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Fertilizer Latino Americano, Mexico City

Mexico's fertilizer market

Coffee crop nutrition

Potash project listing

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The Mexican market



Potash projects

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Get the message



“While we do need to proudly tell the story about how our industry feeds the world, #FertilizerDay should be about more than that. Importantly, it gives us a chance to listen.”

Every journalist has a favourite story about press officers, and vice versa. Politicians can be scathing too. Former UK government minister Chris Mullin was famously surprised that despite his department having 118 press officers not a single one could turn out a decent speech.

My own experience as a journalist – prior to joining this industry I should add – is that press officers typically fall into one of two categories: good and no good, with no place for indifferent. Why is that?

Well, the most likely explanation is that corporate cultures also tend to be one of two types. They can, for example, be inward-looking and tight-lighted, preferring to safeguard and covet information as a default.

The other corporate ethos is to be more engaged, public-facing and open. That comes from a recognition that, in the information age, if you don't go out and tell your own story then others will fill the vacuum and do it for you instead. And the tale they tell might not be favourable or fair to your company or industry.

Put simply, while some press officers welcome external dialogue, others prefer to think of themselves as uncommunicative gatekeepers, the silent guardians of corporate reputation.

In reality, corporate communications often have to fluctuate between both these two extremes. So a reasonable riposte might be: “What makes you think you could do a better job?”

Well, the good news for our industry is that once a year we do all get to be a press officer for 24 hours. On Global Fertilizer Day, everyone has special permission to be an ambassador and tell our story to the world.

Celebrated on October 13th each year, Global Fertilizer Day commemorates the filing of the patent for ammonia production by Fritz Haber in 1908. Some 110 years later, the industrial production of fertilizers on a vast scale globally has brought enormous benefits to world agriculture and society.

Now in its third year, the popularity of Global Fertilizer Day continues to grow. Social media site Twitter, in particular, is where most people and companies now congregate on the day to tweet their views and share positive stories about fertilizers using the hashtag #FertilizerDay.

This industry has much to celebrate. So it's been inspirational to witness so many enthusiastic reactions to Global Fertilizer Day. It has also given me

pause for thought. Here are some of my reflections about how our day of celebration could grow and develop in future:

Yes, we do need to get on the front foot and proudly tell the story about how our industry helps feed the world. But #FertilizerDay should be about more than that.

Importantly, it gives us a chance to listen – to farmers, the public and, yes, even our most staunch and vocal critics too. As well as listening and reflecting, the day can also show that the fertilizer industry is capable of responding, by changing how we operate and do business.

To be sincere and credible on #FertilizerDay, we need to show we're fully committed to sustainability, nutrient stewardship and tackling climate change. That includes both the concrete actions being taken today, and how we're preparing to go further in future. We should show humility, in my view, saying we can, and will, do better.

The day has rightly become a great rallying point for celebrating our role in putting ever more food on the global dinner plate, and at the same time becoming increasingly environmentally-responsible as an industry. But there is no real reason why we can't go further and use the day as a springboard – and have a valuable conversation about how to make this more than a single day out of 365.

One idea might be to start a Global Fertilizer Day Foundation – something that we as individuals and companies could pledge donations to. The proceeds could be used throughout the whole year to help support sustainable farming, fund food waste prevention, and stock food banks.

That's just one idea. I'm sure there are plenty of others. Communicating with the public, as any press officer will tell you, is a two-way street. So the next time we shout out and celebrate our industry, why not show we can get the message too? ■

S. Inglethorpe

Simon Inglethorpe, Editor



Solutions for Phosphoric Acid, P and K Fertilizers production and related businesses

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- In house technology for the design and supply of **Single Super Phosphate** and **Triple Super Phosphate** (powder and granular) production plants
- Cooperation with key European technology oriented companies such as Incro and GEA for the design and supply of **SSP/TSP, NPK, MAP/DAP** (granular and crystal water soluble) production units
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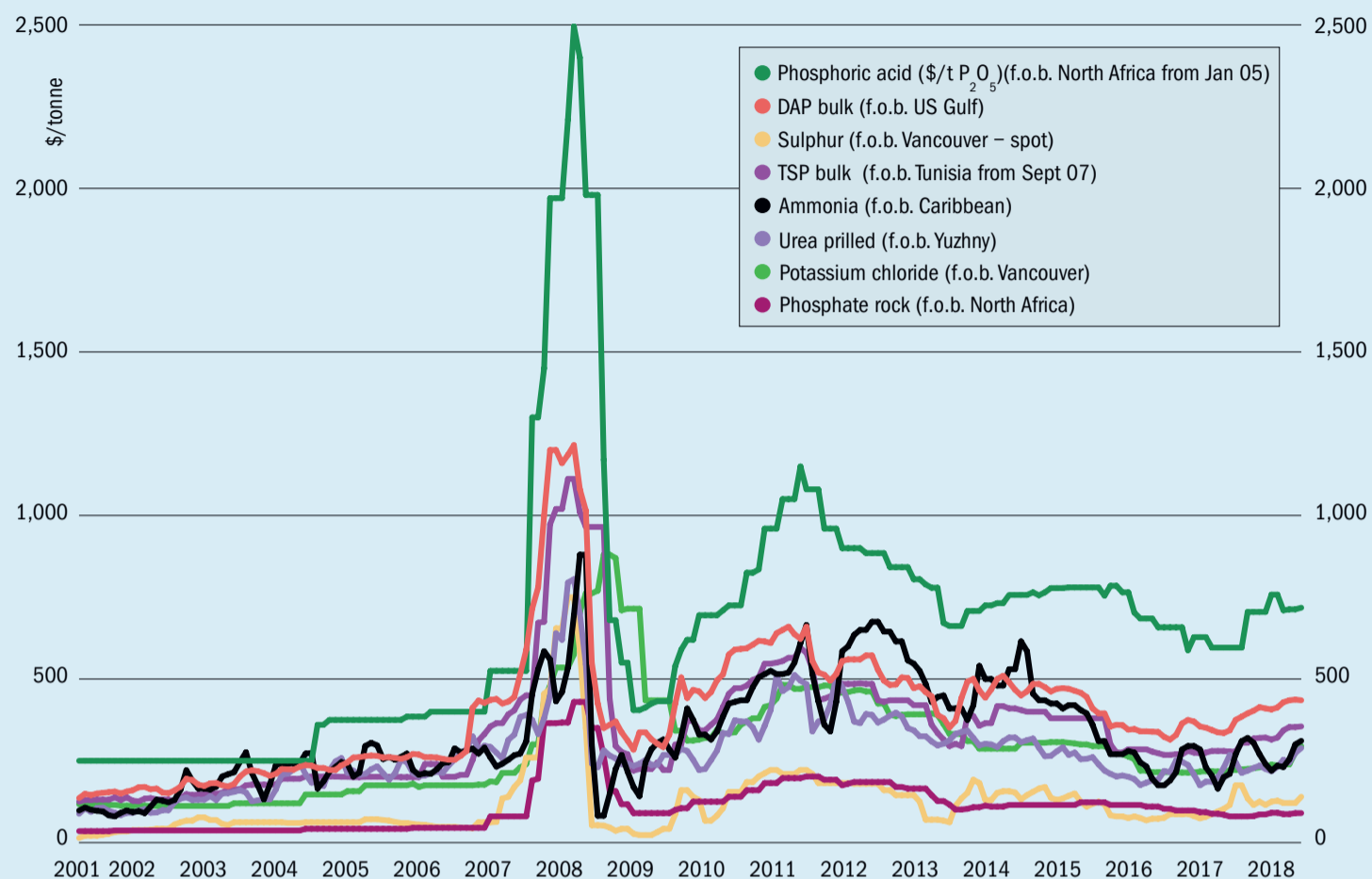
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Market insight

Historical price trends \$/tonne



Source: BCInsight

Market insight courtesy of Integer Research

PRICE TRENDS

Urea: Prices rose throughout the third-quarter on a tightening market affected by looming US sanctions on Iran and rising energy costs. The imminent reintroduction of sanctions is making the purchasing of Iranian product increasingly difficult for buyers in South Asia, East Africa and Europe. Energy prices rises in both the seaborne LNG market and the European spot market have prompted higher producer costs in Europe and gas shortages in Pakistan and Bangladesh. Urea prices in Egypt and China pushed towards \$350/t f.o.b. in October. The collapse of emerging market currencies, particularly in Turkey, is one cloud on the horizon. The increased cost of credit for Turkey's importers and farmers has reduced Turkish import business to almost zero over the last two months.

Ammonia: Building on a strong summer performance, prices continued to increase through September and into October.

Recent ammonia plant restarts have, however, brought more supply to the market and eased pressure on Asian f.o.b. benchmarks. The PAU plant in Indonesia continues to ramp-up production, while the Yara Pilbara plant in Australia has now restarted after an extended maintenance closure. DAP/NPK plant turnarounds at Namhae of South Korea have also helped to ease buy-side pressures in Asia-Pacific. Elsewhere, poor production economics in Europe, caused by \$9-10/MMBtu natural gas prices, have restricted ammonia supply for much of the third-quarter. This has forced efficient European producers like OCI Geleen to favour the use of imported ammonia in urea/UAN/nitrates production, rather than captive ammonia supply.

Phosphate: Upwards price momentum prevailed during September and October, supported by solid demand and limited spot availability. Benchmark DAP prices averaged \$412-443/t f.o.b. at the main hubs, com-

pared to \$418-430/t f.o.b. in August. The strength of the US dollar remains a hot topic. While an overall positive for those commodity exporters holding weakened currencies, it has also made the cost of imported fertilizers and feedstocks increasingly expensive for Brazil, Russia, India and China. Robust Indian DAP buying means the subcontinent is now only half a million tonnes short of its expected import demand total for the year of 5.5 million tonnes. Brazilian MAP demand has been subdued to date, although, with a bumper crop planted, there are still positive expectations that farmers will return to the market in earnest.

