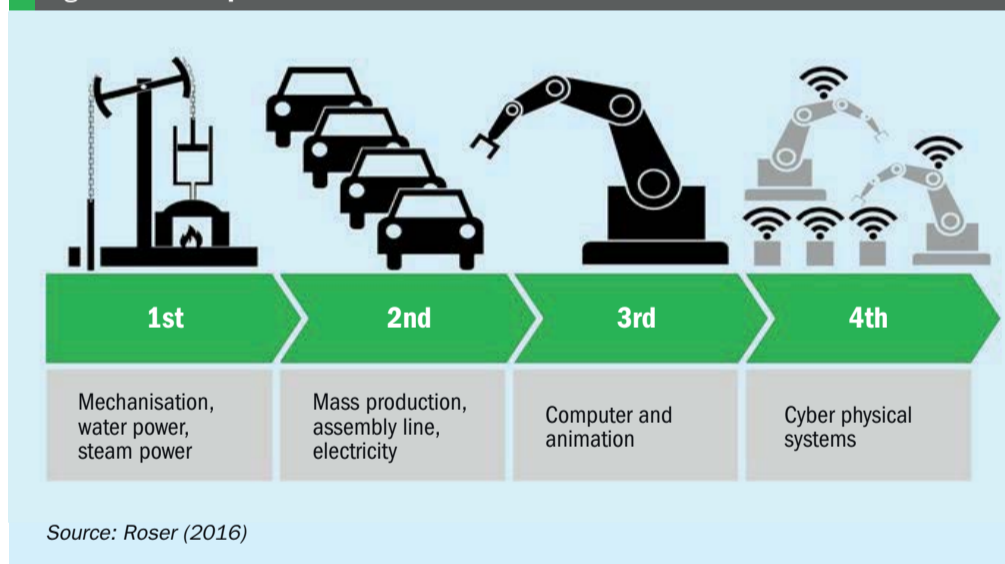
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Digitalisation: supporting customers remotely

As the industrial value chain for fertilizers and their raw materials manages its way through the unprecedented global Covid-19 pandemic, Metso Outotec's **Hannes Storch, Collin Bartlett & Marcus Runkel** reflect on the range of digital tools installed by the company at its industrial reference plants globally.

Fig. 1: The four phases of industrialisation



As we exit from this challenging period, all of us in business need to consider how current ways of collaborating – between ourselves and with our customers – may well need to change, if we are to be better prepared for the future.

In this article, we look at the powerful potential of digital tools for improving plant operations and the interaction between operators, engineers and technology providers. Effective communication between all those involved in plant operations is undoubtedly a key factor for success. While on-site control rooms and field oper-

ators are essential, support from the home office can be of great benefit to all too.

Digitalisation – an overview

Digitalisation – also known as ‘Industry 4.0’ – is the term describing the current trend for automation and data exchange in manufacturing technologies. It includes cyber-physical systems, the internet of things (IoT), cloud computing and cognitive computing¹ (Figure 1).

Industry 4.0 has its roots in the high-tech strategy devised by the German gov-

ernment to promote the computerisation of manufacturing. This strategy introduced a manufacturing concept in which machines are augmented with sensors wirelessly connected to a system that can visualise the entire production line and make decisions on its own.

The specific technologies associated with Industry 4.0 include:

- Cyber-physical systems (CPS)
- The internet of things (IoT)
- The industrial internet of things (IIoT)
- Cloud computing
- Cognitive computing (machine learning)
- Artificial intelligence (AI).

Industry 4.0 is also synonymous with the concept of ‘smart factories’. These create a virtual copy of the physical world and make decentralised decisions. Cyber-physical systems – via the internet of things – then communicate and cooperate with each other and with humans in real-time. This happens internally within a company, and externally through organisational services offered and used by other value chain participants².

Digitalisation is currently seen as the driver for realising productivity improvements – and as the first step along a long route to the ‘smart factory’ of the future. That said, digitalisation also has the potential to severely disrupt traditional business models.

Digitalisation from an EPC contractor viewpoint

Encouragingly, digitalisation has the potential to improve productivity in the engineering, procurement & construction (EPC) industry, as OECD benchmarks show. This is an acknowledgement that current approaches to complex project implementation carry the risk of delays and cost overruns³.

By closer collaboration and integration with technology providers, operators in commodity mining and processing have a great opportunity to improve their key performance indicators (KPIs) throughout the project lifecycle. But, to fully benefit from digitalisation and its potential rewards, there is a need to optimise the digital tools that are already currently available. This, in turn, requires a re-evaluation of the ‘status-quo’ and the conventional methodologies currently employed by the industry.

Domestic EPC contractors in Germany were recently polled on which digitalisation

options they considered key to their projects (see Figure 2), as part of recent studies sponsored by the German Mechanical Engineering Industry Association (VDMA).

Clearly, the digitalisation options considered most important by engineering contractor are highly dependent on: the project under consideration; the industry the project will serve; and the project's ultimate complexity. For each individual project, the EPC contractor has to consider customer needs, budget constraints and project infrastructure, when assessing the digitalisation demands of a given project.

PORS – a simulation-based safety & operational support system

Metso Outotec's PORS (Plant Operability Reliability and Safety) system was developed to guide and support operating personnel at sulphuric acid plants. The system enables safer and more efficient monitoring and control of the sulphuric acid process by enhancing awareness of potential operational problems and challenges.

PORS started as a safety related system associated with heat recovery. But it is now being extended to provide simulation-based support for full plant operations – encompassing the gas cleaning and acid plant as well as upstream metallurgical process steps such as the roasting plant.

A virtual simulator within the PORS system calculates ideal operating conditions. Gap analysis, by comparing ideal with real-time plant conditions, is then used to shift the plant closer to its optimal operational state (Figure 3). Metso Outotec, as a process plant supplier, has all the relevant equipment and process simulation models to undertake this exercise. The company also has the necessary experience and understanding of material characteristics, long-term process behaviour, and the conversion rates of catalytic reactions (SO_2 to SO_3 etc.).

Readings from a distributed control system (DCS) show the current real-time situation at the process plant. By comparing actual readings to the results of the full simulation model – for a process plant or plant site – gap analysis reveals where the process or operating conditions are not as expected. The findings can then be used in several different ways.

If an operational issue is detected, for example, operators can be provided with precise information on which setpoint

Fig. 2: Importance and range of digitalisation options for EPC contractors

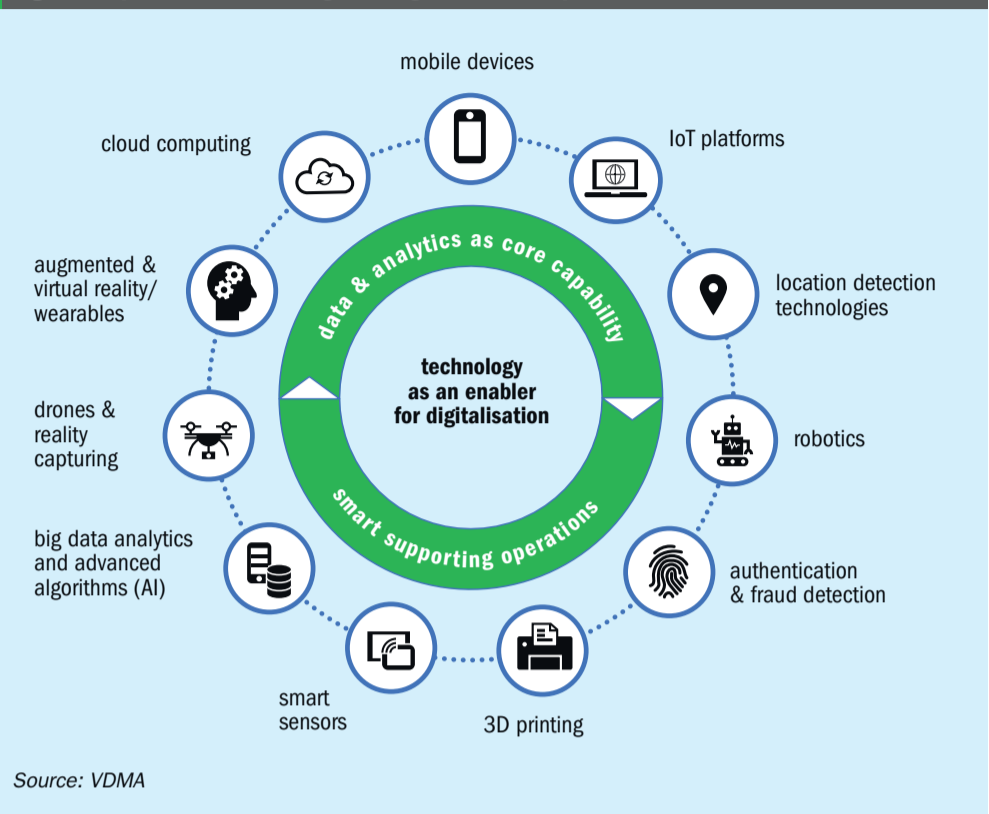
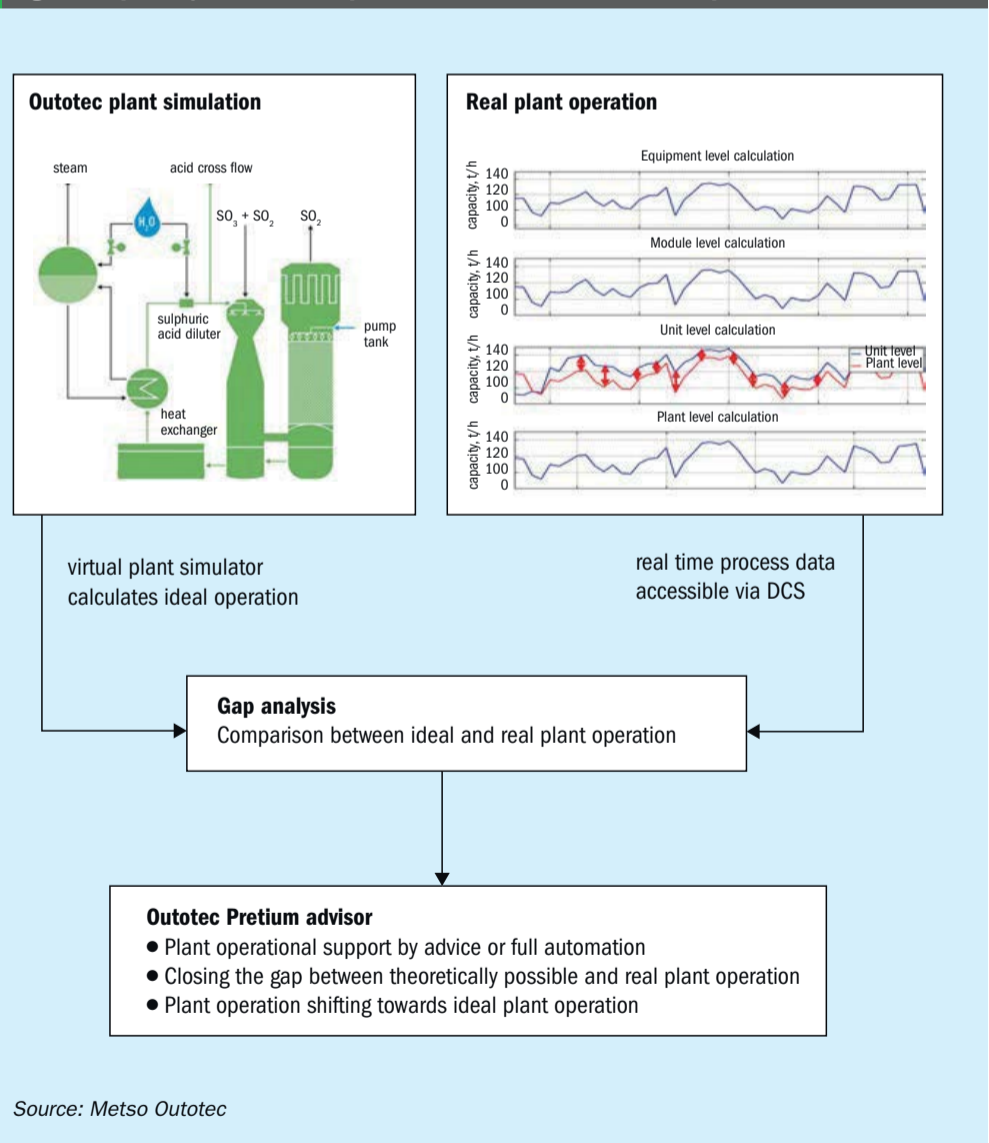


Fig. 3: Gap analysis between plant simulation and measured plant data in real time



needs to be changed to bring the plant closer to the theoretical optimum. (There is also the option to set these setpoints automatically.) This closes the gap between the theoretical optimum and observed operating conditions. In this way, the actual operation of the sulphuric acid plant is improved, using the theoretically possible optimum calculated by Metso Outotec's mathematical simulations as the target.

Gaps can also be caused by fouling of the different types of heat exchangers present in sulphuric acid plants. Mathematical models of heat exchangers are usually highly precise. This enables long-term monitoring to detect fouling trends. The variance between simulated and measured heat exchange can, however, have different causes. Sudden and rapidly rising gaps between theoretical and real measurements, for example, are usually a sign of leakage.

Simulation accuracy

Various Metso Outotec experts need to participate fully – in both fault detection algorithms and operational support – to achieve the required simulation accuracy. Process experts provide process know-how and flowsheet calculations, as well as plant-wide calculation models and site experience. Equipment experts furnish the necessary detailed know-how on single process units, while catalyst experts ensure detailed models for the chemical conversion from SO_2 to SO_3 and H_2SO_4 are accurate.