Potash: Highly-anticipated supply contracts with India and China were finally settled at \$290/t cfr, up \$50-60/t on 2017. This substantial year-on-year increase reflects the 2018 bull-run in the spot market and prevailing market conditions. Spot prices made a quick upwards adjustment, settling at \$353/t cfr Brazil and \$308/t cfr Southeast Asia, on the back of this settlement. In other news, Indian fertilizer importers Zuari and MCFL both raised the maximum

retail price (MRP) of MOP fertilizers to INR 18,980/t (\$262/t). This helped cover the combined effects of the \$50/t hike in the Indian contract price, the rupee's depreciation and the cut in the Indian government's fertilizer subsidy to potash buyers.

Sulphur: Global sulphur prices have surged in recent weeks, with Middle East spot prices breaching the \$170/t f.o.b. mark in

October – up from the \$130-140/t f.o.b. at the start of August. The three main regional producers posted significant price increases for October reflecting bullish sentiment. Steady price rises across the major regions, prompted by tighter balances due to supply-side factors, have been the overriding market theme. Supply availability has been affected by host of factors, including a preference for lighter sweeter

crudes at refineries, maintenance turnarounds and unplanned disruptions. Vessel availability out of the Black Sea has also been limited for much of the year, adding to spot market tightness. Towards the end of October, however, some buyers started to resist higher prices and retreated to the sidelines. A recent Indian purchase tender agreed in the high-\$180s/t cfr is also evidence of slightly softer pricing. ■

Market price summary \$/tonne – End-October 2018

| Nitrogen | Ammonia | Urea | Ammonium Sulphate | Phosphates | DAP | TSP | Phos Acid |
|-----------------------|--------------|--------------------------------|--------------------------|------------------|------------------|---------|-----------|
| f.o.b. Caribbean | 305-316 | | f.o.b. E. Europe 117-138 | f.o.b. US Gulf | 426-430 | - | - |
| f.o.b. Yuzhny | 335-360 | 280-300 | - | f.o.b. N. Africa | 439-454 | 345-365 | 700-735 |
| f.o.b. Middle East | 340-365 | 320-340** | - | cfr India | 426-427 | - | 758-768* |
| Potash | KCl Standard | K ₂ SO ₄ | Sulphuric Acid | | Sulphur | | |
| f.o.b. Vancouver | 280-309 | - | cfr US Gulf | 98-140 | f.o.b. Vancouver | 160-170 | - |
| f.o.b. Middle East | 272-320 | - | | | f.o.b. Arab Gulf | 170-173 | - |
| f.o.b. Western Europe | - | €500-520 | | | f.o.b. N. Africa | 145-175 | |
| f.o.b. FSU | 255-293 | | | | cfr India | 190+ | |

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.

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MARKET OUTLOOK

- **Urea:** Chinese operating rates and production volumes are declining, with producers concentrating on the domestic market as the country moves towards the winter heating season. Integer expects a significant rise in closure rates through the fourth-quarter. This will result from the redirection of gas towards power generation and residential heating, and environmental regulations limiting operating rates at coal-fired urea plants. Prices look set to rise above \$350/t f.o.b. Egypt again in November, to peak by December, driven by strong South Asian import buying and emerging Northern Hemisphere demand. The combined effects of new Central Asian capacity and falling gas prices should, however, see prices ease in 2019's first-quarter.
- **Ammonia:** The near-term outlook is stable with the market being more balanced than in the third-quarter. Much, however, depends on European gas market developments as well as the direct-application season in the US. Gas prices could push back towards \$10/MMBtu, if the European winter is severe, putting further pressure on ammonia producers who may be forced to reduce output. In November, necessary infrastructure maintenance will mean Trinidadian ammonia producers will once again face gas curtailments of

25-35 percent. This factor should support ammonia prices at current levels in the fourth-quarter, when combined with increased US corn acreage. Uncertainties remain over the future of Iranian exports, specifically methods of payment, when US sanctions come into effect in November. On the supply-side, the commissioning of Eurochem's Baltic ammonia plant at Kingisepp early next year has the potential to push down prices in 2019's first-quarter.

- **Phosphate:** Attractive wheat prices are fuelling DAP trade to Northern Europe, netting back to \$440/t f.o.b. Black Sea. We expect 60,000-100,000 tonnes of DAP to arrive in Europe from the Black Sea over the next two months. OCP raised its fourth-quarter phosphoric acid prices to its JV partners by \$10/t to \$768/t cfr. This potentially makes it cheaper for India to import rather than manufacture DAP. Despite this, Indian DAP buying is still set to slow during the remainder of 2018, as requirements are well-covered. Looking ahead, producer price expectations are generally stable-to-firm, although we are unlikely to see any DAP/MAP business completed above \$448/t f.o.b. during the fourth quarter. The imminent shutdown of Nutrien's Redwater plant should provide some price support going into 2019.
- **Potash:** The market should remain tight over coming quarters, given the slower-than-expected ramp-up up of new mines,

and the growing list of suppliers with limited or no MOP spot sales availability. K+S has downgraded Bethune mine's annual production estimates. Production at Vanscoy mine is also expected to fall further following Nutrien's lay-off of 80 workers. BPC and Canpotex are both fully committed on MOP sales until December 2018 and January 2019, respectively. Uralkali, SQM and K+S are also all tight on product. As a result, we expect upward price momentum to continue over the short-term.

- **Sulphur:** The current price run may reach a ceiling of \$200/t cfr in key end-user markets. But any subsequent price correction is likely to be temporary, and not an indication of a shift in market fundamentals. The usual seasonal slowdown in sulphur trade from Canada and the FSU remains a supportive factor for pricing going into winter. Robust sulphur imports into Brazil and Morocco remain bright spots on the demand front. In terms of sulphur supply, we expect to see further increases in export availability from Kazakhstan's Kashagan project in 2019 – with the project projected to exceed one million t/a production capacity. At the same time, the global supply/demand balance is expected to remain tight into the first-quarter of 2019, pointing to buoyant prices, at least in the short-term. ■

SAUDI ARABIA

Ma'aden launches third phosphates mega project

The Saudi Arabian Mining Company (Ma'aden) has started building its third large-scale phosphates complex ('Phosphate 3').

The company kick-started the project in October by awarding a \$892 million engineering, procurement and construction (EPC) contract for a new ammonia plant to Daelim. The new 3,300 t/d (1.1 million t/a) plant will be built at Ras Al-Khair on Saudi Arabia's eastern coast. The plant will generate ammonia for additional diammonium phosphate (DAP) production at Ras al Khair.

Technology for the ammonia plant is being provided by thyssenkrupp Industrial Solutions, who worked on the plant's front end engineering and design (FEED) and also built all of Ma'aden's other ammonia plants. Completion is set for the end of 2021.

The EPC contract was signed by Darren Davis, Ma'aden's president and CEO, and Heon Jae Yim, Daelim's CEO, in Riyadh.

"Today's announcement is the next step in securing Ma'aden's leadership position in the global phosphate fertilizer market," said Darren Davis. "With today's award and the launch of Phosphate 3, we are building on our existing world-class phosphate business, ensuring that the phosphate resources of the Kingdom are developed efficiently, and delivering a meaningful contribution to the Saudi Vision 2030 goal of economic diversification."

"As a leader in global EPC, it is our pleasure to have another opportunity to work for Ma'aden," said Heon Jae Yim. "With Ma'aden's superb leadership and our accumulated expertise



Ma'aden Wa'ad Al-Shamal Phosphate Company's Umm Wu'al mega project was completed in August 2017.

and know-how in project management, we recently successfully completed the ammonia plant for the Ma'aden Waad Al-Shamal Phosphate Company. We are very proud to once again serve Ma'aden and the Kingdom, and are committed to the success of this new project for Phosphate 3."

Ma'aden's Phosphate 3 project will cost an estimated \$6.4 billion and boost the Kingdom's finished phosphates capacity to nine million t/a on completion.

BRAZIL

Yara completes Galvani ownership

Yara International has completed its purchase of Brazilian phosphates fertilizer producer Galvani (Galvani Indústria, Comércio e Serviços), having bought-out the remaining family stake for \$70 million in October.

Its local subsidiary, Yara Brazil, now owns the single super phosphate (SSP) plant and bulk blending unit at Paulínia outright, together with the under-construction Salitre phosphate project. Salitre has an annual production capacity of approximately 1.2 million tonnes for phosphate rock and 1.5 million tonnes for finished phosphate fertilizers (SSP equivalent).

"This deal streamlines our production footprint in Brazil, securing full ownership of key Yara Brazil production assets, complementing its extensive distribution capabilities and achieving a more integrated position in the Brazilian market," says Lair Hanzen, executive vice president, Yara Brazil.

Yara's agreement with the Galvani family includes a cash payment of \$70 million over a 3-year period on closure of the deal,

and a future payment conditional on project success.

The Galvani family will still own and control the Bahia-based Luis Eduardo Magalhães production plant and the Angico dos Dias and Irecê mines, as well as the Santa Quitéria greenfield phosphate project. These assets now make up a new company worth \$95 million.

Completion of the purchase is conditional on approval from Brazil's antitrust regulator CADE.

CANADA

ICL to sell recovered nutrients

Vancouver-headquartered Ostara Nutrient Recovery Technologies and Israel's ICL Specialty Fertilizers have entered into a long-term sales and distribution agreement and strategic partnership.