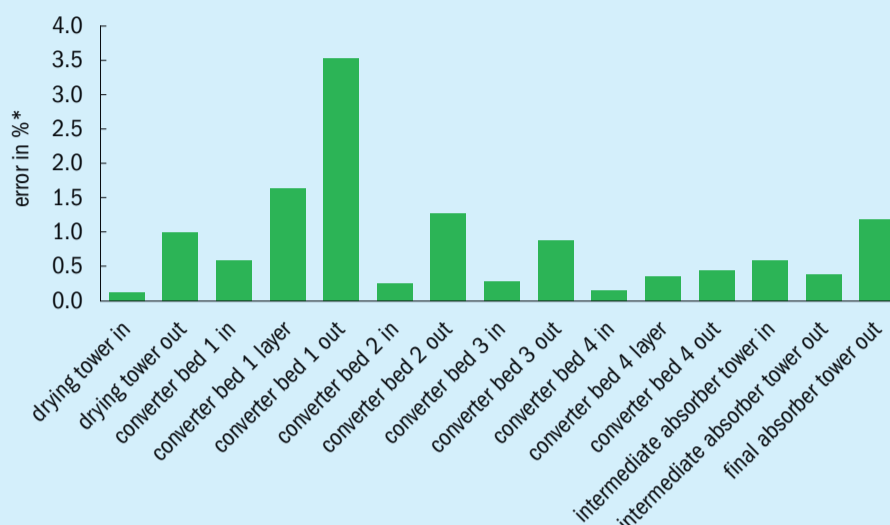
The accuracy of simulated versus actual temperature readings in the simulation of a sulphuric acid plant flowsheet is shown in Figure 4. The percentage error is calculated from:

$$e = \left| \frac{\gamma_{\text{sim}} - \gamma_{\text{measured}}}{\gamma_{\text{measured}}} \right| \cdot 100$$

This compares the simulated temperature value (γ_{sim}) in Kelvin (K), at each process step, with the respective temperature measurement (γ_{measured}) in K, as captured by the DCS. The DCS measurements are mean values obtained over a specified time range.

Figure 4 confirms that the simulation is highly accurate, with most simulated temperature readings having an error value of below one percent. The first converter stage outflow temperature does, however, show a deviation between measured and simulated temperature of more than three percent – a discrepancy that requires fur-

Fig. 4: Sulphuric acid flowchart simulation: accuracy of simulated temperature at each process step



* See text for calculation

Source: Metso Outotec

ther investigation. Such an error could mean that either the model parameters are inaccurate or that the catalytic converter in the first stage is showing the effects of aging.

Vitaly, this gap analysis of simulated results versus actual DCS measurements demonstrates just how important instrumentation engineering is – that includes equipment design, the location of instruments, measurement ranges, instrument installation and the quantity of instruments. The more precise and careful this engineering is, the easier it is to match simulated parameters with real world measurements.

In our view, the use of digital tools requires a highly diligent approach to instrumentation. A special focus is needed in the selection of instruments and how many are in standby/installed status. The placement of instruments in the right physical location is even more important.

The overall conclusion is a simple one. Unlocking the full power of digital tools is only possible if there is an intimate knowledge of the sulphuric acid plant's prevailing flow and reaction regime.

Advanced automation – integration of upstream process steps

Metso Outotec – in addition to offering simulation-based fault detection and operational support – has rapidly ramped up

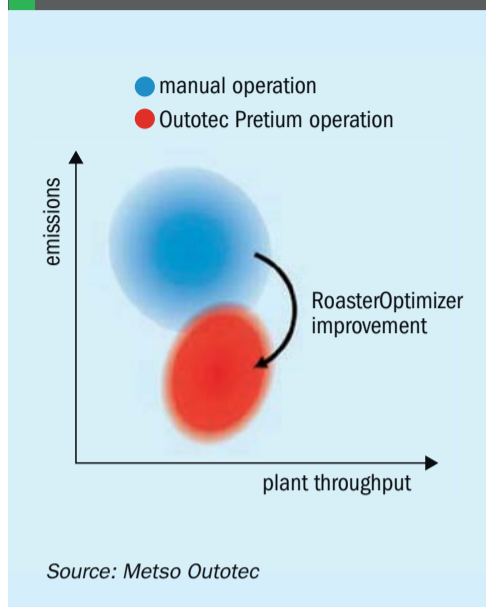
its capabilities in advanced process control and automated optimisation for the whole sulphuric acid plant unit. By applying a fully-automated control and optimisation system to the upstream metallurgical roasting plant, strong improvements in the operational stability of the entire sulphuric acid and gas cleaning plant train are now possible. The system – known as *RoasterOptimizer* – is currently being operated by a select group of Metso Outotec customers. This is enabling their roasters to operate at increased throughput while maintaining a high level of product quality.

The *RoasterOptimizer* is a multi-variable control and optimisation system that enhances roaster operation. The system – besides monitoring and taking into account various roasting plant variables – also considers process variables in the downstream gas cleaning and acid plant. As a consequence, one of the benefits of implementing *RoasterOptimizer* is that, by encompassing the complete process chain, it ensures and guarantees that environmental emission values are not exceeded, while at the same time increasing plant capacity.

Figure 5 shows the expected long-term environmental improvements delivered when a plant is in operation with *RoasterOptimizer*. This clearly demonstrates the system's advantage, in terms of reduced emissions.

With *RoasterOptimizer*, the following positive measurable effects and benefits

Fig. 5: Outotec's *RoasterOptimizer* system: expected long-term emissions reductions



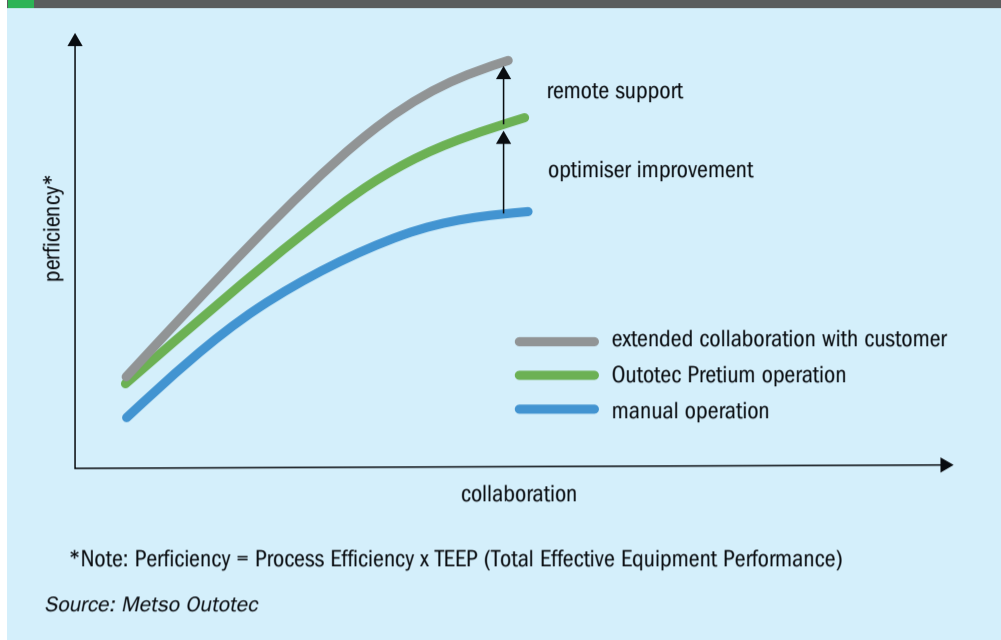
can be achieved after several months of operation:

- Feed material preparation with increased blend flexibility → Addition of waste streams and/or low grade concentrates, production cost reduction
- Roaster plant availability and capacity increase → Process stabilisation, reduced stress on plant and equipment
- Acid plant environmental improvements → Lowering SO₂ emissions, reducing bottlenecks
- Leaching efficiency increases → Higher calcine product quality, production cost reductions in the hydrometallurgical plant.

Combining digital tools for upstream metallurgical process steps (feed preparation, roasting etc.) and downstream process steps (gas cleaning, sulphuric acid production and hydrometallurgical plant sections) reveals the full operational potential of 'Industry 4.0' for today's sulphuric acid production sites.

The integration of *RoasterOptimizer*, for stabilising and optimising the fluidised bed-roaster, and PORS, for monitoring and supervising the full acid production process, provides a good example. This combined approach is able to optimise the full production chain of the roasting-gas cleaning-sulphuric acid-leaching plant. The leading-edge plant performance achieved, through the adoption of simulation and digitalisation, represents a significant step towards the fully-automated production processes expected in future.

Fig. 6: Productivity advantages of optimiser improvement and extended collaboration with customers



Supporting customers remotely in the future

Metso Outotec has actively supported its installed plant base globally during the current pandemic, offering advice and support to our customers throughout this unprecedented disturbance to production. For our references where expert advanced monitoring and control features are installed, we are providing feedback on future developments that will ensure our digital tools offer even greater value in the future. In the section below, we reflect on the experiences gained with our installed digital tools during 2020, and outline our future digital offerings.

During the current pandemic, the remote support services for our digital tools have proved a success – as the majority of these support staff work from home-based environments under normal circumstances. Also, because these support staff already have access to our centralised process support teams, our customer technical support has in no way been disrupted.

Looking ahead, one obvious omission from our digital offering has been the lack of a complete and joined-up 'big picture' of the whole process. A digital system supporting a process unit – such as a smelter, hydrometallurgy plant or parts thereof – has significant inputs from upstream and side streams, for example. Yet these may not have the same level of digitalisation. Therefore, in many situations where a trend in the data is observed, there is a need for a more holistic production overview to ensure that actions are taken at

the correct stage of the process.

Achieving this 'big picture' level of understanding is not necessarily easy. It requires communication, transparency and trust between individual production units operated by customers. The advice and input from Metso Outotec's process support staff also needs to be seamlessly incorporated.

There is also a wide spectrum of operator attitudes towards digital tools currently. These range from total distrust ("Big Brother is watching us" and "this box will take my job away" being typical reactions) to a potentially naive reliance on digital tools as a magic bullet. Somewhere between these two extremes is the rightful and more pragmatic approach. This acknowledges that, firstly, operator skill and experience is paramount and, secondly, furnishing an operator with digital tools that he/she can trust allows that individual to make better operational decisions.

Metso Outotec is integrating existing digital tools into our current EPC services and offerings. Based on our process industry heritage and know-how, we are also pressing ahead and developing new modular analytical/autonomous solutions for our global customer base. However, regardless of what an EPC contractor develops and brings to market, the fact that the digital maturity level in the industries we serve is relatively low remains an obstacle. Our focus, therefore, must be to support 'early adopters' to confirm the success and applicability of digital technologies and Industry 4.0. The man-

tra “do what you can, with what you’ve got, where you are” – widely and indirectly attributed to Theodore Roosevelt – is a valid summing up of digitalisation in the industries Metso Outotec serves.

We are acutely aware of our industry’s general deep mistrust regarding data security and allowing ‘intimate’ access to their production data. An open-source approach between customer and engineering partner is required, in our view, to break down the ‘black box’ mentality and build the necessary trust that leads to successful partnerships. The following fundamental issues need to be addressed for all parties to reap the advantages (Figure 6) that digitalisation can offer:

- All parties are part of the solution. Transparent revenue/profit models are also necessary to benefit all those involved. An attitude of ‘sharing, but not owning’ is probably the greater challenge.
- Having open and transparent communication and trust is fundamental and needs to be part of the skillsets of all participants.
- Ensuring data security and providing

guarantees that use of data will be for ‘purpose only’ are critical factors

- Industry benchmarking and industrial KPIs are areas that require more focus and attention.

Summary

Digitalisation (Industry 4.0) is seen as a driver for improving process efficiency. Its introduction can/will ultimately disrupt traditional business models as well. Digitalisation is also likely to herald a fundamental change in the relationship and balance between EPC contractors and customers.

Metso Outotec has always presented their digital tools to the industry as a ‘work in progress’. For digital solutions to be a success in industrial operations, there needs to be a strong bond of trust between us and our customer – and an acknowledgement that both parties have something valid to offer in reaching the ultimate digital solution.

Indeed, our experience to date indicates that the efficiency of the digital tool increases significantly when the trust and

collaboration between process support personnel and plant operators is allowed to deepen and flourish.

Metso Outotec has always accepted the ethos of ‘sharing, but not owning’ the data associated with plant operations. Probably the greatest challenge to wider digital applications, in our view, will depend on this key issue being accepted and resolved.

Ultimately, it is our customers who will decide on the future direction of the industry. So they must also be able and willing to take a leap of faith if the ‘digital adventures’ and possibilities described here are to become a reality and a success. ■

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Innovation showcase



Yara's handheld N-Tester device.

PHOTO: YARA INTERNATIONAL

We profile a selection of innovative speciality products and agronomic technologies that have recently been brought to market.

Perstorp launches chloride-free liquid potassium fertilizer

Sweden's **Perstorp** entered the fertilizer market in May with the launch of *Amicult™ K42*.

This chloride-free liquid potassium fertilizer has a high solubility and absorption rate, without increasing salinity or clogging foliar and drip irrigation systems. The product has a potassium content of 42 percent and is described by the company as an "organic Potassium salt dissolved in water".

Specifically designed for fertigation and foliar application, *Amicult* will initially be available in Brazil, Chile, US and Europe.

"With high-salinity and arid agricultural land increasing, it's time for more refined fertilizer options. *Amicult* offers a tested and proven chloride-free potassium based product. It is the smart way to increase profitability, improving crop yield and water use efficiency," said Claudio Gaino, vice president for the Formates business unit at Perstorp.

The high solubility of *Amicult* makes it a good choice for drip irrigation systems. Being a liquid fertilizer, it can be applied at critical development stages where the crop needs an additional supply of potassium.

High chloride levels have a negative impact on crop development in agricultural regions where saline soils are an issue. Being a low salt index product, *Amicult* reduces the risk of adding to soil salinity.

Valuably, *Amicult* shows high foliar uptake efficiency under drought conditions. Its quick foliar uptake – at times when it is difficult to foresee frost – also help protect crops against frost damage.

"Years of innovation work has led to the discovery of the positive effects with *Amicult K42*. We are excited to now offer the market a chloride free fertilizer component that not only decreases salinity problems but has proven effect on higher yield and crop quality, and also improves drip irrigation efficiency", says Martina Håkansson, the business development director for Formates at Perstorp.

World's first polyhalite product

ICL Fertilizers recently switched all production at its UK Boulby Mine in North Yorkshire from muriate of potash (MOP) to *Polysulphate*, the world's only commercially-available polyhalite product. ICL has successfully trialled *Polysulphate* as a low-

chloride, multi-nutrient (sulphur, magnesium, potassium and calcium) fertilizer on a wide variety of crops, including barley, brassica, canola, coffee, oil palm, potatoes and wheat.

ICL offers a family of four polyhalite products as part of its new *Fertilizerplus* line of premium fertilizers:

- Straight *Polysulphate* in granular or powder form
- The *ICL PKplus* range of PK (phosphorus and potassium) granular fertilizers containing *Polysulphate*
- *ICL Potashplus*, a granular fertilizer formulated from a combination of MOP (KCl) and *Polysulphate*
- *Polysulphate Premium*, uniform, round-shape *Polysulphate*.

Polysulphate contains:

- 48 percent SO₃ as sulphate
- 14 percent K₂O as potassium sulphate
- 6 percent MgO as magnesium sulphate
- 17 percent CaO as calcium sulphate

Applying *Polysulphate* ensures a continual supply of sulphur to crops throughout the growing cycle, and reduces the risk of sulphur leaching in sandy soils, espe-

cially under high rainfall conditions. It also provides magnesium to support crop yield and quality. This is becoming ever more important as soil magnesium deficiency is becoming increasingly widespread. Granular *Polysulphate* (2-4mm) has excellent spreading characteristics and is an ideal fertilizer to apply alongside straight nitrogen. *Polysulphate*, being a natural mineral, has been approved for organic agriculture in different countries (Austria, Brazil, Canada, France, Germany, Hungary, Israel, Italy, Japan, Poland, the Netherlands, the UK and the US).

ICL PKpluS, produced at the company's plants in Amsterdam and Ludwigshafen in Germany, allows the application of P and K to be separated from nitrogen applications. By avoiding N overdosing or leaching, the use of *PKpluS* improves nitrogen use efficiency and helps prevent costly and environmentally-damaging nitrogen losses. *PKpluS* is also a cost effective PK fertilizer for nitrogen-fixing legumes, such as soybean, peas and alfalfa, which require no additional nitrogen fertilization.

ICL PotashpluS has a much lower chloride level than MOP due to its *Polysulphate* component. Its sulphur content also meets the fertilization requirements of crops with high sulphur demand, such as canola, wheat, legumes and grassland. In addition to supplying potassium (37% K₂O), *PotashpluS* supplies sulphur (9% S) in sulphate form for protein and oil formation, magnesium (3% MgO) for photosynthesis, and calcium (8% CaO) for strong, high-quality crops – all in the same application. It also contains boron.

Polysulphate Premium consists of uniform, robust spheres of *Polysulphate* that blend easily with other granulated fertilizers. Its smooth surface protects against abrasion, humidity and damage. While its spherical shape provides a steady flow rate and a consistent broad spread during field application.

CENTURO – next-generation nitrogen inhibitor

Koch Agronomic Services (Koch) is part of Koch Industries, Inc., a privately held company based in Wichita, Kansas. Koch and its affiliates produce and market a proven and expanding global portfolio of plant performance technologies for agriculture producers and the turf and ornamental sector.

CENTURO[™] is Koch's next-generation nitrification inhibitor for use with anhydrous

ammonia and urea ammonium nitrate (UAN). This innovative new product from Koch combines two distinct advantages:

- Firstly, it incorporates the patented active ingredient Pronitridine to provide highly effective below-ground nitrogen protection.
- Secondly, it also offers unrivalled flexibility as an easy-to-handle solution that is noncorrosive to the metals used with UAN and anhydrous ammonia equipment.

The launch of *CENTURO* in July 2018 was a milestone moment, as it marked the first time in more than 40 years that a nitrification inhibitor received registration from the US Environmental Protection Agency (EPA), under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Koch made *CENTURO* available in Canada from September 2019.

CENTURO was developed in-house by a team of chemists at Koch in the US. It was created specifically to help farmers and the agriculture industry – and more generally society as a whole – meet the challenges of increasing food production while minimising the associated environmental impacts.

"At Koch, we know that feeding the estimated nine to 10 billion people by year 2050 will require more food to be grown on roughly the same amount of land used for farming today," said Steve Coulter, the company's senior vice president. "The agriculture industry needs to continually innovate in all areas of the value chain. Our teams around the globe have that in mind as they work towards tomorrow's solutions."

CENTURO is an important tool for protecting a farmer's investment in nitrogen fertilizer from leaching and denitrification losses. As a nitrification inhibitor, *CENTURO* slows the conversion of ammonium to nitrate, making it less susceptible to environment loss and helping keep the nitrogen in the root zone for plant and crop uptake. In fact, US research has shown that *CENTURO* will hold nitrogen in ammonium form three times longer than without an inhibitor.

The use of *CENTURO* on nitrogen in agriculture also supports the implementation of the 4R Nutrient Stewardship initiative. *CENTURO* – by helping to keep applied nitrogen in the right place and available at the right time – helps protect the nitrogen so it remains there when the crop needs it most. Following the 4R nitrogen management framework is an important way of helping farmers optimise crop yield potential and profitability.

4Rs Nutrient Stewardship is an innovative and science-based approach that offers enhanced environmental protection, higher production, increased farmer profitability, and improved sustainability. The concept is to use the right fertilizer source, at the right rate, at the right time, with the right placement.

CENTURO exemplifies Koch's commitment to creating real, sustainable, long-term value for customers and society, according to the company, and its focus on developing customer-driven solutions that maximise plant performance and minimise environmental impact.



CENTURO is a nitrification inhibitor suitable for use with anhydrous ammonia.

PHOTO: KAS

Compass and Marrone Bio Innovation joins forces

Compass Minerals and **Marrone Bio Innovations** unveiled a new collaboration on biofertilizers last year.

The two companies are joining forces to develop new speciality plant nutrient products enhanced with microorganisms. The plan is to bring patented technologies to market and create innovative products to enhance plant health and growth. The new products will increase crop health and reduce crop stress by enabling crops to take up nutrients more efficiently.

The collaboration will combine Marrone Bio's access to a collection of 18,000 novel microorganisms with Compass Minerals' expertise in speciality plant nutrition. By improving plant vigour, the resulting value-added products should provide growers with higher crop yields and a better return on investment.

Microorganisms are known to control pests and plant diseases and improve the health, growth and yields of crops. They also reduce drought stress, salt stress and other environmental stresses.

Importantly, by making major nutrients and micronutrients more available, microbes are known to increase nutrient uptake efficiency and improve plant growth. This helps farm profitability and the environment by reducing excess nutrients.

"Compass Minerals Plant Nutrition is excited to have access to the rich collection of Marrone Bio's microorganisms that have shown the ability to improve plant health and growth," said Ryan Bartlett, vice president of innovation and product development at Compass Minerals. "This collaboration is an important one as we continue to expand our... plant nutrition portfolio... with this unique line of products."

"[With] our combined technologies and core competencies, we look forward to working with Compass Minerals Plant Nutrition as a partner in the development of exciting new products that don't exist in the market today," added Pam Marrone, CEO of Marrone Bio.

The new InnoSolve range from Innovar Ag

Innovar Ag is probably best known for its pioneering work on stabilized nitrogen fertilizers (SNFs) in many countries globally. Without proper protection, more than 50 percent of nitrogen fertilizers applied to

plants will be lost to the environment as a result of complex soil reactions. The *Neon family* of products are the latest advance in this arena from Innovar Ag. These products are designed to protect against nitrogen losses, both above and below ground.

Having designed products that prevent nitrogen losses, Innovar Ag next turned its attention to other essential mineral nutrients in crop systems. The result was *InnoSolve PKMe*. This synthetic biodegradable polymer fertilizer additive addresses the need to increase crop uptake of macro nutrients and micronutrients. *InnoSolve PKMe* does this by preventing nutrients from becoming locked within soils – due to extreme pH levels, complexation with soil organic matter and other mechanisms.

Environmental stresses and competition within complex agricultural systems are a particular threat to crop growth and yield. Plants can use energy – that would otherwise go into crop development – to protect themselves against pests, weeds, diseases, extreme temperatures and unbalanced water supply. These all generate different types of plant stress. Innovar Ag launched the following three new biostimulant products in June 2020 to address such challenges and support best management practices in crop production:

- **InnoSolve Amino:** This amino acid product works at plant physiology level by increasing chlorophyll production, stimulating growth and boosting energy to support plant reactions at various crop development stages. The key for amino acid products is to finding a specific source, preferably of vegetable origin, without contaminants in the formulation.
- **InnoSolve Gold:** This phosphite-based product enables the plant to defend itself, from both biotic and abiotic stresses, by employing SAR (systemic acquired resistance) responses. It introduces to the market a new category of phosphite, complexed with amino acids, able to provide superior water solubility and a fast response.
- **InnoSolve Silicon:** This product contains a silicon polymer (40% Si) derived from silicic acid. It increases stress tolerance through cell walls by strengthening and thickening cuticles. The chemical/physical barriers that plants acquire once treated with this product improve disease and pest resistance. Lower transpiration also reduces water usage, helping crops reach target yields even when water supply is restricted. *InnoSolve Sili-*

con also helps plants avoid aluminium, iron and manganese toxicity.

These new products are useful tools for fine-tuning fertilization programmes. This wider portfolio allows Innovar Ag and its partners to promote a 4R nutrient stewardship approach for evaluating crop conditions, customise best management practices and improve crop results for farmers.

Yara turns smartphones into nitrogen sensors

A new innovation from **Yara International** allow farmers to measure crop nitrogen requirements using their smartphones. The company launched the new precision farming tool, known as *Yaralrix*, in March last year.

Nitrogen analysis has traditionally required expensive equipment beyond the reach of most growers. Yara's aim in introducing the new tool is to make precision farming accessible to all farmers.

Yaralrix includes a free-to-download app available for both Android and Apple's iOS. The app uses the smartphone's camera to determine the nitrogen demand of different crops in the early stages of growth. For measuring nitrogen demand during later growth stages, the app requires an additional *N-Tester* hardware device. This is available as either a smartphone clip-on, or as a separate *Bluetooth*-enabled device.

"Every field is different. By enabling farmers to simply use their smartphones for precision farming, *Yaralrix* is a game-changer that can ultimately provide millions of farmers with new insight about their crops," commented Stefan Fürnsinn, Yara's senior vice president for digital farming.

He added: "We are now taking the first steps with the launch of *Yaralrix* across Europe. With access to precise data about the nutritional needs of crops, we can produce more food and reduce the environmental impact of farming at the same time."

Yaralrix works by measuring chlorophyll levels using a smartphone camera combined with one of two hardware devices. This enables precise measurements of the nitrogen needs of crops – making it easier for the farmer to apply the correct amount of fertilizer.

The app – without any additional hardware – can determine the nitrogen needs of winter wheat, oilseed rape, maize and barley during early growth stages. After making its measurement, the app provides an instant recommendation about



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how much fertilizer the crops need. This recommendation is based on algorithms and knowledge accumulated over more than 20 years of field research.

The app can be supplemented with the *N-Tester Clip*. This add-on device clips over the smartphone camera, transforming it into a nitrogen sensor for precise nitrogen recommendations at later growth stages. Farmers will initially receive a beta version of the *N-Tester Clip* prior to its formal market launch.

Farmers also have the choice of purchasing the *N-Tester BT* device for *Yaralrix*. This connects to smartphones via *Bluetooth* to provide nitrogen recommendations for crops in later growth stages. *N-Tester BT* is suitable for winter and spring barley, winter rye and winter triticale, as well as the previously mentioned crop types. It also saves historical data, improving the ability of farmers to make the right nitrogen recommendations.

Nutrien offers customers *xarvio* digital farming app

Nutrien’s North American retail arm, **Nutrien Ag Solutions**, is now offering BASF’s *xarvio*™ *SCOUTING* app to its customers.

The decision to provide access to this leading agronomic tool, announced in June last year, is part of a wider digital collaboration between the Colorado-headquartered farm retailer and the Agricultural Solutions division of BASF.

Providing BASF’s *xarvio*™ *SCOUTING* app will enable Nutrien’s farm customers to detect and identify weed and pest pressure as they monitor and protect crops during the growing season. The potential for offering the agronomic capabilities of BASF’s *xarvio*™ *Field Manager* are also being actively explored. This app offers crop protection advice, including timings and variable rate map applications, for managing weeds, diseases and pests.

“These tools help improve growers’ results and we’re excited to be able to feature the *xarvio*™ *SCOUTING* app,” said Sol Goldfarb, vice president for digital strategy at Nutrien Ag Solutions.

“We are proud to have the *xarvio*™ *SCOUTING* app featured on the Nutrien Ag Solutions customer portal and to explore the agronomic intelligence of *xarvio*™ *Field Manager*,” added Paul Rea, senior vice president for BASF Agricultural Solutions, North America. “Through our work together, BASF... and Nutrien Ag Solutions can help change the industry by providing growers with the products, services and

now digital tools to support their success.”

Nutrien also expanded its digital agriculture services through the acquisition of Agrible Inc for \$63 million in September 2018.

Agrible markets a broad range of digital agronomic products for farmers. They include *Morning Farm Report*®, *Spray Smart*®, *Nutrient Engine*® and *Find My Seed*®. The Illinois-based company has around 17,000 customers who collectively farm around 11 million acres in total.

“Agrible has developed a very impressive set of digital agronomic and sustainability tools which can be immediately incorporated into our existing digital platform,” said Mike Frank, president of Nutrien Ag Solutions. “We are excited to welcome Agrible’s talented team to Nutrien Ag Solutions’ digital organization and to expand our presence into Champaign, Illinois,” Frank added.

“Agrible has dedicated its business strategy to building market-leading digital tools that provide growers with the information and insights they need, when and where they need them,” said Paul Miller, chief science officer & co-founder of Agrible. “This exciting combination with Nutrien Ag Solutions is the ultimate validation of our strategy and the ideal platform to significantly scale-up the capabilities that we have built.”

DNA tagging of fertilizers

The need to establish iron-clad traceability all the way along agricultural and food supply chains is becoming increasingly clear and urgent. While the detection of adulteration is an important issue, safety and security are the most pressing concerns driving the introduction of traceability for fertilizers such as ammonium nitrate (AN).

In response to domestic car bomb attacks four years ago, the Turkish government introduced a ban on the sale and distribution of AN-based fertilizers in June 2016 – until an effective tracking system was established. Subsequently, in January 2018, Turkey became the first country globally to mandate DNA tagging of all locally produced and imported AN-based fertilizers. This government mandate required the full implementation of a number of requirements, including DNA tagging, secure packaging, and a code registry system that allows the contents of each bag of AN to be traced to its source.