Under these new arrangements, ICL will now market and sell Ostara's *Crystal Green*, a struvite-based phosphate fertilizer, into the EU, supplying the turf and lawncare markets.

Crystal Green is recovered from municipal wastewater at 15 plants worldwide

using Ostara's *Pearl* technology. It is a continuous-release fertilizer incorporating the company's trademarked *Root Activated* phosphorus. Advantageously, *Crystal Green* contains virtually no cadmium or other heavy metals. It also only releases phosphorus, nitrogen and magnesium in response to the organic acids produced by growing roots. This ensures that phosphorus is available for uptake when required by plants, while at the same time reducing the environmental impacts caused by leaching and nutrient run-off.

"It is more important than ever before to grow higher quality turf grass with lower inputs, and we at ICL Specialty Fertilizers are dedicated to bringing new products and technologies to our global network that support this philosophy," said Robert van Spingelen, an international marketing manager at ICL Specialty Fertilizers. "Our partnership with Ostara provides ICL Specialty Fertilizers access to a unique, clean, circular economy phosphorus source with a technology that has proven to give better rooting to turf grass than traditional phosphorus sources."



PENXCEL
TECHNOLOGY

Power your innovation with PENXCEL Technology

PENXCEL™ Technology is a unique, patented formulation system to deliver EEF additives for dry and liquid fertilizer. Discovered by a PhD who used similar compounds in human pharmaceutical formulations, the technology has been harnessed to deliver innovative ingredients for agriculture. The PENXCEL system delivers many performance benefits over industry standard formulations.

■ Penetrates Deeper For More Consistent Results

PENXCEL technology delivers active ingredients deeper into solid fertilizer granules more consistently. This innovative formulation allows the use of active ingredients previously deemed “impossible to be coated” on fertilizer. It also works well in liquid fertilizer providing an advantage over powders that stubbornly float on the surface and blow off granules in a cloud of dust.

■ Blends Faster Even In Challenging Cold Weather

Products using PENXCEL technology have low viscosity, so handling is easy. They pump or pour quickly, even in freezing cold temperatures, accelerating blending up to 25% faster than industry standard formulations. Saving time is critical during application season. PENXCEL provides superior performance in high-volume, high-speed mixers. The result is consistent fertilizer products that flow freely and perform in the field.

■ Excels In The Field, Excels In Safety

Field trials have demonstrated superior performance for PENXCEL technology, which has been attributed to more consistent coverage and deeper penetration of the active ingredients. Lab tests show that PENXCEL Technology is safer than the industry standard formulations. The key ingredient’s safety profile, as proven by its use in human medicine, is evident in the results.

Leverage PENXCEL Technology In Your EEF Products For 2018

Want to drive innovation forward? PENXCEL Technology allows you to maximize your existing infrastructure to offer value-added EEF products with minimal investment. For more information visit InnovarAg.com today.

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van Spingelen added: “As phosphorus is recognized by the EU as a critical raw material, ICL Specialty Fertilizers is proud to use this clean phosphorus source derived from recycling.”

“Ostara is forging the path in resource recovery and reuse. Together [with ICL Specialty Fertilizers] we are excited to offer the European market a product that exemplifies the circular economy concept while also improving plant health,” said Molly Biedenfeld, Ostara’s vice president for nutrient market development and sales. “With the EU’s increased scrutiny of cadmium levels and other heavy metal concentrations in fertilizer, *Crystal Green* is uniquely positioned to benefit EU market participants.”

Nutrien closes New Brunswick

Nutrien announced the permanent closure of its New Brunswick potash mine in November, following a strategic review of potash operations.

The New Brunswick site in Saskatchewan has been out of operation since it was mothballed early in 2016. The closure decision will incur a \$1.8 billion write-off cost. The move by Nutrien reflects a shift to lower cost production at its six remaining potash mines in the province.

“The decision to close the New Brunswick potash facility reflects [our] ability to increase potash production in Saskatchewan at a significantly lower operating and capital cost than resuming production in New Brunswick,” Nutrien said in a statement, adding that: “[It] has no impact on Nutrien’s previously announced financial guidance or future global potash sales.”

Nutrien says it remains positive about long-term potash market fundamentals, and its ability to ramp-up production at its other lower-cost Saskatchewan mines to meet growth in global demand.

UNITED KINGDOM

Sirius awards port construction contract

Sirius Minerals has awarded an engineering, procurement and construction (EPC) contract to McLaughlin & Harvey Ltd for a port handling facility at Teesside on England’s North Sea coast.

The contract covers the design-and-build for a 250,000 tonne capacity product storage unit, ship loading equipment, ship outload infrastructure, and the final product screening facility. The contract,

announced in November, was agreed on a lump-sum basis.

The decision means Sirius is close to completing the procurement programme associated with the ‘stage 2’ financing of its Woodsmith polyhalite project. This is currently under-construction at a site near Whitby in North Yorkshire. Only the mineral transport system (MTS) fit-out is now remaining, with STRABAG named as preferred contractor for this.

“We are pleased to have entered into another significant construction contract for the ongoing construction of our world leading polyhalite project,” said Chris Fraser, managing director and CEO of Sirius. “In 18 months we have made great progress and are now nearing the completion of the procurement programme to support our stage 2 financing process.”

The port handling facility will receive polyhalite from the Woodsmith Mine site transported via a 37-kilometre underground mineral transport system, and then processed into *POLY4*, the finished product, at the Wilton Materials Handling Facility (MHF).

Sirius separately announced in October that Jacobs Engineering had secured the engineering, procurement & construction (EPC) contract for the MHF, also located at the port of Teesside. The seven million tonne capacity MHF will crush polyhalite ore and granulate it before sending it to the nearby dock for shipping.

“As the EPC provider for Sirius Minerals, Jacobs is delivering a materials handling facility that is scalable and able to support changing agriculture needs,” said Andrew Berryman, Jacobs’ senior vice president and general manager for mining, minerals and technology. “From the run of mine stockpile to the final product loadout, the materials handling facility will contribute to local and global food supply.”

“Securing a partnership with a company the calibre of Jacobs is great for us and a testament to the world-class nature of this project,” said Sirius’ chief development officer Simon Carter. “Their knowledge of EPC projects in the mining sector is hugely valuable, as is their experience of construction projects on Teesside.”

AUSTRALIA

Jacobs sells energy, chemicals and resources arm

Jacobs has sold its energy, chemicals and resources (ECR) business to Australia’s WorleyParsons for \$3.3 billion.

WorleyParsons secured the deal by offering Jacobs \$2.6 billion in cash and \$700 million in WorleyParsons ordinary shares.

The sell-off will allow Jacobs to focus on high-priority infrastructure and government projects for its two remaining higher-growth and higher-margin business areas: Aerospace, Technology, Environmental & Nuclear (ATEN) and Buildings, Infrastructure & Advanced Facilities (BIAF).

“For Jacobs, this transaction marks... [our focus] on more consistent, higher-margin growth as a leader solving the world’s critical challenges,” said Steve Demetriou, Jacobs chairman and CEO. “The increased financial flexibility we gain from this sale better positions us to invest in our ATEN and BIAF businesses.”

Jacobs will initially use the \$2.6 billion net proceeds from the sale to pay down debt, as well as deploy capital for further mergers and acquisitions. Jacobs bought its US rival CH2M for \$3.27 billion in 2017.

The boards of both companies have approved the sale, which is expected to close in the first half of 2019, subject to conditions and regulatory approval.

SPAIN

OCP buys Fertinagro stake

OCP Group has taken a 20 percent share in Spanish plant nutrient company Fertinagro Biotech.

The stake was secured through the purchase of one-fifth of Fertinagro’s capital by an OCP subsidiary company. The necessary regulatory approvals for the part-purchase have been obtained and the move has also been approved by Fertinagro’s shareholders.

Fertinagro and OCP have jointly signed an intellectual property and know-how license agreement, together with a co-development agreement, as part of the transaction. These will allow the two companies join forces to develop innovative agriculture and plant nutrition products, as well as joint industrial and commercial projects.

“The strategic partnership we concluded with Fertinagro Biotech is a new step towards achieving our global growth strategy focusing on creating innovative, customised plant nutrition solutions,” said Mostafa Terrab, OCP’s chairman and CEO. “Furthermore, this alliance is intended to deliver more opportunities ahead as we grow together, leveraging both companies’ complementary strength and capabilities.”

“OCP’s investment in Fertinagro will open many new opportunities to share knowledge and technologies with farmers, helping them achieve better competitiveness and sustainability,” said Generoso Martin, Fertinagro Biotech’s founder. “We believe the alliance of efficiency, technology and scale brought by this unique partnership will undoubtedly benefit millions of growers around the world.”

UGANDA

Sukulu phosphates plant opens

Uganda’s president Museveni formally opened the Sukulu phosphate project at the end of October

The project is being developed by Guangzhou Dongsong Energy Group as part of a major \$620 million Chinese investment in an industrial complex in Uganda’s Tororo District.

The Sukulu phosphates plant will produce 50,000 t/a initially, eventually rising to 100,000 t/a. The plant is the first in East Africa to produce finished fertilizers from the mining, beneficiation and processing of phosphate rock. Dongsong Energy is also investing in iron and steel production, glassmaking and brick making at the complex.

At the commissioning ceremony for the Sukulu plant, president Museveni, welcomed the money that will be saved by reducing Uganda’s reliance on fertilizer, glass, steel and iron imports.

“In 2013, Uganda was spending \$50 million on importing fertilizers from China but this will stop. We were spending \$23 million on glass per year. All these imports will stop and instead we will be exporting

to the region,” president Museveni said.