Part of the solution was the deployment of ground-breaking *D-ART 3000* DNA tagging systems from Californian technology company **SafeTraces**. These systems provide state-of-the-art traceability and have already

been deployed at fertilizer manufacturing plants in Europe and the Middle East.

The company’s innovative DNA tagging technology can be seamlessly integrated into manufacturing lines for products of any size, solid or liquid, including a wide range of agricultural inputs. Once applied, the DNA tracer provides an unbreakable link between the physical product and its digital blockchain-secured certificate. An easy-to-use barcode reading system identifies the DNA tracer and can recover information on the origin of the product at any point in the supply chain.

The *SafeTraces D-ART 3000* system combines up to 32 DNA sequences to produce a practically unlimited number of unique *safeTracers*™ DNA barcodes. Each *safeTracers*™ solution is sprayed onto the product as it is packaged while production information is simultaneously recorded in a blockchain-secured database.

Each unique DNA barcode consists of short (<100 base pair) non-living, non-viable DNA sequences encapsulated in food-grade materials. These include gums, resins, proteins, and lipids such as carrageenan, albumin, and soy lecithin. All formulations are GRAS – ‘generally recognized as safe’ by the US Federal Drug Administration – and have no impact on product quality, shelf life or taste. *safeTracers*™ can be formulated for granular products, such as fertilizers and grains, as well as for product coatings and liquid products.

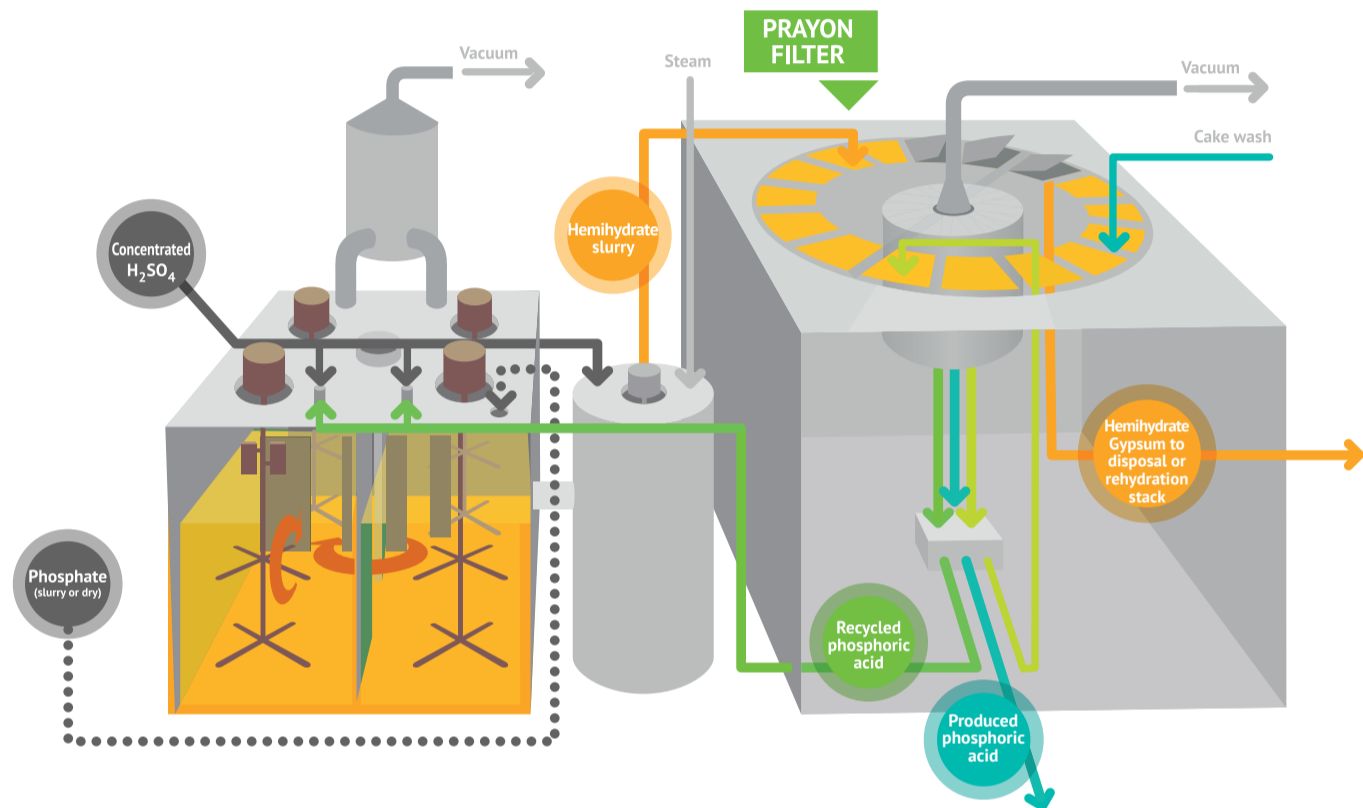
Once *safeTracers*™ are on the product, they are invisible and cannot be removed or adulterated, locking in a level of traceability that package labelling cannot provide. The DNA barcodes are detectable only with the matching DNA barcode reading system. This comprises a small portable reader, an easy-to-use test kit and authorised access to the database. The time taken from sampling the product to identifying and confirming a match for the DNA barcode takes no more than 15 minutes. For certain commodities, the system is also capable of detecting if dilution or adulteration has occurred by measuring changes in the DNA tracer concentration.

For ammonium nitrate, the stability of *safeTracers*™ has been tested in the laboratory at room temperature under ‘worst case’ chemical conditions. Results show that DNA barcode formulations were stable for the equivalent of two years. The integrity of the system – i.e. the probability that the complete system will correctly identify a DNA barcode applied to a product lot – has also been rigorously tested and shown to be 99.4-99.9 percent accurate. ■

phosphates
& potash

INSIGHT

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Covid-19 and phosphates: from fear to optimism (for now)

IMAGE: NHEMZ/SHUTTERSTOCK.COM

The phosphates market to date has remained remarkably resilient during the Covid-19 pandemic. Despite early fears, 2020 has seen strong overall demand so far and no major supply-side disruptions. But concerns still lie ahead, as **Alberto Persona**, principal phosphate analyst at Fertecon/IHS Markit, explains.

That time when we first began to hear the Chinese city of Wuhan, the capital of Hubei province, regularly mentioned on the news seems so long ago now – almost a different era. As lockdown measures began to be imposed in China, the spreading Covid-19 contagion received more and more worldwide media coverage. The global phosphate industry was perhaps the most concerned at the time – with good reason too.

Hubei province is China’s phosphate powerhouse and a key global production hub, accounting for as much as nine percent of global diammonium phosphate (DAP) capacity and 15 percent of mono-ammonium phosphate (MAP) capacity. Despite operating rates typically being much lower than capacity, Hubei is no less significant, both in terms of domestic sales – in what is the world’s largest phosphates market – and export availability (Figure 1).

Developments all happened very fast in Hubei, once Covid-19 took hold. By the time February had ended, phosphate mines and chemical plants in the province were told not to resume production after seasonal maintenance rounds. The whole of the province was placed under strict lockdown, a significant hindrance to the crucial truck-based movement of phosphates to key demand hubs in northeast China. Extended labour shortages also meant that even exports were facing significant delays.

Consequently, many started fearing that Chinese DAP/MAP would not be available for export during much of the first-half of 2020, if not longer. Some even suggested China might need to increase phosphate imports drastically to meet unfulfilled demand (Figure 2).

Fig. 1: Hubei province: share of ammoniated phosphate market

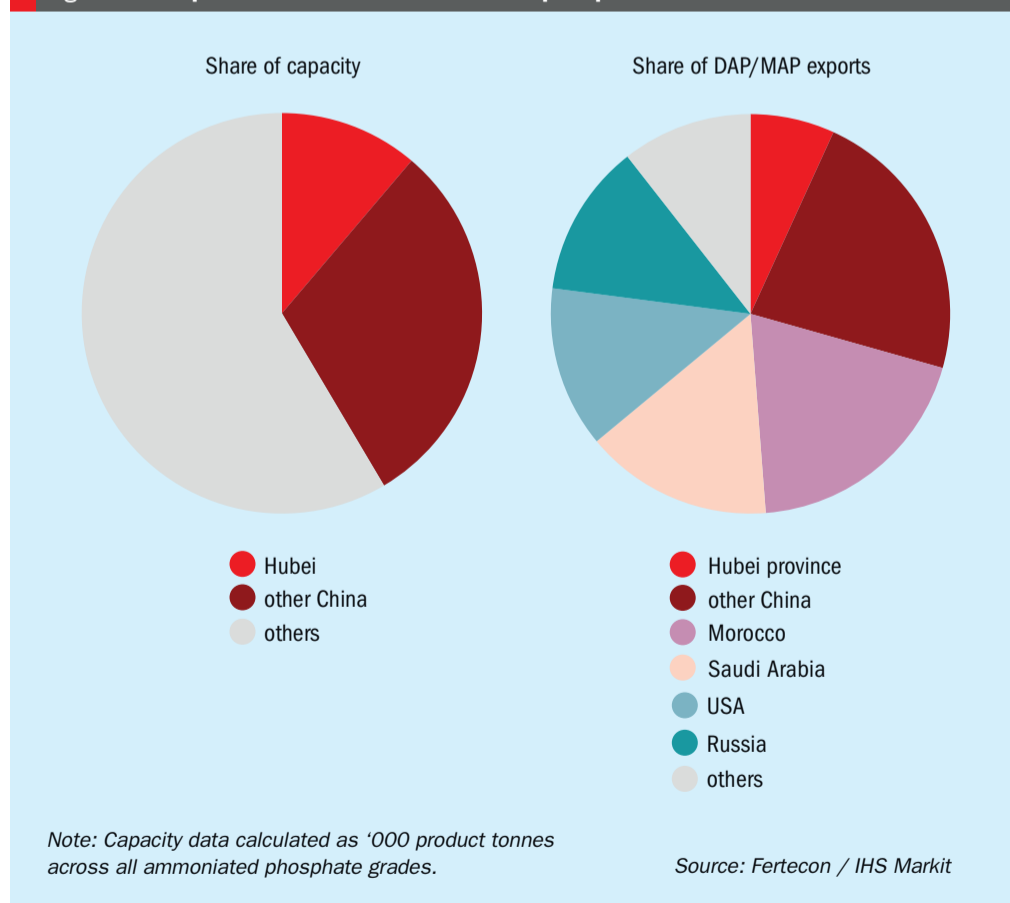
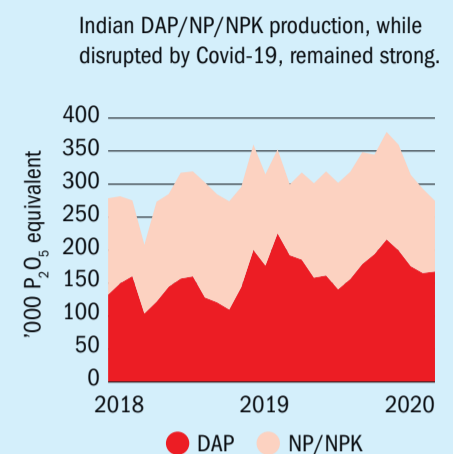


Fig. 2: Chinese DAP trade, 2000-2019



Source: Global Trade Atlas (GTA) | IHS Markit

Fig. 3: Indian DAP/NP/NPK production 2018-2020



Source: Fertilizer Association of India (FAI)

In reality, neither of these two pessimistic scenarios transpired. This was because Chinese production outside Hubei was less affected by the pandemic, and existing phosphate product stock levels were also sufficient to maintain a broadly balanced market, avoiding phosphate price dips and hikes alike. Indeed, production in Hubei province already started to ramp-up again in early March, with almost all operations resuming good running order by early April. In fact, January-March 2020 DAP/MAP exports were only 400,000 tonnes lower than the same period in 2019. If anything, lost first-quarter business seems to have triggered a desire to keep Chinese production rates firm for the remainder of the year, matching the peak import season in key markets such as India and Brazil.

Fears of scarcity evolved fast into oversupply worries

The shift from a Chinese Covid-19 epidemic to a global pandemic triggered wide-ranging government responses in many countries. This inevitably placed a drag on fertilizer movements, particularly for land-based transportation across national borders (e.g. in Europe) and also on truck loading as control on vehicles and drivers was tightened. Fertilizer plants, however, were generally exempt from full shutdown, having been classed as an 'essential business' in most economies.

Consequently, the operations of many phosphate producers have remained almost unscathed, with any disruptions, even when significant, in general being short-lived.

GCT in **Tunisia**, which had decreased its workforce at mines and chemical plants to 30 percent in March, increased this to 50

percent in April, a sequence of events that ended with the surprising revival of the second granulation line at the Gabès plant – an example of supply tightness-turned-increase. JPMC in **Jordan** faced a 10-day restriction in port capacity at Aqaba. But the market impact of this was minimal as the timing coincided with annual turnarounds. CMOG and Mosaic in **Brazil** briefly struggled with labour availability in parts of Brazil – as local mayors moved to prohibit bus transport. But this proved to be a temporary situation that was resolved within the space of one week. The **Peru** phosphate rock miner Miski Mayo suffered a longer idling of about two months, yet exports were relatively unaffected, being kept buoyant by available stocks until operations resumed in June.

India proved to be the only country where a significant decrease in production was apparent. A country-wide lockdown was announced in strong and decisive terms – perhaps a necessity for a country of 1.4 billion people – by prime minister Narendra Modi on 25th March. Such decisiveness did, however, lead to a series of misunderstandings. Notably, it wasn't until a few days later that port operations and fertilizer manufacturing were officially declared 'essential'. Even this short time lag was enough to scare exporters, traders and charterers – particularly those active in basic and intermediate chemicals (phosphoric acid, sulphuric acid, ammonia etc.) – causing a sharp reduction in arrivals. At the same time, local police, still uncertain about which rules to enforce, occasionally prevented plant and port employees from reaching their workplaces. The situation on the subcontinent did, however, return to

normal within about three weeks. Yet the sheer size of the Indian market meant this was enough to cause a sizeable year-on-year decrease in total production volumes (Figure 3).

A number of issues are still continuing to affect Indian phosphate production and distribution, as labour availability remains tight for tasks such as in-plant product movement, bagging, and the loading of trucks/railcars. This situation appears to have favoured the import of finished phosphate fertilizers into India, in preference to local production based on raw material imports, as a way of reducing the overall movement of materials. The resulting temporary increase in Indian import demand for finished fertilizers (DAP/NP/NPK) was definitely welcome news for exporters seeking business opportunities. In particular, it marked a strong return of Moroccan DAP exports to Southern Asia, off-setting significant lost sales of phosphoric acid to this market.

India has not been the only country enjoying a good performance in import demand. Many economies where a sizeable share of the population is in rural employment have supported fertilizer demand by strengthening or reviving subsidies for crop inputs and revenue support schemes. Some of the import demand seen could also have other explanations, such as hoarding behaviour by importers, or even farmers, to secure supplies, while available, and take advantage of relatively low interest rates.

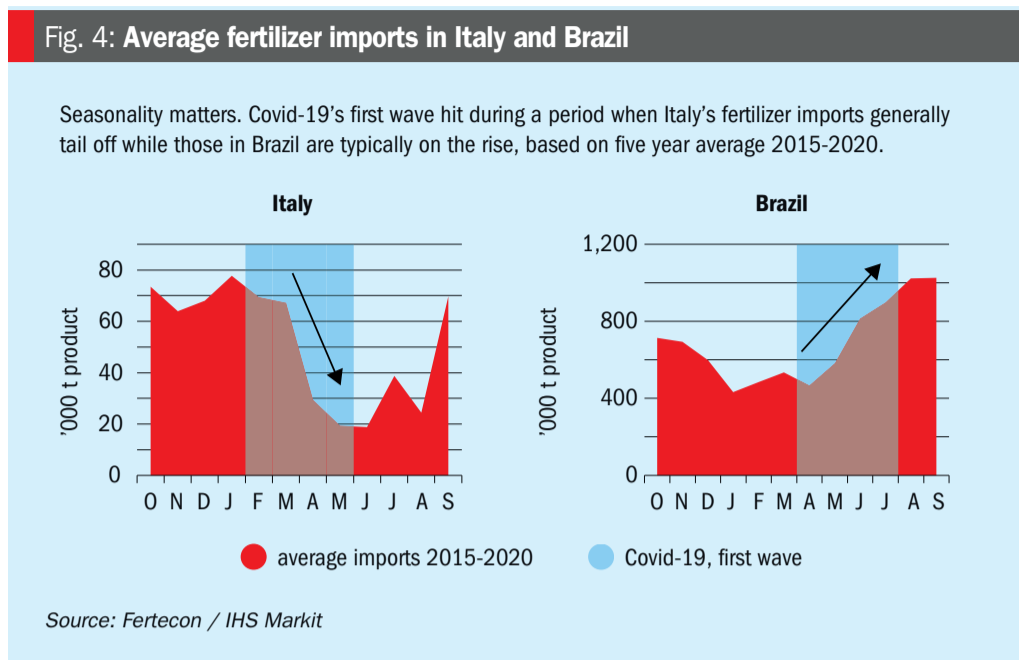
Focussing on key phosphate markets, **Brazil** imported record quantities of ammoniated phosphates during the first five months

of 2020, taking full advantage of prevailing international prices. The Latin American agricultural powerhouse enjoyed good demand, both from strong *safrinha* maize planting and stock replenishment well ahead of the main *safr* soybeans season. Covid-19 related swings in foreign exchange rates have also played a part – as improvements in Real-denominated revenues on crop exports have more than off-set higher dollar-denominated input purchases.

Demand in the **United States** was also strong – to a somewhat surprising extent. Planting for both maize and soybeans increased significantly year-on-year. This was despite a sharp decrease in maize-based ethanol production – a consequence of Covid-19 and the oil price war – and ongoing trade tensions with China. High North American application rates have been boosted by strong US planting at a time of cyclically low phosphate prices.

Concerns ahead?

Overall, the early part of 2020 has seen strong phosphate demand, as described above, with no major supply-side disruptions. The United States, however, makes a good case study for where we think there are reasons for concern further ahead. Strong US spring planting has supported demand in 2020. Yet large year-end crop stocks after the summer harvest could depress crop futures – causing a ripple effect into 2021 affecting both spring planting in the US and the Brazilian *safrinha* crop. Brazil, while not affected by lockdown measures so far, is still facing exponential growth in Covid-19 cases. Labour shortages for truck-based



delivery of fertilizers and crops cannot therefore be ruled out for the 2020 *safr* season.

In addition, top-up fertilizer applications around the world, particularly on fruits and vegetable crops, could suffer as farmers face limited access to fresh markets. All the while, big risks not linked to Covid-19 remain. These include the tragic impact of desert locust swarms in East Africa and Pakistan, and African Swine Fever in East and Southeast Asia.

However, it is not all doom-and-gloom. Those crops more essential for food consumption (e.g. rice, wheat) remain relatively firm, given the focus in many countries on building strategic stocks of staple foods. This bodes well for the autumn application season in the northern hemisphere and for the main import season in Oceania. At the same time,

key phosphate producers have plenty of time to adjust their production plans for the second-half of the year. Availability of key raw materials such as sulphur and sulphuric acid will, however, remain crucial to support such plans.

In general, the risks of either sharp inflation or price collapse seem to have retreated for now – making a repeat of the 2008/09 super-cycle seem unlikely. Overall demand continues to be strong and availability high.

Nevertheless, even if we discount the risk of a second wave of Covid-19 infections, market fundamentals do provide cause for concern over the short-term, particularly for the 2021 northern hemisphere application season. With key parts of the world having survived an unprecedented short-term shock from the global Covid-19 pandemic, now is the time to revive longer-term planning. ■



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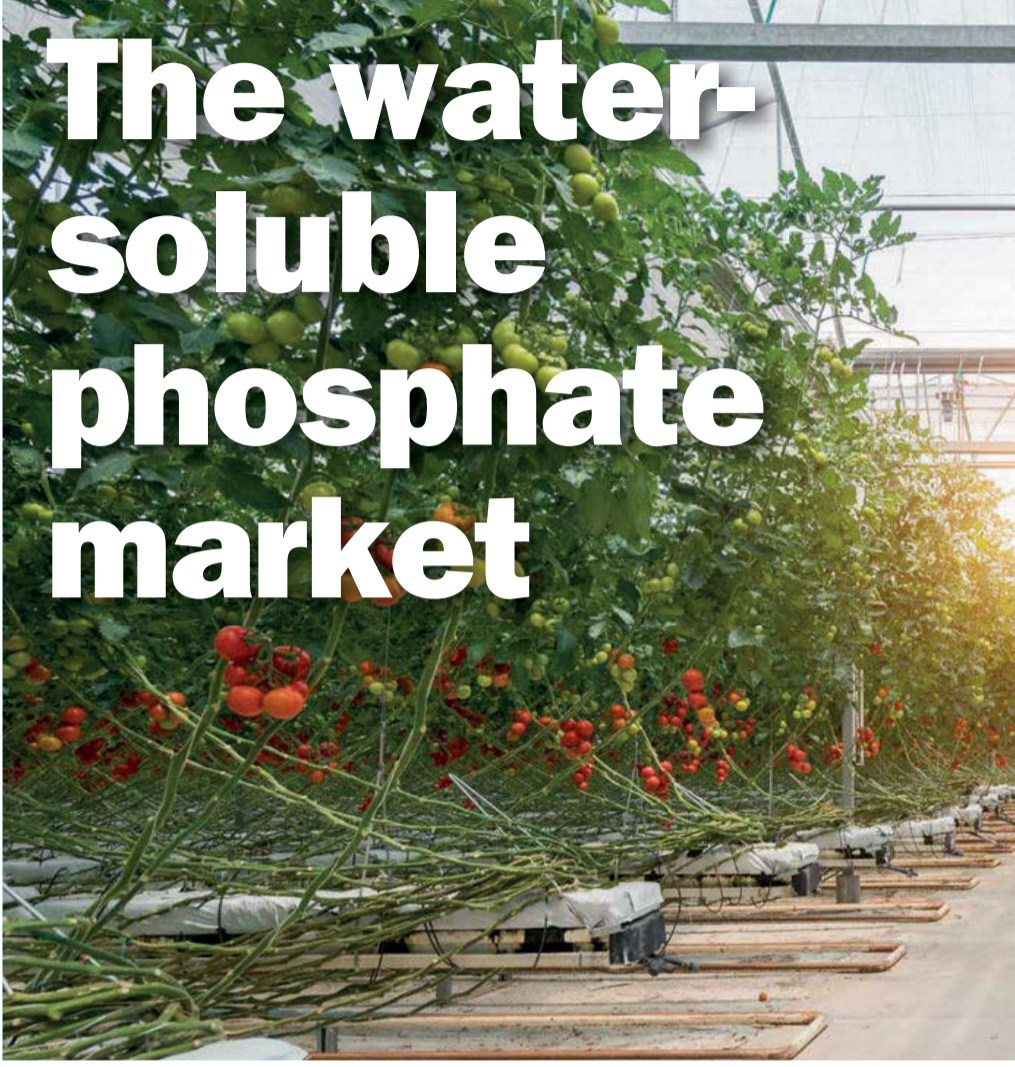
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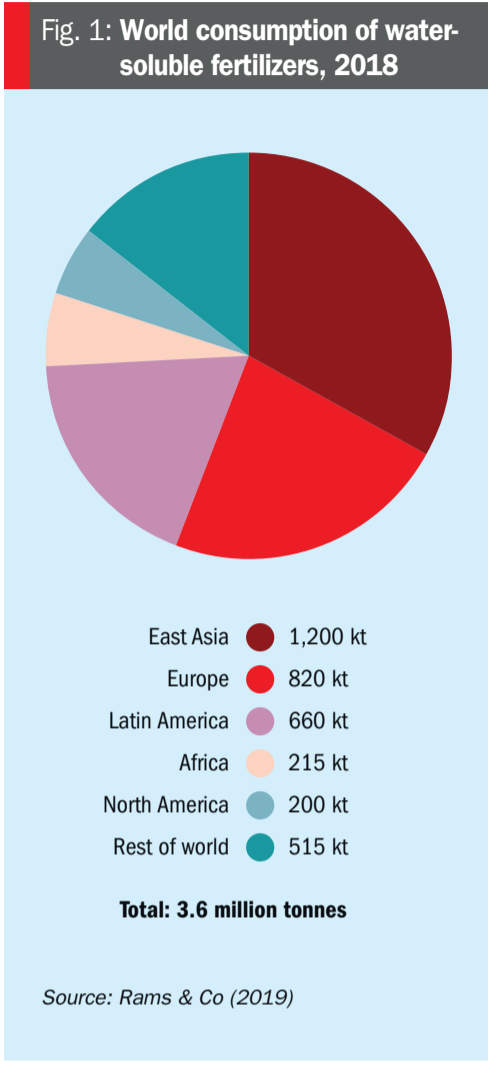
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Water-soluble phosphates such as MKP are used in hydroponic systems for tomatoes.



The water-soluble phosphate market

PHOTO: ICL



Demand from horticulture has seen the use of water-soluble phosphates rise globally to almost one million tonnes annually. We assess the market and its growth prospects, identify leading producers and highlight recent product innovations.

Water-soluble fertilizers (WSFs) are a niche group of speciality products that nevertheless occupy a strongly-growing segment of the global fertilizer market. The world market for WSFs – valued at \$14-15 billion according to some estimates – generates around \$3.6 billion in wholesale revenues annually¹.

Latest global sales volumes are estimated at 3.6 million t/a, up by around 360,000 tonnes in two years, a rise of more than 10 percent. East Asia and Europe are the leading regional consumers of WSFs with a market share of 33 percent and 23 percent, respectively. Latin and North America combined are also responsible for a further 24 percent of world WSF consumption¹ (Figure 1).

Applying fertilizers in soluble form offers a number of clear-cut efficiency

gains for commercial growers – whether in terms of input costs, nutrient use efficiency, labour, time or energy. The adoption of WSFs also comes at a time of agricultural intensification – the drive to get more crop per drop and per acre – a trend that is in turn linked to constraints on water and land availability.

The market for water-soluble fertilizers is largely split between fertigation, with a two-thirds share of consumption, and foliar applications which account for most of the remaining one-third of usage.

Growing demand for WSFs has been a natural consequence of the adoption of drip irrigation systems in fruit and vegetable growing. The rise of fertigation – the delivery of water-soluble fertilizers via irrigation systems – has been a particular strong driver of market growth.

Almost 16 million hectares of land are now watered via drip irrigation worldwide. Adoption is particularly high in China, the US, India and Spain (Figure 2).

Europe, where deployment of high-tech hydroponic and drip irrigation systems is relatively widespread, represents a sizeable and a mature market for WSFs. The WSF market in Africa has also benefitted from the growth in horticulture to serve the European market and the attendant rise in drip irrigation that has accompanied this.

The scale of the WSF market in North America, in contrast, has been constrained historically by competition with liquid fertilizers and the region’s relatively small vegetable growing market. India, meanwhile, is a small (around 150,000 t/a) but skyrocketing growth market for WSFs¹.