The Sukulu project is China’s biggest private investment in Uganda, and the country’s Chinese ambassador, Zheng Zhuuang, thanked president Museveni for supporting Chinese-Ugandan bilateral investments.

Mr Weidong, the president of Dongsong Energy, said completion of the first phase of the project would provide 1,400 jobs, a total that would rise to 3,000 workers once the project’s second phase was finished.

SLOVAKIA

Duslo ammonia plant starts up

TechnipFMC has successfully completed the construction of Duslo’s new ‘Ammonia 4’ production plant.

TechnipFMC’s initially secured the engineering, procurement and construction (EPC) contract for the project in 2014.

The 1,600 t/d plant, located at Duslo’s existing fertilizer complex at Sal’a, is now operational, having previously passed performance tests in July. The plant uses latest-generation Haldor Topsoe technology to minimise energy consumption and cut pollutant emissions. Its completion makes Duslo – part of the Agrofert group – one of Europe’s most energy efficient and least polluting ammonia producers, according to TechnipFMC.

Marco Villa, EMIA president at TechnipFMC, said: “This milestone confirms TechnipFMC’s long-lasting relationship with Haldor Topsoe, the global market leader in ammonia technology and catalysts. The completion of this new generation unit also reflects TechnipFMC’s engineering and construction leadership in the chemical, refining and petrochemical sectors.”

UNITED STATES

EuroChem takes over Trammo assets

EuroChem Group has taken over Trammo’s fertilizer distribution network. This includes substantial transport and storage assets for both dry and liquid fertilizers.

The move substantially expands the Group’s North American distribution network, especially on the US East Coast and in West Canada. EuroChem now operates 25 US warehouses with a combined storage capacity of around 500,000 tonnes.

The US market is an important one for EuroChem, accounting for some 11 percent of sales in 2017. It previously expanded its presence in the US through the acquisition of fertilizer distribution business Ben-Trei in 2015.


“The agreement with Trammo will substantially increase our storage capacity, while also broadening our geographic reach,” said Charlie Bendana, EuroChem’s managing director for North America. “It will support the ongoing expansion of our US business, allowing us to fulfil growing demand from local farmers for high-quality fertilizers.”

Cronus awards ammonia plant contract

Cronus Fertilizers has awarded the engineering, procurement and construction (EPC) contract for its Tuscola, Illinois, ammonia plant to thyssenkrupp Industrial Solutions (TKIS).


Construction on the 2,300 t/d (760,000 t/a) plant is due to start in 2019’s second quarter. The new plant will supply ammonia to farmers throughout Illinois and the US Midwest.


“thyssenkrupp Industrial Solutions is honoured Cronus Chemicals has selected




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us as the designated EPC contractor for their planned 2,300 t/d ammonia plant project in Illinois,” said Dennis Lippmann, CEO thyssenkrupp Industrial Solutions, North America. “We look forward to continuing our partnership and supporting Cronus during the next phase of this exciting project... which will move forward once the financing is completed.”

TURKMENISTAN

Urea plant commissioned

The \$1.6 billion Garabogazkarbamid nitrogen fertilizer complex was officially opened in September by Turkmenistan’s president Gurbanguly Berdimuhamedov.

Located at Garabogaz on Turkmenistan’s Caspian Sea coast, the complex includes a 2,000 t/d ammonia unit designed by Haldor Topsoe and a 3,500 t/d urea plant designed by Saipem. The urea plant also incorporates an Uhde Fertilizer Technology granulation section for product finishing.

The complex, built by Mitsubishi and Turkey’s Gap Insaat, is owned and operated by state-owned company Turkmenhimiya. The site also includes a seawater desalination unit and generates its own electricity from a gas turbine. The complex also has access to a dedicated loading dock fitted with two Liebherr 80 tonne loaders.

LITHUANIA

Water-soluble fertilizer plant opens

EuroChem subsidiary AB Lifosa has opened a new €14 million water-soluble fertilizer plant at Kedainiai, Lithuania.

The 25,000 t/a capacity plant will produce crystalline urea phosphate, adding to existing production of water-soluble diammonium phosphate (DAP) and monoammonium phosphate (MAP) at the site

“The new facility will further strengthen Lifosa’s position in the global fertilizer market,” said Jonas Dastikas, Lifosa’s general manager. “At the same time, the construction of the plant is an investment in the sustainable development of the company.”

RUSSIA

Acron signs fertilizer supply agreements

Acron Group has entered into new fertilizer supply agreements with the regional agriculture departments of Bryansk and Novgorod for 2019.

Acron will supply the two regions, located in western Russia, with a total of 100,000 tonnes of ammonium nitrate and NPK fertilizers next year as part of the deal.

The growing domestic market is becoming increasingly important to Acron and other Russian fertilizer producers. The company supplied Russian farmers with 630,000 tonnes of fertilizers in the first nine months of 2018, up 15 percent on the same period last year. Ammonium nitrate and NPKs remain Russian agriculture’s preferred fertilizers.

Acron chairman Alexander Popov said: “Supplying mineral fertilisers to Russian farmers is Acron Group’s top priority. We sign agreements with regional subdivisions of Agro-Industrial Complex every year to map out our effective cooperation. The Group is ready to satisfy the needs of Russian farmers, and we are confident that it will help produce high yields”.

INDIA

PhosAgro agrees import deal with IPL

Russia’s PhosAgro is to supply the Indian market with up to two million tonnes of fertilizers over the next three years.

The company signed a new agreement to supply Indian Potash Limited (IPL), India’s largest fertilizer importer, with diammonium phosphate (DAP) and NPK fertilizers between 2019-2021. The deal is thought to be worth around \$1 billion for PhosAgro.

In a separate agreement, PhosAgro and IPL, together with the Russian Direct Investment Fund (RDIF), will jointly pursue promising Indian fertilizer investment projects.

Both agreements were signed in October with Russian president Vladimir Putin and India’s prime minister Narendra Modi both present.

PhosAgro CEO Andrey Guryev said: “This cooperation agreement is a significant contribution to... Russian non-resource-based high-tech exports and an additional incentive for further investment in the domestic fertilizer industry, which will strengthen food security in Russia and India, and increase trade between our countries.”

IPL’s managing director, Parvinder Singh Gahlaut, said: “This agreement is an important step in the development of cooperation between our companies and countries in the mineral fertilizer sector. PhosAgro’s products have always stood out because of their high quality and efficiency. This will create significant opportunities for our farmers to increase yields and strengthen the country’s food security.”

PAKISTAN

Urea plants restart

Pakistan has restored gas supplies to three urea plants, in a bid to supply enough urea to meet upcoming Rabi season (October–March) demand.

The government has acted to secure the supply of gas feedstock to fertilizer producers by agreeing to cover 50 percent of the cost of LNG imports. These will provide one-third of the gas required, the remainder coming from domestic sources. This arrangement is temporary, though, and will last only four months.

The country’s previously-idled plants, including those operated by Fatima Fertilizers and Agritech, are expected to produce 300,000 tonnes of urea over the next four months, versus expected seasonal demand of 400,000 tonnes. The government says it will import the remaining 100,000 tonne urea shortfall.

Despite this short-term fix, Pakistan’s fertilizer industry will continue to face gas supply constraints over the longer-term.

Around 90 percent of the country’s urea plant feedstock requirements come from the Mari gas field. This is expected to start depleting in 6-8 years’ time. Three companies, Fauji Fertilizer Company, Fatima Fertilizers and Engro, all depend on Mari gas. They collectively account for some 5.2 million t/a of the country’s total urea capacity of 6.2 million t/a.

OMAN

Omifco mulls third urea plant

The Oman India Fertiliser Co (Omifco) is looking to expand capacity at its Sur ammonia-urea complex.

The company is considering adding a third urea train (1.3 million t/a capacity), at an estimated cost of \$1.0 billion.

Omifco is half-owned by the Oman Oil Co, with two Indian partners, the Indian Farmers Fertiliser Cooperative Ltd (Iffco) and the Krishak Bharati Cooperative Ltd (Kribhco), each holding a 25 percent share. Offtake from the plant is used to supply Indian farmers with urea.

Omifco hopes to complete a feasibility study for the expansion by the end of 2018. Go ahead will be partly conditional on natural gas availability, although the start-up of Oman’s Khazzan project has increased this. Omifco is also considering debottlenecking Sur’s two existing 800,000 t/a ammonia-urea trains as an alternative option.

People

Jochen Tilk stepped down as executive chair of Nutrien, the world's largest crop nutrition company, at the end of September. He also resigned his directorship of the company. He is replaced by **Derek Pannell**, previously Nutrien's lead director, who becomes the company's non-executive chair. Nutrien's board and management thanked Jochen for his strong and effective leadership, and for helping guide the new company during its formation and integration "Jochen's key objectives are well on track and he and the board have decided that it would be the right time to hand over the leadership of the board to an independent chair," Nutrien said in a statement. A decision to appoint a new independent chair is likely to be made around the time of the 2019 annual general meeting, the company confirmed.

Nutrien separately announced the retirement of chief financial officer (CFO) **Wayne Brownlee** at the end of October, bringing to a close what it called "an exceptional career in the sector". Nutrien thanked Wayne for his leadership, and his contribution to the company's creation and its financial strength. Mr Brownlee's successor has yet to be named.

The Mosaic Company has announced several changes to its senior leadership team from the beginning of next year. **Walt Precourt**, currently senior vice president (SVP) for phosphates, will become SVP for strategy and growth, a newly-created role. Walt will lead Mosaic's business development and market & strategic analysis teams in future. He previously served as Mosaic's SVP for Potash. Mr Precourt will

work out of the company's Tampa headquarters.