The world market for WSFs is forecast to grow at around 5-7 percent p.a. during the current decade to reach 6.4 million tonnes by 2028¹. Underlying long-term growth fundamentals remain good, with the expansion potential for fruit and vegetable growing in Asia providing a particularly strong demand push. The future trajectory

Fig. 2: Drip irrigation: top ten countries by land area, 2018/19*

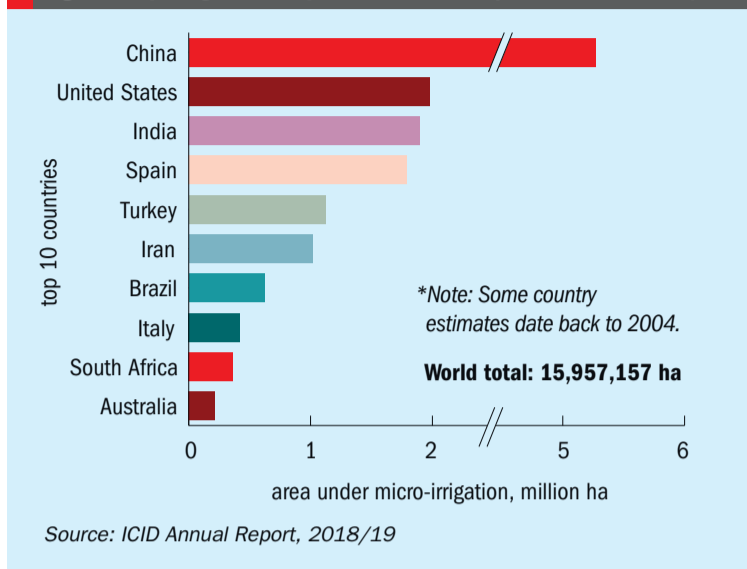
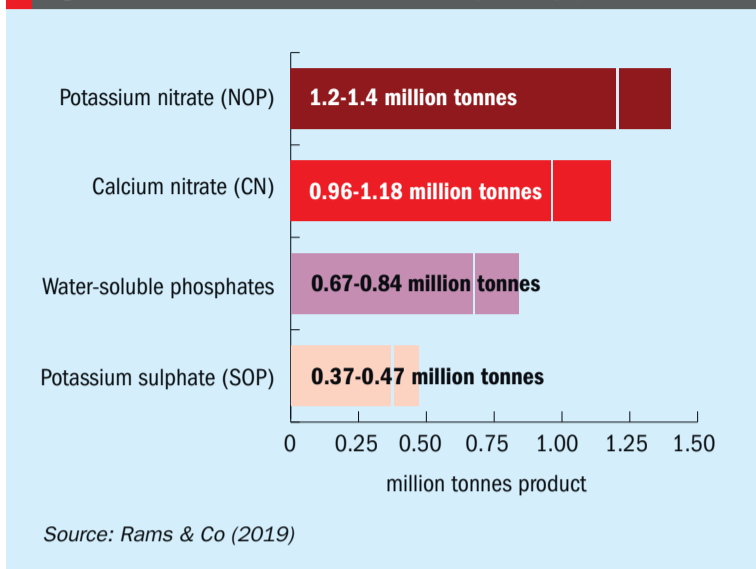


Fig. 3: Water-soluble fertilizer consumption by product, 2018



of Chinese agriculture – including tighter environmental regulation, rising labour costs and efficiency improvements – also offers favourable growth prospects¹.

Water-soluble phosphates

The water-soluble fertilizer market is divided between four main product categories (Figure 3):

- Potassium nitrate (NOP)
- Calcium nitrate (CN)
- Water-soluble phosphates
- Potassium sulphate (SOP)

The manufacture and sale of water-soluble phosphate products has grown into a sizeable global market of almost one million tonnes – a sales volume that is roughly equivalent to 30 percent of the total world market for WSFs². Main products include:

- Monoammonium phosphate (MAP, 12-61-0)
- Monopotassium phosphate (MKP, 0-52-34)
- Phosphoric acid
- Diammonium phosphate (DAP, 18-46-0)
- Urea phosphate (UP, 18-44-0)
- Polyphosphates

MAP and MKP combined account for almost 90 percent of world consumption. MAP is the dominant product in the global marketplace, with a market share of more than 70 percent² (Figure 4).

Monoammonium phosphate (MAP)

MAP is by far the most widely produced and consumed type of water-soluble phosphate globally. World consumption is around 680,000-690,000 t/a, with China alone accounting for almost six-tenths of

the global market. The EU, Latin America – particularly Brazil and Mexico – and Mediterranean countries such as Turkey also represent sizable regional markets for water-soluble MAP (Figure 5).

Average global growth in the water-soluble MAP market (4-5% p.a.) masks distinct regional variations. Much strong growth prospects in Asia (14% p.a.) contrast with the more stagnant growth rates (1-2% p.a.) seen in the mature markets of North America and the EU.

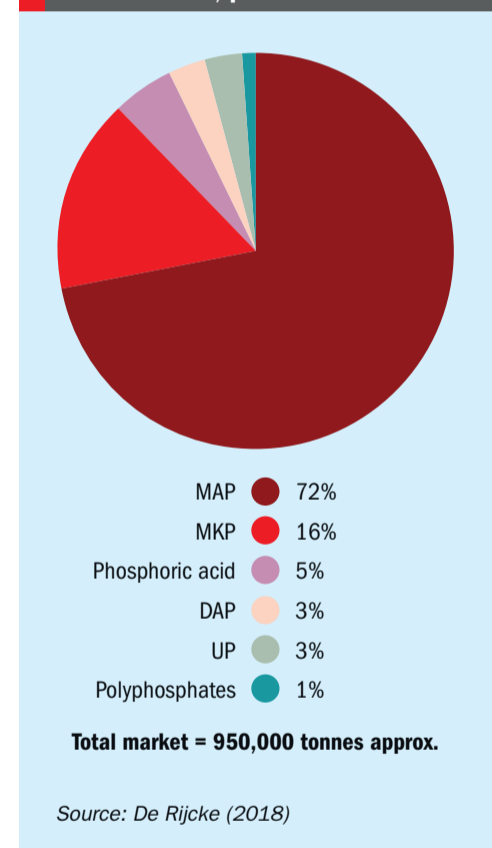
Global water-soluble MAP production capacity is circa 695,000-745,000 t/a, with the majority of this capacity (400,000-450,000 t/a) being located in China. Major global producers include:

- Prayon: 70,000 t/a capacity
- Israel's ICL Specialty Fertilizers and Haifa Group: combined 75,000 t/a capacity (including MKP)
- Russia's Uralchem, GMZ and EuroChem: 70,000 t/a capacity combined
- North America's Innophos: 50,000 t/a capacity
- China's Kingenta: 30,000-40,000 t/a capacity

Prayon has been manufacturing horticultural phosphates in Europe for over 40 years. The Belgian company markets a comprehensive range of water-soluble fertilisers. These were consolidated under the single *Hortipray*[®] brand in 2011. The *Hortipray*[®] range of fertilizer products are designed for application to fruits, vegetables, flowers and plants by fertigation. All these products are recognised for their purity and high solubility. They include:

- Monoammonium phosphate (MAP)
- Monopotassium phosphate (MKP)
- Potassium nitrate (NOP)

Fig. 4: Water-soluble phosphate market, product basis



- micronutri Fe
- Pbooster

Notably, Prayon also markets the *Hortipray*[®] *anticalc* range of water-soluble fertilizers for fertigation. The Belgium-based producer offers *anticalc* versions of both of its standard *Hortipray*[®] MAP and *Hortipray*[®] MKP fertigation products:

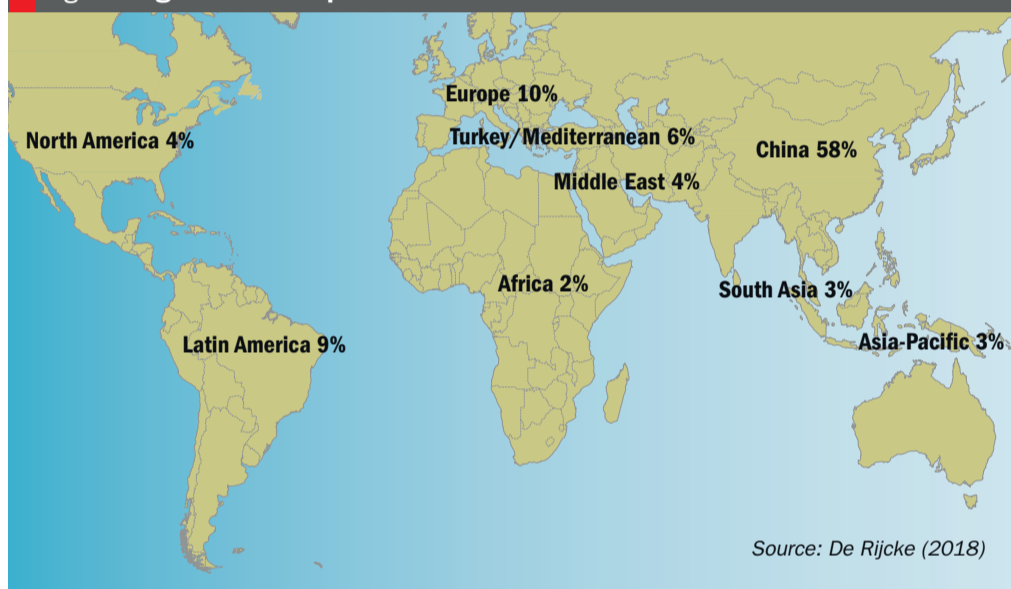
- *Hortipray*[®] MKP *anticalc* contains 52 percent phosphorus (P₂O₅) and 34 percent potassium (K₂O) and has a solubility of 230 g/L at 20°C

Table 1: Main types of water-soluble phosphates

	Mono-ammonium phosphate	Mono-potassium phosphate	Urea phosphate	Phosphoric acid
Abbreviation	MAP	MKP	UP	PA
Formula	NH ₄ H ₂ PO ₄	KH ₂ PO ₄	CO(NH ₂) ₂ ·H ₃ PO ₄	H ₃ PO ₄
N-P-K content (%)	12-61-0	0-52-34	17.5-44-0	0-61-0
Solubility at 25°C (g/l)	410	260	1,104	670
SI	30	8.4	55	51
pH (0.1% solution)			2.5	2.2

Source: various

Fig. 5: Regional consumption of water-soluble MAP



Source: De Rijcke (2018)

- Hortipray® MAP anticalc contains 61 percent phosphorus (P₂O₅) and 12 percent nitrogen (as NH₄) and has a solubility of 384 g/L at 20°C.

Both Hortipray® anticalc products are designed to ensure continuous and uniform irrigation and avoid the unnecessary loss of water and nutrients. Their anticalc properties prevent the build-up of lime-scale and phosphates on irrigation pipes and the growth of bacteria. This reduces the risk of blockages and uneven irrigation. It also extends the life of irrigation pipes.

Monopotassium phosphate (MKP)

Monopotassium phosphate (MKP) is sold commercially as a fertilizer, food additive and fungicide.

Fertilizer-grade MKP is a high-analysis product (0-52-34) that provides plants with a concentrated supply of both potassium and phosphorus. MKP is primarily marketed

as a speciality fertilizer for use on high-value crops, to justify its premium. Its high purity and water solubility make it an ideal fertilizer for fertigation – hydroponics in particular – and foliar application.

MKP is a highly-concentrated source of both P and K with a total nutrient content of 86 percent. Applications help to increase the sugar content of fruit crops and improve their quality. Its use is especially valuable in situations where nitrogen fertilisation needs to be limited.

MKP is fully water-soluble with a low salt index and is free of chloride, sodium and other deleterious constituents. It can be used as a buffering agent in fertigation solutions due to its moderately low pH. MKP helps to optimise the plant absorption of nutrients by maintaining pH at 4.5.

MKP is the most expensive type of water-soluble product on the market (average cost of \$1,700/t in 2017, for example). Total world production is in the region of 160,000 t/a, with China responsible for

roughly one-third (50,000-60,000 t/a) of global production volumes. Major import markets include the US, Netherlands, Thailand, Italy and Belgium.

Outside of China, leading MKP suppliers Israel's ICL Specialty Fertilizers (Nova PeaK) and Haifa Group (Haifa MKP) both have the capacity to produce around 35,000 tonnes of MKP annually, with Belgium's Prayon (Hortipray MKP) producing a further 20,000 tonnes each year. Yara International (YaraTera Krista MKP) is another notable producer.

ICL is one of the largest manufacturers of MKP fertilizers worldwide. The company markets Nova PeaK (0-52-34), a high-purity MKP product that quickly and completely dissolves in water. This is manufactured via an exclusive ICL-owned technology to ensure maximum quality. Nova PeaK has the highest phosphorus concentration of any straight fertilizer available on the market. The product can be applied to any type of crop and is suitable for any fertigation system. Nova PeaK offers the following benefits:

- The highest concentration phosphorus fertilizer on the market
- Very low salt index (150-300 ppm sodium level)
- Very safe for fertigation applications (drip irrigation, hydroponics, sprinkles, pivots) or foliar spraying, being free of chlorine, sodium and impurities, without the risk of phytotoxicity or leaf burn
- Buffering effect stabilises the pH of nutrient solutions
- The absence of nitrogen permits nutrient application at the optimum P:K ratio for growth stages – such as rooting, flowering, fruit set, ripening and harvest – where lower nitrogen levels are required.

ICL markets Nova PeKacid (0-60-20) as a PK fertilizer for hydroponic growing and open-field horticulture. This fully soluble and strongly acidifying crystalline powder is ideal for fertigation on calcareous soils and/or hard irrigation water. It can be mixed in the same tank as other water-soluble fertilizers containing calcium and magnesium. Nova PeKacid also has valuable anti-clogging properties and can boost nutrient uptake due to its acidic nature.

Most edible crops grow well at a pH 5-6.5. In fertigation, therefore, the pH of the water supply and, even more importantly, the pH of the substrate/soil has a major impact on crop growing success.

The pH of the substrate influences nutrient uptake by the plant. High pH, for

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example, limits the uptake of iron, leading to leaf yellowing and production loss. The pH of the water supply is also important as this directly impacts the solubility of fertilizers. In addition, it can cause precipitation within systems, leading to blocked drippers, causing additional problems.

The high amounts of bicarbonate in hard irrigation water is another critical factor, as this will increase the pH of the substrate during long crop cycles. Rising pH can be prevented, however, by using an acidifying product such as ICL's *Nova PeKacid* to take out bicarbonate.

To help growers to easily adjust the water pH to the desired level, ICL has developed the *PeKacid Advisor* app. This free downloadable app takes into account the initial water pH and bicarbonate levels to calculate the adjustment needed to reach the desired pH.

Yara's *Krista MKP* is a free-flowing, finely-crystalline water-soluble fertilizer that can be applied to a wide range of horticultural crops. It makes an ideal source of phosphorus and potassium during late applications to fruiting plants, when nitrogen applications need to be controlled. The product dissolves quickly in water, making it suitable for both foliar application and fertigation use, including hydroponics, drip systems, low throw sprinklers, centre pivots and spray units.

YaraTera Krista MKP can be used in combination with nitrogen fertilizers such as calcium nitrate (in a separate stock tank), potassium nitrate, ammonium nitrate and urea. Its buffering behaviour stabilises the pH of fertigation solutions (pH 4.5) and increases the effectiveness of pesticide sprays. Foliar applications can help suppress leaf diseases such as powdery mildew.

Urea phosphate (UP)

Urea phosphate (UP) is highly-acidic soluble NP fertilizer produced by reacting urea with phosphoric acid. It is essentially a crystalline and nitrogen-containing form of phosphoric acid. Its high acidity can be both an advantage and a disadvantage. In hard water regions, the 'anticalc' characteristics of UP solutions are useful for preventing blockages in pipes and nozzles in drip irrigation systems. Conversely, the corrosive nature of UP solutions is potentially damaging unless drip irrigation systems are properly protected with resistant materials.

Due to these characteristics, the global market for UP is niche and relatively-small,

just 28,000-29,000 t/a according to some estimates. Dubai-based SQM Vitas (*Ultrasol Magnum P44*) operates 30,000 t/a of production capacity. Manaseer Group also runs a 25,000 t/a UP production plant in Jordan.

EuroChem subsidiary AB Lifosa opened a new €14 million UP plant at Kedainiai, Lithuania, in 2018. The 25,000 t/a capacity plant will produce crystalline UP, adding to existing production of water-soluble DAP and MAP at the site.

Innovation

Monband (Hebei Monband Water Soluble Fertilizer Co), founded in 2009 and headquartered in Shijiazhuang, Hebei, was one of the first Chinese companies to register and produce water-soluble fertilizers. The company has been one of China's biggest suppliers of technical-grade MAP and water-soluble fertilizers since 2013. It currently operates six water-soluble fertilizer production lines with a combined annual output of 60,000 tonnes. These produce water-soluble MAP, MKP, NOP, NPK with micro-nutrients and SOP.

Monband also produces 20,000 tonnes of granular fertilizers annually from two production lines, and has a further three production lines dedicated to liquid fertilizers. Its main product lines include ammonium sulphate, calcium nitrate, technical-grade MAP and MKP.

The company exports around 50-60 percent of its output, supplying speciality fertilizers to more than 50 countries globally. Its main international markets are South-east Asia (50%), Africa (30%) and South America (20%).

Prayon has been a notable innovator in the water-soluble phosphate market, developing and introducing new products such as anticalc MAP and MKP.

Prayon's latest products harness the properties of polyphosphates. These polymerised compounds sequester calcium and magnesium, reducing precipitation at high pH, helping to keep irrigation systems clean. By improving phosphorus uptake, polyphosphates also allow phosphate to be applied more efficiently, according to Prayon.

Pbooster (0-48-47), for example, is a water-soluble fertiliser developed by Prayon for crops grown without soil in hydroponic environments. *Pbooster* is designed to completely substitute for standard hydroponic products such as MKP and phosphoric acid. The product's combination of polyphosphates and orthophosphates,

prevents phosphate from precipitating with calcium, magnesium and trace elements. Polyphosphates are also more stable at higher pH than orthophosphates, acting to prevent the formation of insoluble precipitates above pH 6-6.5. Overall, *Pbooster* guarantees phosphate availability, ensuring healthier plant roots. The polymerised phosphate present:

- Does not precipitate
- Does not react with other nutrients
- Is always available, even at high pH.

Polyphosphates are also incorporated in Prayon's *micronutriFe* product. This innovative micronutrient-enriched WSP has proved to be a highly effective iron fertilizer compared to standard chelated products. Two years of trials have demonstrated the efficiency of *micronutriFe* in growing tomato, cucumber and strawberry crops hydroponically.

Historical growth set to continue

The adoption of water-soluble fertilizers is part of a wider shift to more lucrative speciality products within the global fertilizer market. More than 20 million tonnes of speciality fertilizers were consumed globally during 2018, excluding micronutrient products. Although this still represents a minor – if growing – proportion of overall sales volumes, the higher margins achieved by speciality products generated \$5 billion in added-value for fertilizer producers¹.

Historical growth in the WSF market (circa 6% p.a) has been driven by the adoption of drip irrigation, as well as wider market factors such as the need for crop quality and yield improvements, better water and nutrient use efficiency, and environmental concerns over greenhouse gas emissions and eutrophication. Looking ahead, positive growth looks set to be maintained, supported by production cost reductions and technological advances. There are early indications that the rise of speciality products more generally signals a fundamental shift away from commodity fertilizers (market de-commoditisation) and their future move into the mass market as mainstream, standard products¹. ■

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Water-solubles: rising star of the speciality market

As the rising star in the fast-growing speciality plant nutrients market, smart fertilizer producers are expanding their water-soluble product portfolios. **Sana Boulabiar** and **Matias Navarro**, Veolia Water Technologies North America, explain the attraction.

Speciality products for speciality crops

Two agricultural sector trends link together the popularity of speciality fertilizers with speciality crops. Firstly, growing interest in healthy eating and rising disposable incomes are driving up the consumption of fresh fruits and vegetables, leading to an expansion in horticulture devoted to speciality crops. Secondly, these intensively-cultivated and sensitive crop types are also increasingly grown using micro-irrigation or hydroponic systems, often within greenhouses.

Both trends are boosting demand for highly-soluble products that can be injected into irrigation or hydroponic systems to directly supply fruit and vegetables with nutrients alongside water – a practice known as fertigation.

Meanwhile, conventional fertilizers that are less soluble and more impure are increasingly falling out of favour, as the chemical impurities present can damage roots and foliage. Their insoluble content can also damage expensive micro-irrigation equipment by clogging subsurface drip lines and emitters, impairing operations and incurring significant repair costs.

Water, water everywhere – but for how long?

Agriculture will increasingly have to compete with other users to access water. By 2050, for example, more than half of the world's projected population of 9.7 billion people will live in water-stressed regions, according to MIT researchers. Consequently, flood irrigated land, which represents about 37

percent and 34 percent of the total arable land in China and India, respectively, will need to undergo large-scale conversion to more water efficient systems that minimize water usage. These include modern precision agriculture methods such as micro-irrigation (drip irrigation). Such methods optimise soil moisture conditions while delivering greater efficiencies in land and water usage. Although the micro-irrigation market has traditionally been dominated by Europe, the future growth potential lies in Asia-Pacific where China and India apply drip irrigation to just 0.6 percent and two percent of their arable land, respectively.

As a consequence, the adoption of water-soluble fertilizers is gaining pace (Figure 1) as growers look for higher returns. Their use is also being driven by

more investment in micro-irrigation infrastructure, greater regulatory scrutiny over nutrient losses, and the growth in fertigation and foliar application. The burgeoning value of the water-soluble fertilizer market – estimated to be above \$15 billion currently – means it is gaining the attention of most fertilizer majors.

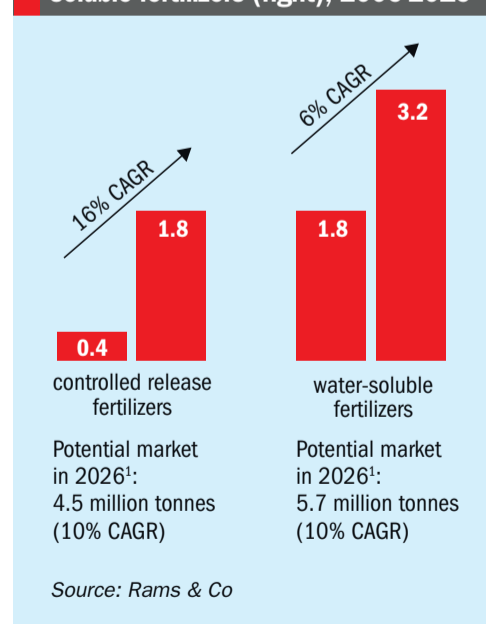
Water-soluble fertilizers, the rising star

Water-soluble fertilizers exhibit a range of highly desirable properties. Their purity, efficacy as plant nutrients, overall handling properties and long-term thermal stability are all superior to other formulations.

Water-soluble fertilizers, despite their attractiveness, have generally been regarded as a niche segment of the overall market. Yet there is good evidence that this is beginning to change. Research by consultants CRU shows that, of the top 10 NPK grades currently placed on the market by fertilizer producers globally, the second and third most frequently offered types are NPK 18-18-18 and 20-20-20, respectively, both of these being water-soluble fertilizers. Similarly, CRU's research also shows that water-soluble MAP (12-61-0) is now the second most offered NP grade worldwide. While, for PK grades, soluble MKP (0-52-34) topped the ranking as the most offered grade globally.

This authoritative analysis, being based on product data from around 50 of the world's largest compound NPK producers, demonstrates how the growing availability of water-soluble NPK grades is challenging the dominant market position of other formulations such as NPK granules and blends.

Fig. 1: Growth in market for controlled-release fertilizers (left) and water soluble fertilizers (right), 2006-2016



The power of crystallisation

Of all the many categories of speciality fertilizers entering the market – ranging from controlled-release and slow-release fertilizers (CRFs and SRFs) to stabilised nitrogen fertilizers (SNFs) and micronutrient products – crystalline water-soluble formulations are emerging as the hottest-selling products on the global fertilizer market due to their high performance characteristics. Being fully-soluble, highly-pure (typically >99%wt), with very low-to-zero levels of sodium, chlorine or heavy metals, and also largely free of the insoluble impurities (usually less than 0.1%wt) that can clog spray and dosing systems, they are an excellent match for the needs of modern farmers.

As a result, established crystallisation processes are currently experiencing a renaissance. This is being spurred by renewed interest in reliable production technology for water-soluble fertilizers that is capable of meeting product requirements for purity and solubility. One of the main advantages of crystallisation technology is its ability to consume lower-grade raw materials as feedstocks, even waste streams, and convert these into high-value fertilizer products. The ability to accept such feedstocks, without additional pre-treatment steps, delivers a huge cost saving to fertilizer producers. The reuse of low-grade or waste materials also fulfils sustainability criteria.

One powerful example of crystallisation's capabilities is the conversion of merchant grade phosphoric acid (MGA) into water-soluble phosphate products. This process can be specifically designed to achieve targets for purity, crystal shape and size to match a particular application. Crystallisation technology also comes with proven production results and low process risks.

Crystallisation is also an effective production process for the manufacture of high-quality water-soluble SOP (sulphate of potash). A range of different feedstocks of varying quality can be used to produce SOP crystals. Sodium sulphate brines or other natural brines, including polyhalite brines ($K_2SO_4 \cdot 2CaSO_4 \cdot MgSO_4 \cdot 2H_2O$), schoenite brines ($MgSO_4 \cdot K_2SO_4 \cdot 6H_2O$) and even kainite brines ($KCl \cdot MgSO_4 \cdot 3H_2O$), are all suitable. Another option is to manufacture SOP from the waste streams of pulp and paper mills. In this process, glaserite (a double salt of SOP and sodium sulphate) is initially recovered via a black liquor ash treatment system and then converted into high-quality SOP crystals for fertilizer use. Whatever the feedstock option, the crystallisation process holds the key when it comes to controlling the purity and the size of the final SOP crystals.

The production of crystalline fertilizers can be a complex endeavour. That makes proper screening and evaluation to identify the best process option – one that is able to deliver the desired quality and solubility – essential. Fertilizer producers therefore need to choose technology and equipment providers with proven expertise in both process development and commercial scale-up. Only providers that combine hands-on laboratory know-how with relevant industrial experience have the capability to build on their previous crystallisation project successes and reproduce them reliably and consistently.

Veolia helps fertilizer producers position themselves in the speciality fertilizer market by diversifying their portfolios and lowering their reliance on traditional commodity products. Forward-looking producers can now seize higher-margin opportunities in the fast-growing horticultural market by producing – thanks to Veolia's leading-edge *HPD*[®] crystallisation technologies – speciality products both profitably and sustainably. ■

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Weir employees discussing the pump house at a mine in Finland.



PHOTO: WEIR MINERALS

Weir Minerals: the engineering experts

Weir Minerals has the global engineering expertise to tackle the world’s harshest and most extreme mine and quarry environments. These range from Canada’s frozen north to tropical Indonesia and the remote deserts of Chile, Mongolia and Australia. This expertise extends to Florida’s phosphate mining district, where a dedicated multi-disciplinary team is delivering an integrated approach to some tough mining challenges.

Engineering expertise has always been the driving force behind the success of Weir Minerals, ever since brothers James and George Weir invented the Weir boiler feed pump in 1871, founding what would later become the Weir Group.

For almost 150 years, Weir has built its business on the principle that if something’s worth doing, it’s worth doing right – and to do something right in mining, you need the right team.

An integrated approach

Today, Weir Minerals assembles and deploys bespoke multi-disciplinary teams to reliably resolve even the most intractable customer problems. Known as Integrated Solutions teams, these combine

diverse experience from comminution to tailings, from chemistry to hydraulics.

“We need integrated solutions now more than ever. With this approach, we continually listen to our customer’s pain points and identify ways in which we can improve their process,” says John McNulty, Vice President of Global Engineering and Technology at Weir Minerals. “Integrated Solutions also aligns closely with the Weir Group’s sustainability strategy. We often talk to our customers about the challenges they face in terms of energy consumption, water usage and waste, and brainstorm ways in which we can help reduce their environmental impact. In the current climate, this approach is absolutely critical.”

When confronted with a problem that requires more than a single piece of

equipment, Weir Minerals draws on its Integrated Solutions teams. These are made up of process engineers, design engineers, product experts, materials scientists, supply chain and logistics experts, as well as local sales teams who know the customer’s site back to front.

These multi-disciplinary teams make sure that a problem is considered from all perspectives. This ensures that potential issues and opportunities to optimise the circuit are identified, with upstream and downstream benefits.

Expertise for every mine and quarry

With almost 10,000 employees operating in more than 50 countries, Weir Minerals can build teams with working experience of every kind of mine and quarry – in environments ranging from Canada’s frozen Oil Sands region and Indonesia’s rain-prone coal mines to remote deserts in Chile, Mongolia and Australia.

In Florida’s phosphate mining region in the United States, Weir’s Integrated Solutions team has revealed how understanding and selecting the right type of equipment and equipment materials is important as well.

“While material selection always plays an important role in selecting the right

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equipment, it's a particularly important task in the phosphate industry," says Paul Mattson, a Process Optimization Engineer for Weir Minerals.