Bruce Bodine, the current potash SVP, is also moving sideways to become SVP for phosphates from January. Mr Bodine originally joined Mosaic's predecessor company in 1999. He has worked for its potash and phosphates business units in a range of roles previously. Bruce will be based in FishHawk, Florida. **Karen Swager**, who currently works in the phosphates business unit as vice president for minerals, is set to join Mosaic's senior leadership team. She will replace Bruce to become the new SVP for potash. Karen is another long-serving executive, having joined Mosaic's predecessor company in 1994. She was previously the general manager of a number of individual mines and processing plants. Ms Swager will be based in Regina, Saskatchewan, Canada.

"While our potash, phosphates and Mosaic Fertilizantes businesses will remain the central engine that drives Mosaic, innovation and new avenues of growth are also important to our future success, said Mosaic's president and CEO Joc O'Rourke. "I am confident that Walt, Bruce and Karen – all proven leaders – will help Mosaic achieve its remarkable potential in the years ahead."

Mikhail Rybnikov has been appointed first deputy CEO of PhosAgro. He was previously the chief operating officer (COO) and general director of its JSC Apatit subsidiary. Mikhail will take charge of strategic development in his new role. He will also lead on PhosAgro's production investments in its subsidiaries. Mr Rybnikov has

successfully delivered a number of large investment projects for PhosAgro in the past. These include the construction of new ammonia and urea production lines in Cherepovets, an ammonia pipeline in Bala-kovo, NPS fertilizer production in Volkhov, and Kirovsk's second main shaft. **Vladimir Davydenko** has replaced Mr Rybnikov as general director of JSC Apatit.

Celso White has been elected an independent director of CF Industries. His election brings membership of CF's board of directors to eleven. Mr White is currently the global chief supply chain officer of Molson Coors Brewing Company. "We are pleased to welcome Celso to the CF Industries' Board," said Stephen Furbacher, CF Industries' board chairman. "Celso's ... deep expertise in all aspects of the supply chain, understanding of the agriculture industry and background in engineering and environmental, health and safety issues will benefit the board and our management team greatly." Mr White also serves on the board of Colorado UpLift currently. He holds an MBA from DePaul University and an electrical engineering degree from Bradley University.

Nigeria's Notore Chemical Industries appointed **Ohis Ohiwerei** as its new executive director in September, following the retirement of chief financial officer (CFO) **Femi Agbaje**. The appointment means Mr Ohiwerei becomes Notore's deputy managing director and CFO. Mr Agbaje, who joined Notore in 2007, has served as a board director since 2011. He remains with the company as a non-executive director. ■

Calendar 2018/2019

NOVEMBER

28-29

European Mineral Fertilizer Summit, AMSTERDAM, The Netherlands
Contact: Mado Lampropoulou, ACI
Tel: +44 (0)20 3141 0607
Email: mlampropoulou@acieu.net

JANUARY 2019

28-30

Fertilizer Latino Americano, MEXICO CITY, Mexico
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup.com

MARCH

4-7

Nitrogen+Syngas 2019 Conference, BERLIN, Germany
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup.com

6-7

IFA Production and International Trade Meeting, LONDON, UK
Contact: IFA Conference Service, 28 rue Marbeuf, 75008 Paris, France.
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

25-27

Phosphates 2019 Conference, ORLANDO, Florida
Contact: CRU Events
Tel: +44 (0)20 7903 2444
Email: conferences@crugroup.com

APRIL

8-11

IFA Global Technical Symposium, NEW ORLEANS, Louisiana, USA
Contact: IFA Conference Service, 28 rue Marbeuf, 75008 Paris, France.
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org



Fertilizer Latino Americano 2019

CRU Events in collaboration with Argus will convene the 2019 Fertilizer Latino Americano conference at the Hilton Reforma, Mexico City, 28-30 January.

Above: Aerial view of Mexico City skyline from Chapultepec Park.

Mexico City is the bustling, vibrant setting for this year's CRU/Argus Fertilizer Latino Americano conference. The event is the longest running and most influential fertilizer industry meeting in Latin America – and is celebrating its 30th anniversary in 2019.

Fertilizer Latino Americano attracted more than 700 delegates in 2018. The conference offers excellent networking opportunities and is aimed at senior executives from across the international fertilizer supply chain, with leading producers, traders, distributors and consumers all represented. The conference's January timing has always been an advantage, allowing fertilizer companies to meet and do business with key stakeholders at the very start of the year.

The conference promotes commerce, investment, partnership and innovation across the Latin American market. A large-scale exhibition and numerous networking events throughout the conference offer extensive business opportunities.

As its name suggests, Fertilizer Latino Americano has a particular focus on the Latin American region, a large influence on global fertilizer demand, while at the same time having a global reach with attendance from over 50 countries.

The annual conference is a CRU and Argus collaboration and in 2019 has the support of **Anacofer**, the **International Fertilizer Association (IFA)**, **The Fertilizer Institute (TFI)**, **Anda**, **Fertilizar** and **Abisolo**.

Dominic Halahan, CRU's portfolio director for fertilizer events, is looking forward to welcoming delegates to Mexico City in

January: "Latin America is an agricultural powerhouse accounting for 12 percent of total global NPK demand, with Mexico positioned as the second-largest consumer in the region, accounting for eight percent of total consumption. From agricultural land expansions in Brazil to efficiency gains in Mexico, the region's fertilizer industry continues to grow steadily.

"Next year will mark the 30th anniversary of the Fertilizer Latino Americano conference and since the inaugural event we have visited every key market in the region, supporting the industry through bull and bear markets alike. We are expecting 700 delegates to join us in Mexico in January 2019 to trade and barter the fertilizers for planting seasons, to listen to the informative presentations and to help us celebrate the event's 30th edition." ■

2019 SPONSORS:
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SEE YOU IN MEXICO! *Fertilizer International* magazine is proud to be the official media partner for Fertilizer Latino Americano 2019. We will be exhibiting at the event and are very much looking forward to meeting industry friends, both old and new. www.fla-conference.com

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Event highlights and advantages

- A must-attend networking event at the start of the year with representation from all the major stakeholders in the Latin American fertilizer market
- Unparalleled networking opportunities as 700+ senior fertilizer executives from 50 countries meet to discuss market strategies and arrange business deals
- Deepen business networks in Latin America and meet new customers in the Mexican market
- Hear the latest forecasts in N, P & K markets for better business planning
- Learn about the latest developments in: supply, demand, and logistics; the latest technologies; trade; and a dedicated session on speciality fertilizers

Key speakers

- **Balbir Singh Shekhawat**, Head of Development and Agronomy, Indorama Fertilizers
- Speaker to be announced, OCP
- **Chris Lawson**, Head of Phosphates, CRU
- **Andy Jung**, Director, Market and Strategic Analysis, The Mosaic Company
- **Brad Griffith**, Senior Vice President Plant Nutrition, Compass Minerals
- **Armelle Gruere**, Market Analyst, Agriculture Service, IFA
- **Peter Harrisson**, Head of Sulphur & Sulphuric Acid Analysis, CRU
- **Dr Cleiton Sequeira**, Latin America Manager, Agronomy & Sales, Koch Fertilizer

- **Krish Shanmuga**, Global R&I Director, Fertilizers, Novacare Agricultural Specialties, Solvay
- **Rafael Delgado**, Latin American Sales and Technical Manager, Sackett-Waconda
- **Laura Cross**, Head of Nitrogen, CRU
- **Luiz Grossman**, Founder, Optionline
- **Martin Torres Duggan**, Member of the Board of Directors and Scientific Coordinator, Soil Science Association of Argentina
- **María Fernanda González Sanjuan**, Executive Manager, FERTILIZAR
- Speaker to be announced, ICL
- **Dr Nils Berger**, Senior Agronomist Global R&D Premium Products, EuroChem
- **Humphrey Knight**, Potash Analyst, CRU

Conference themes

- **IFA Workshop:**
Latin America outlook and fertilizer demand forecasting
- **Panel Discussion:**
Global investments in Latin American fertilizer markets
- **Panel Discussion:**
Global supply and demand trends in Latin America
- **Focus on innovation:**
Enhanced efficiency products, the role of precision blending in modern agriculture, and the pros & cons of IOT and Big Data for the fertilizer industry
- **Panel Discussion:**
Latin American speciality fertilizer markets