"Not only does the phosphate industry face high erosion concerns, as all of the mining industry does, it also faces high corrosion concerns. The best materials for corrosion and the best materials for erosion do not typically overlap, making the importance of material selection that much more critical."

Nothing is impossible, even crocodiles!

In addition to selecting the right equipment and materials – to provide maximum efficiency and wear life in any given situation – the wide-ranging expertise within Integrated Solutions teams allows them to troubleshoot and provide tailor-made answers to particular problems, according to the local situation and circumstances. Examples include flying in equipment when roads freeze in winter, finding ways to prevent crocodiles climbing onto floating equipment, or turning waste products like tailings into a resource.

"For us, we believe nothing is 'impossible' and we continually look for better ways of doing things," says Seda Kahraman, a Regional Process Engineering Manager for Weir Minerals.

"Our team is made up of specialists each possessing different process systems' expertise including, but not limited to: troubleshooting, designing tools, and process simulation programs. We combine this wealth of knowledge to deliver innovative solutions that address our customers' varied needs."

Unique interdisciplinary expertise

The key to Weir Minerals' Integrated Solutions approach is the collaboration between an entire team of experts. This ensures that the root causes of a customer's challenge are identified and that all the contributing factors are fully scoped. This is where Weir Minerals' unique interdisciplinary expertise has proved to be invaluable.

Teams typically perform process audits during site visits to identify bottlenecks. They then advise on the most appropriate solution for the customer using flowsheets, mass balances, 3D layouts, and feasibility studies. The aim is not just to resolve the problem the customer came to Weir Minerals with, but to go beyond this and optimise their process as well. By saving energy, reducing water and waste, or increasing capacity, this ultimately saves the customer money.

About Weir Minerals

Weir Minerals employs more than 8,900 people worldwide, delivering end-to-end solutions for all mining, dewatering, transportation, milling, processing and waste management activities. Annual revenues were more than £1.2 billion in 2014. Weir Minerals has an advanced product range incorporating brands such as *Warman*® centrifugal slurry pumps, *GEHO*® PD slurry pumps, *Linatex*® rubber products, *Vulco*® wear resistant mill linings, *Cavex*® hydrocyclones, *Trio*® crushers and screens, *Enduron*® comminution equipment, *Isogate*® slurry valves, *Multiflo*® mine dewatering solutions, and *Lewis*® Pumps.

Expert Integrated Solutions teams from Weir Minerals deliver reliable and efficient mining solutions to customers, based on the company's industry-leading equipment. ■



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Potash players adapt to the Covid crisis

IMAGE: NHEMZ/SHUTTERSTOCK.COM

The fertilizer industry's 'essential' status is no barrier to bearish pricing, according to **Andy Hemphill**, senior markets editor for potash at ICIS Fertilizers.

The global fertilizer industry has endured the hardships and uncertainty thrown up by an unprecedented global pandemic better than most. Yet there is no denying that potash market players have felt the disruptive influence of Covid-19.

As one of the world's most-used stock fertilizers – with a global name plate production capacity for muriate of potash (MOP) north of 69 million t/a and around 53 million tonnes traded annually – potash is a commodity trusted by agribusinesses across the planet.

Conversely, in contrast to its widespread demand, potash supply is controlled by a small number of producers located in just handful of countries, namely Russia, Canada, Israel, Jordan, Germany and Belarus.

As Covid-19 spread internationally, this combination of a massive global market supplied by a limited number of large-scale producers has worked in favour of the potash industry by helping the sector avoid the logistical difficulties faced by the less consolidated nitrogen and phosphate sectors and many other industries.

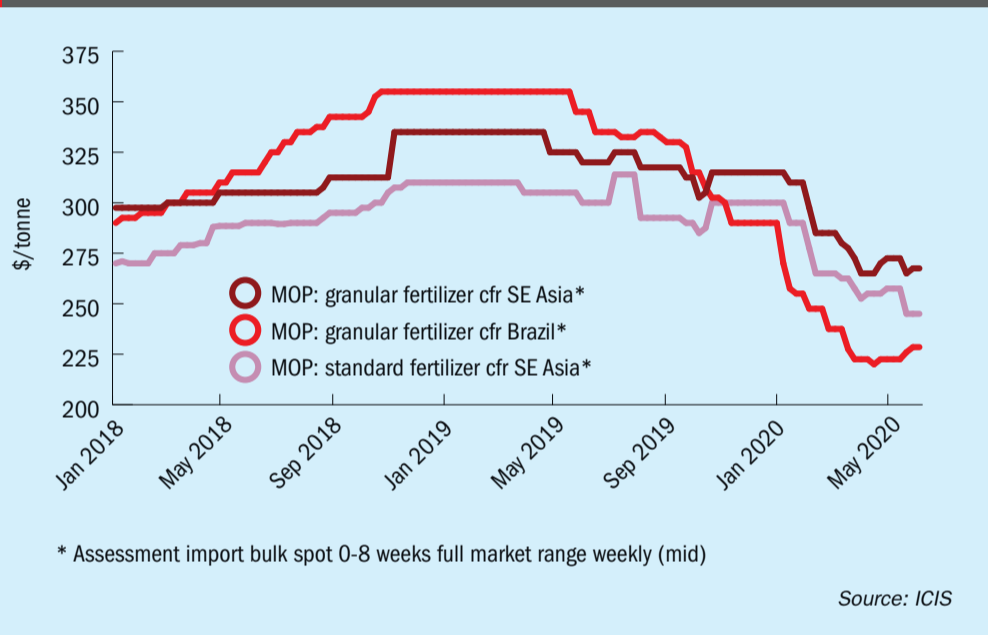
Before the storm

The global potash market entered the Covid-19 pandemic having ended 2019 in a difficult position. Producers publicly announced cuts to production towards the end of last year – a traditional response to the slower period, demand-wise.

That said, potash producers were arguably too slow in acting to curb output in 2019. This was especially true given the already high inventory levels in Brazil, a key potash import market, and with Chinese importers played the waiting game on their next long-term import contract.

These factors combined to leave the potash market somewhat long on supply as 2020 approached. In the pre-pandemic

Fig. 1: MOP cfr spot prices, January 2018 – May 2020, for Brazil (granular, standard) and Southeast Asia (granular)



start to the year, the general consensus was the potash market would remain inactive until March, at least.

Southeast Asian buyers were stalling purchasing decisions, awaiting news of a new bellwether Chinese settlement. In India, meanwhile, key importing companies, tired of waiting for China, had instead settled their own six-month supply contract at \$280/t cfr (cost & freight). While this was down \$10/t on the 2019 agreement, it only covered a six-month period of 2020.

The market responded soon after by showing signs of recovery. Indian buyers actively purchased cargoes, Southeast Asian powerhouse PT Pupuk Indonesia snatched up large tonnages – albeit low-priced material from Laos – and Brazilian warehouse draw also increased.

But these green shoots were not to last. Values quickly slipped again, depressed by weak demand as nations awoke to the threat of the Covid-19 spreading in their

midst. The resulting civilian lockdowns, plant closures, port *force majeure*s, workforce restrictions, and fluctuating exchange rates caused a month or more of unexpected disruption.

The 'new normal'

From the chaos came limited clarity for the potash trade. Most governments classified fertilizers as 'essential goods', which stripped away some of the logistical snags and allowed improved transport of potash from mine to field. The likes of Russia and Belarus cut through red tape, ensuring the big-name players could keep trading with relative ease.

That left the industry with one key hurdle to overcome – the slow degradation of potash prices at points across the globe (Figure 1). A price descent that Belarus Potash Company (BPC) set out to nip in the bud with a surprising announcement.

On 30th April, BPC revealed it had settled a contract with a consortium of Chinese buyers for the long-term supply of standard-grade MOP fertilizer in 2020 at a price point of \$220/t cfr (*Fertilizer International* 496, p8).

The agreement – a \$70/t decline on the previous benchmark of \$290/t cfr agreed for 2018-2019 – took many players by surprise, with one Southeast Asian distributor describing the decrease as “amazing” and “beyond predictions”.

Although potential decreases of \$30-50/t were heard to be on the table for this key bellwether deal, in the event such predictions proved to be too conservative.

Announcing the contract as “a vital step”, BPC said: “The price of the new China contract builds a firm foundation for the stabilisation, recovery and further incremental development of the global potash market.”

Rival Russian potash producer Uralkali, however, was distinctly unimpressed. “The price agreed is not appropriate either for the length of that particular contract, or for the industry as a whole,” Uralkali judged.

“Potash producers incur high investment costs to maintain existing production capacities and develop new deposits. This activity is necessary to meet the growing global demand for fertilizers,” Uralkali added.

Then, just two weeks after news of the Chinese benchmark deal, the global potash market watched on with interest as the Indian settlement arrived.

This six-month supply agreement was finalised at \$230/t cfr – a \$50/t slide on the last agreement – but \$10/t above China’s benchmark deal. This further cemented “the basement of the market”, as a Latin American sales chief of one potash major told ICIS.

Onwards and upwards?

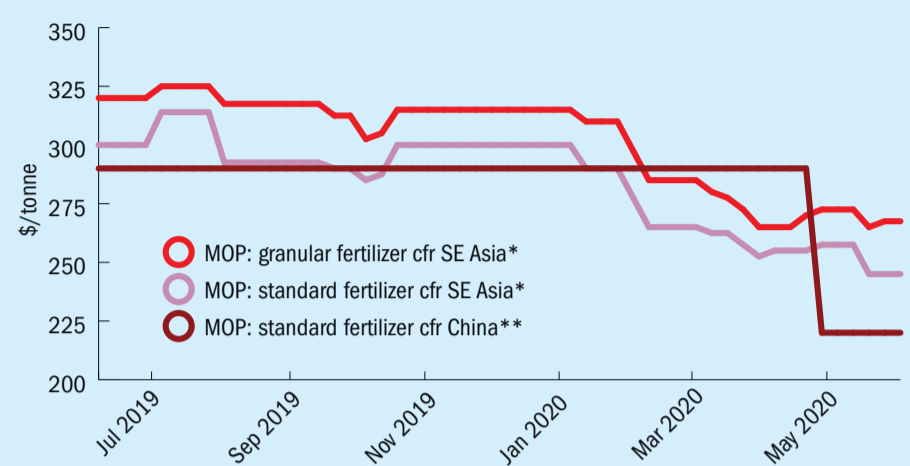
Now, as 2020’s third-quarter approaches, two schools of thought have developed in the global potash market.

One school holds that the China and India settlements are a useful jumping-off point for trade, and a secure bottom to the market in a time of uncertainty.

However, another rival school of thought is that these contract price declines undercut the future stability of the potash industry, at a time when the world and the industry is facing future ambiguity ahead.

Indeed, this divergence of opinion and market ambiguity has been reflected in pricing.

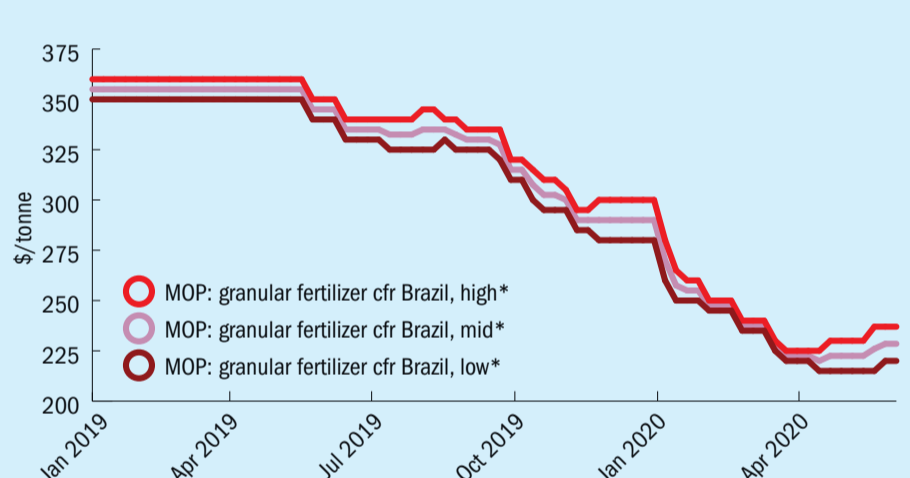
Fig. 2: China six-month contract settlement vs Southeast Asia MOP cfr spot prices (granular, standard), July 2019 – May 2020



* Assessment import bulk spot 0-8 weeks full market range weekly (mid)
 **Assessment bulk contract half year contract survey quarterly (mid)

Source: ICIS

Fig. 3: Weekly range for Brazil granular MOP cfr spot price, January 2019 – May 2020: low, medium and high



* Assessment bulk spot 0-8 weeks full market range weekly

Source: ICIS

In Southeast Asia, many palm oil plantations, most notably in Malaysia, feeling the pressure of fluctuating crude palm oil (CPO) futures and returns, continue to delay potash applications.

When combined with the decline in China’s long-term agreement, this has seen bids for both standard- and granular-grade potash drop abruptly (Figure 2), leaving producers with little room to manoeuvre in talks.

Conversely, the other side of the coin is that Brazilian demand has become increasingly healthy throughout 2020 – even though the threat of coronavirus-related disruption continues to loom large over the nation. Brazil’s logistics are particularly vulnerable as its reliance on trucks for transport could leave the market paralysed, should drivers opt to remain home to pre-

serve the health of their families.

Potash majors sold June and July Brazil MOP cargoes at \$230/t cfr, and have pushed up price levels by \$10/t for August, September and October offers.

That said, compared to the highs seen in Brazilian granular pricing in 2019, sales into Latin America’s agricultural powerhouse still have some way to go (Figure 3).

Second wave spectre

Overall, the potash market has withstood the trials of the Covid-19 pandemic with relatively little disruption thus far. But few in the market are confident that no more difficulties lie ahead, especially with the potential spectre of a second wave of infections on the horizon. ■

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ISSN: 0015-0304

Design and production:
JOHN CREEK, DANI HART



Printed in England by:
Buxton Press Ltd
Palace Road, Buxton, Derbyshire,
SK17 6AE
© 2020 – BCInsight Ltd

BCInsight

Published by: BCInsight Ltd
China Works, Unit 102,
100 Black Prince Road,
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