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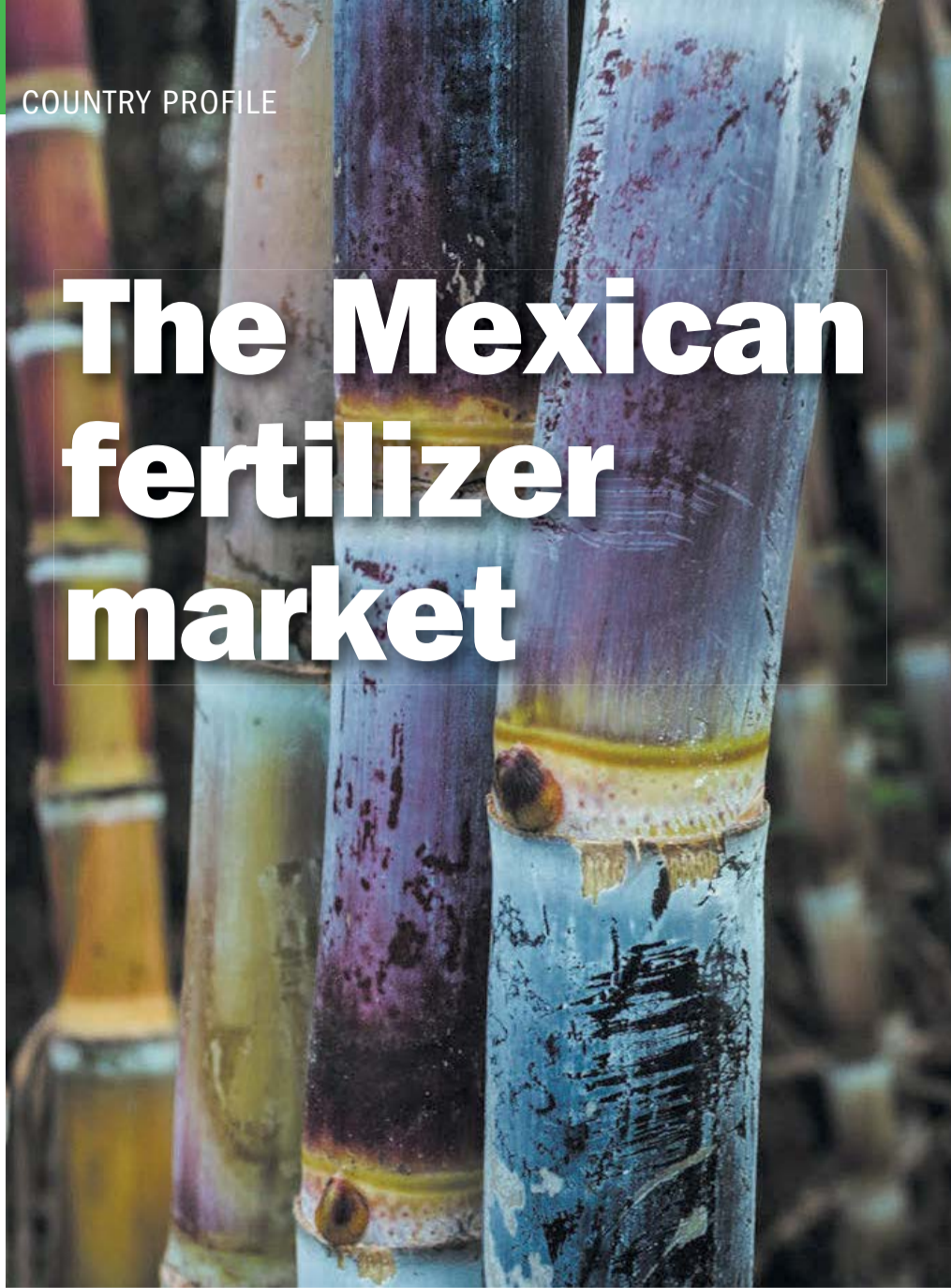
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The Mexican fertilizer market

PHOTO: ICEINK/SHUTTERSTOCK.COM



Sugarcane accounts for nine percent of Mexico's fertilizer consumption.

Mexico is Latin America's second largest fertilizer market after Brazil. Domestic fertilizer production and fast-growing imports support a large and diverse agricultural sector.

Agricultural diversity

With a large land mass and a diverse range of climates, Mexico is well-suited to large-scale agricultural production. Around 16 million hectares of arable land – out of the total of 23 million hectares available – is currently cultivated. Just four crops – corn, sorghum, beans and oats – account for around two thirds of the land area under cultivation (Figure 1). Roughly 80 percent of the country's agricultural is rain-fed, rather than irrigated, and therefore more reliant on seasonal rainfall.

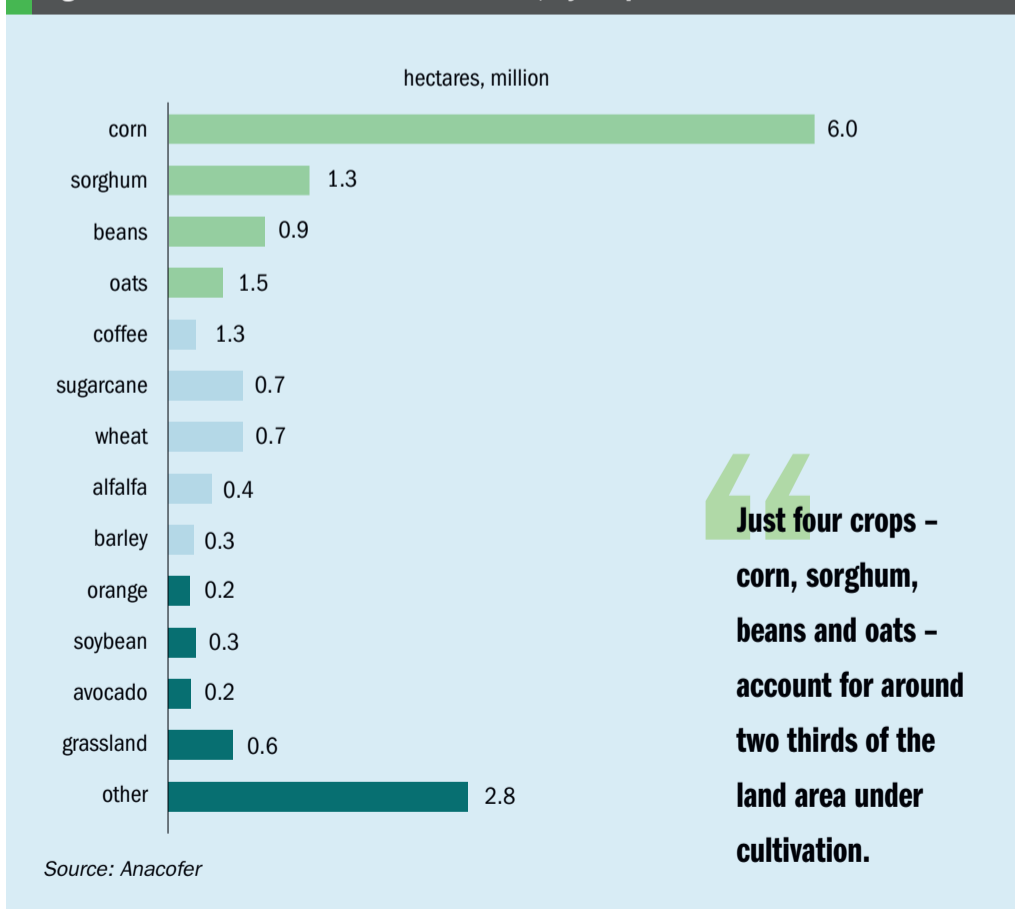
The country is a major producer of avocados, lemon and limes, grapefruit, maize and edible beans. A wide variety of salad crops including tomatoes, cucumbers and peppers are also grown at scale. The production of greenhouse-grown crops, in particular, has expanded, and helped to drive agricultural growth over the last decade.

Although still a major contributor to the economy and employment, agricultural growth has generally failed to keep pace with other sectors of the economy in recent decades. Mexican agriculture grew at annual rate of 1.8 percent between 1993 and 2016, for example, compared to GDP growth of 2.5 percent p.a. over this period. Despite this, the value of the country's agricultural exports reached \$30 billion in 2015. A significant portion of the Mexican labour force (13-14%) is also dedicated to agriculture.

Export success

Mexico is the world's 11th-largest agricultural and livestock producer, and the third-largest in Latin America. The country is notably the world's leading avocado producer and beer exporter and fifth largest

Fig. 1: Mexico: land area under cultivation, by crop



“Just four crops – corn, sorghum, beans and oats – account for around two thirds of the land area under cultivation.”

Fig. 2: Mexican agriculture's North/South divide



egg producer. Mexico's avocado crop has been dubbed 'green gold', with the country responsible for one-third of the total global harvest of 5.8 million tonnes in 2017. In terms of agricultural export growth, the Mexican government has identified two crops, peppers and green chilli, as having particularly strong potential:

- Mexico is the world's third largest green chilli exporter, exporting 1.4 million tonnes valued at \$985 million dollars in 2017
- The country also occupies the first place internationally in the export of peppers, exporting 150,304 tonnes values at \$154 million dollars in 2017

Mexico's combined pepper and green chilli production was 3.2 million tonnes in 2017, a volume that has grown annually by just under five percent on average since 2003.

The country's agricultural and fishing output is expected to grow by about three percent in 2018. The US remains Mexico's main agricultural trading partner, receiving \$25.5 billion, almost 78 percent, of Mexico's total agricultural exports. Mexico's agricultural exports to Canada also exceeded two billion dollars for the first time in 2017, a year-on-year rise of 11 percent.

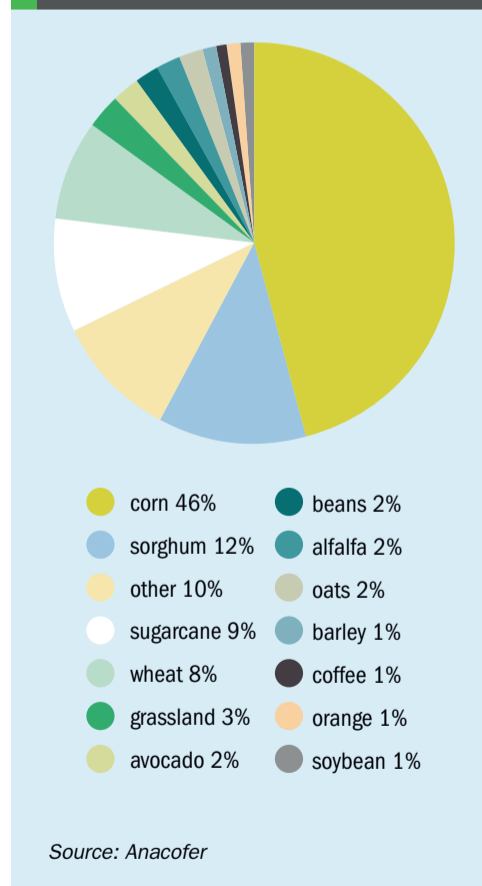
A north-south divide

Agriculture in Mexico's north and north-west regions is more advanced than in the country's south (Figure 2). Farms are larger in size, mostly irrigated (80%), have access to credit, and are predominantly commercial – with a focus on the cultivation of corn, durum wheat, edible beans,

vegetables and other cash crops. Farms in the north and northwest are also over 25 hectares in size on average, compared to the national average farm size of five hectares.

More than half of Mexico's farmland is located in the central highlands. Better transport infrastructure in central Mexico allows farmers to export products very quickly to major markets in the US and Canada. The region's small farmers grow

Fig. 3: Mexico: fertilizer consumption by crop



mainly corn and beans and are highly dependent on irregular rains. The government has attempted to alleviate rain-dependency by promoting the construction of additional reservoirs, ponds and irrigation channels. With the limitations on rain-water availability, especially in the central highlands, production in irrigated greenhouses is increasing rapidly in Mexico, delivering greater yields to farmers and higher quality produce.

Long-standing land tenure arrangements have a major influence on Mexican agriculture. Over 65 percent of all farmers are not land owners but classed as 'ejidatarios' – holders of a share in common land. This form of inherited property rights, which dates back to the Mexican revolution, has undoubtedly held back agricultural growth in the country. Nevertheless, farmers are still leasing more land year-on-year to create larger and more productive farm units.

Agriculture in Mexico's south still faces obstacles to growth. Average farm size remains very low (1-5 hectares) and production is largely subsistence-based, rotating between corn and edible bean growing. Parts of the south, however, are associated with productive commercial farming. Most of Mexico's sugar cane mills are located in the south, for example. Their sugar production (over 6 million tonnes) covers domestic demand leaving some excess for exports. Coffee and banana plantations in the south are also growing rapidly to meet both domestic and export demand.

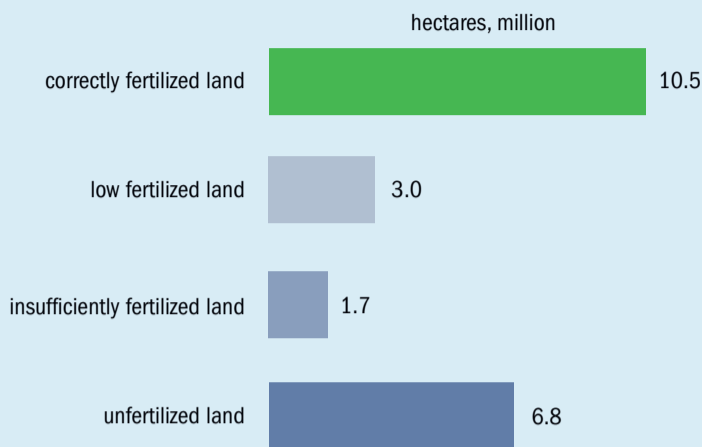
Fertilizer consumption

Increasing fertilizer use has contributed to Mexico's rising agricultural productivity. The application of fertilizers has also contributed to soil conservation and rising renewable energy output through biofuels production, according to Anacofer, Mexico's fertilizer trade association.

Unsurprisingly, given the large acreages devoted to their cultivation, corn, sorghum, sugarcane and wheat together account for three-quarters of Mexico's fertilizer consumption (Figure 3).

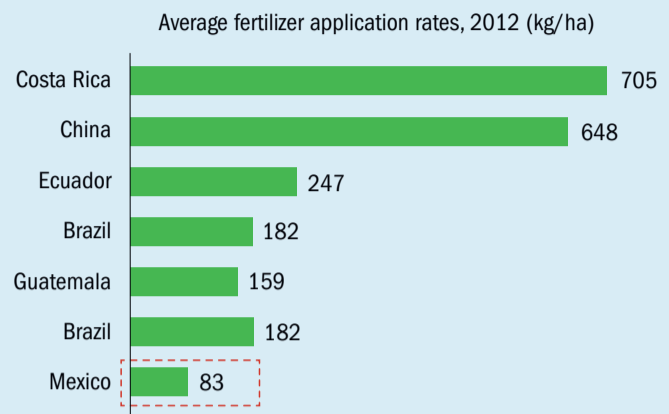
Encouragingly, there is great scope for increasing fertilizer application rates and consumption in Mexico. It is estimated that, out of the 22 million hectares of arable land currently cultivated, only 10.5 million hectares is correctly fertilized and 6.8 million hectares is not fertilized at all (Figure 4). Fertilizer application rates (83

Fig. 4: Area of arable land under fertilization in Mexico



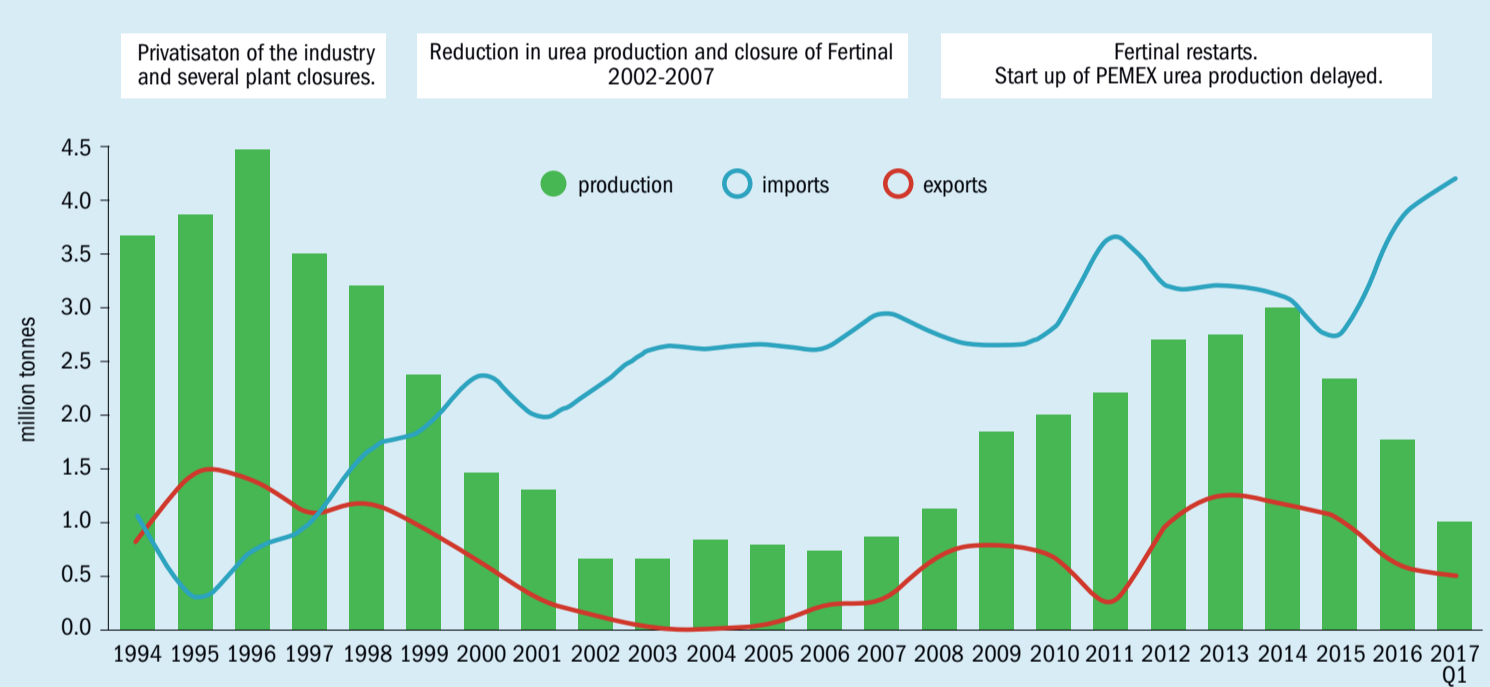
Source: Anacofer

Fig. 5: Average fertilizer application rates, Mexico vs other Latin American countries



Source: Anacofer

Fig. 6: Mexican fertilizer production, exports and imports, 1994-2017



Source: Anacofer

kg/ha) are also low by regional standards (Figure 5).

Mexico is Latin America's largest fertilizer market after Brazil. Consumption stood at 2.194 million nutrient tonnes in 2017, versus 17.185 million nutrient tonnes for Brazil, 1.844 million nutrient tonnes for Argentina and 0.468 million nutrient tonnes for Chile.

Mexico has become ever more reliant on fertilizer import over the last 25 years, with import volumes rising from around one million tonnes to close to four million tonnes currently (Figure 6). Fertilizer imports have risen by almost 50 percent in the last decade alone.

Domestic fertilizer production, in contrast, has seesawed over the last two decades. It rose as high as 4.5 million tonnes in 1996, only to fall below one million tonnes annually in the early 2000s. Domestic production of almost two million tonnes in 2017 was largely focussed on:

- Ammonium sulphate (AS): 838,800 tonnes
- Monoammonium phosphate (MAP): 450,800 tonnes
- Diammonium phosphate (DAP): 374,500 tonnes
- Triple superphosphate (TSP): 312,500 tonnes

While ammonium sulphate production in Mexico is almost exclusively for domestic application, just one-quarter of phosphates production ends up being consumed domestically (c. 278,000 tonnes in 2017) as a large percentage of output is destined for the export market (c. 870,000 tonnes).

According to estimates for 2016, Mexico produced around 1.8 million tonnes of fertilizer – exporting about 0.6 million tonnes of this amount – supplemented by imports of 3.8 million tonnes (Figure 6). National fertilizer consumption, on this basis, is currently in the region of five million tonnes.

Fertilizers imported into Mexico in 2016 (3,776,334 tonnes in total) mainly comprised of:

- Urea: 1,837,180 million tonnes (48.6%)
- DAP: 313,981 tonnes (8.3%)
- AS: 277,609 tonnes (7.4%)
- NPKs: 262,124 tonnes (6.9%)
- Phosphonitrate: 246,756 tonnes (6.5%)
- Muriate of potash (MOP): 196,995 (5.2%)
- MAP: 157,999 tonnes (4.2%)
- Calcium ammonium nitrate (CAN): 120,928 tonnes (3.2%)
- Potassium nitrate: 99,291 tonnes (2.7%)
- Urea ammonium nitrate (UAN): 91,556 tonnes (2.4%)
- Calcium nitrate: 81,185 tonnes (2.1%)

Nitrogen fertilizers make up around two-thirds of all Mexican fertilizer imports, with urea alone being responsible for almost half of import volumes. This preference for nitrogen fertilizers by Mexico's farmers is reflected in the country's out-of-balance nutrient consumption: 1,579,000 million nutrients tonnes for N in 2016 (71%), versus 375,000 tonnes P₂O₅ (17%) and 259,000 tonnes K₂O (13%). When coupled to the

“Nitrogen fertilizers make up around two-thirds of all Mexican fertilizer imports, with urea alone being responsible for half of import volumes.”

country's relatively low application rates, this suggest there is great potential for more balanced fertilization in Mexico – with a shift away from nitrogen to more phosphate and potash use – as well as a growth in overall fertilizer consumption. Moves towards more balanced fertilization would also open up the Mexican market to secondary nutrient and micronutrient products.

Market prospects

Mexico's large agricultural sector offers great commercial potential for fertilizer producers, importers, traders, distributors and retailers. Fertilizer imports, in particular, have shown substantial growth during the past five years. The Pemex-owned phosphate fertilizer plant on Mexico's west coast, and its currently dormant urea plant on the east coast, are gearing up for higher production output, according

to Anacofer. However, the domestic production and availability of ammonia remains an unresolved bottleneck at present.

Looking ahead, Mexican fertilizer demand is expected to grow somewhere between 0.4-1.7 percent annually between now and 2025. Mexico's fertilizer consumption has grown by more than one million tonnes since the mid-1990s, and could grow by as much as 600,000 tonnes again by the mid-2020s.

International companies continue to show an interest in Mexico's sizeable and still growing fertilizer market. Trade association Anacofer is also willing and ready to play a major role in substantially increasing fertilizer usage in the country, by acting as a partner to all participants in Mexico's fertilizer value chain. The association believes this will help Mexico maintain its status as a top global producer of produce such as avocados, berries, tomatoes, green chilli and corn. ■

Acknowledgement

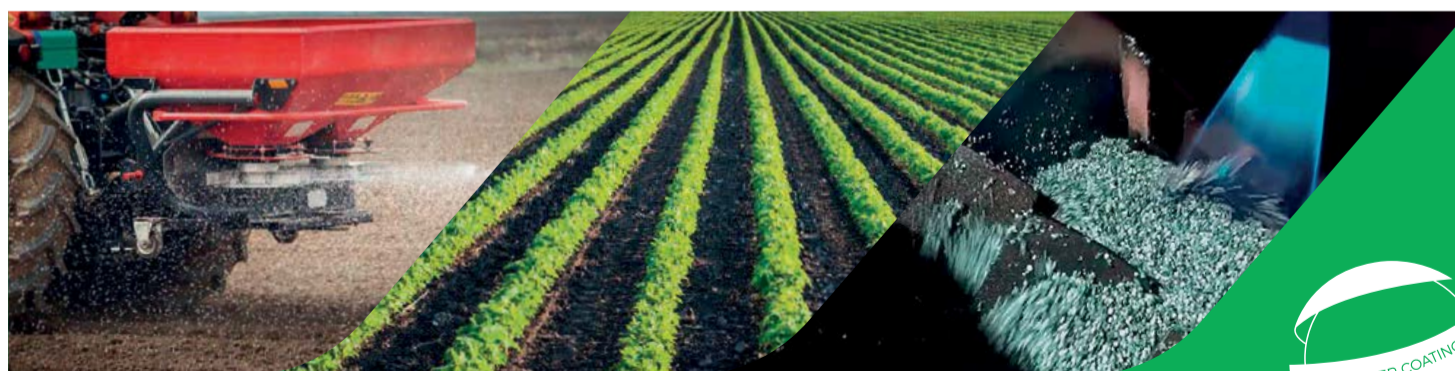
Sara Ormaza Calderon, general manager, Anacofer, and **Juan Beron**, the general secretary, are kindly thanked for their considerable contribution to this article.



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ANACOFER

Anacofer is Mexico's national fertilizer industry association. Founded in 2002, originally as an association of fertilizer importers, the name of the association was changed in 2012 to encompass the whole fertilizer value chain, including producers, importers, traders, distributors and retailers.

Today, Anacofer's membership stands at 18 companies, and its diverse range of members represent the majority of Mexico's fertilizer industry. The association's main mission is to increase domestic fertilizer consumption to strengthen Mexico's status as one of Latin America's most important food producers.

The association's member companies are listed below:

Agrocolmex

Domestic supplier Agrocolmex (Agrocolmex SA de CV) has more than 20 years' experience in fertilizer commercial sales and distribution in central Mexico. The company's product portfolio includes:

- Nitrogen fertilizers: urea, calcium ammonium nitrate (CAN), ammonium sulphate (AS) and phosphonitrate
 - Phosphates: diammonium phosphate (DAP), single superphosphate (SSP) and triple superphosphate (TSP)
 - Potash: potassium chloride (MOP), potassium sulphate (SOP) and Mosaic's K-Mag
 - Specialities: complex NPK mixtures, water-soluble and micronutrient products
- The company also markets soil conditioners and organic fertilizers.

Fertinal/Pemex Fertilizantes

Pemex Fertilizantes is a wholly-owned subsidiary of state-owned oil & gas giant Pemex (Petroleos Mexicanos). The company is divided into three business units:

- **Fertinal:** Latin America's main phosphates fertilizer producer operates the Lázaro Cárdenas plant (1.4 million t/a capacity) and a phosphates mine in Baja California Sur, both on the Pacific coast. The Lázaro Cárdenas plant produces monoammonium phosphate (MAP), diammonium phosphate (DAP), granular triple superphosphate (GTSP) and phosphoric acid, as well as ammonium nitrate, nitric acid and sulphuric acid.
- **ProAgro:** the former Agronitrogenados-owned Coatzacoalcos urea plant (one million t/a capacity) at Veracruz on the Gulf in Mexico. This plant is due re-start urea production in 2019.
- **Cosoleacaque:** this company, also located at Veracruz, is Mexico's only ammonia producer, owning four plants and an exclusive transport pipeline running from the Gulf of Mexico to the Pacific coast.

Fertiquim

Part of Alfa Omega Group, Fertiquim (Comercial Fertilizantes Quimicos SA de CV) is dedicated to the import/export, sale and distribution of mineral fertilizers. The company markets and distributes urea, DAP and potash throughout Mexico, as well as products such as sulphuric acid, granular sulphur and ammonium sulphate (granular, golden and white). Its product portfolio is supported by strategic alliances with international and domestic fertilizer producers and trading companies. Fertiquim's trading, distribution and logistics network allows it to successfully import to, and export from, Russia, Finland, the US, Canada, Central and South America, the Caribbean and parts of Africa and Asia.

Innovación Agrícola

Innovación Agrícola is the largest retailer of agricultural products in Mexico, as well as providing crop production services to farmers via a team of 160 technical advisors. Its portfolio includes crop nutrition (SQM and Yara brands), crop protection, grain seed, irrigation and bioagriculture products. Its own brands include the *Plantoria*, *Platinum Line*, *Esterra* and *Gramidia* product lines. Innovación Agrícola serves Mexico's main agricultural areas, operating more than 40 branches in the states of Sinaloa, Nayarit, Jalisco, Colima, Aguascalientes, Puebla, Queretaro, Guanajuato, Chihuahua, Sonora, Baja California and Baja California Sur.

ISAOSA

Founded in 1996, ISAOSA (ISAOSA SA de CV) is one of Mexico's leading fertilizer import, sales and distribution companies. Acting as an exclusive supplier, its portfolio includes soil-applied fertilizers and water-soluble and liquid products for fertigation and foliar applications. ISAOSA is currently investing more than \$20 million in a new terminal at Tampico port, as well as upgrades at the ports of Manzanillo

and Topolobampo. The company is also strengthening its premium product portfolio to secure its position as Mexico's most innovative agricultural nutrient provider.

Npk Soluciones

Npk Soluciones (Npk Soluciones Para El Agro Y La Industria SA De CV) is a Mexican-owned fertilizer import and distribution company, with a strong network in the country's southern states and central highlands. The company has 25 years of fertilizer business experience, mainly serving the sugar cane industry. Npk Soluciones sells and distributes a wide range of fertilizers including urea, DAP, MAP, AS, MOP, potassium nitrate and NPK blends, including 16-16-16. It distributes products from warehouses located in the ports of Veracruz, Altamira and Coatzacoalcos.

Pacifex Fertilizantes

Pacifex (Pacifex Fertilizantes SA de CV) is one of the top players in the Mexican fertilizer market, importing more than 400,000 tonnes annually. The Guadalajara-headquartered company serves distributors and large Mexican consumers with a wide portfolio of imported nitrogen, phosphate, potash and NPK products, including liquid urea ammonium nitrate (UAN). Pacifex is also the exclusive supplier of nitrogen stabilised *NitroSource*® and *NitroGNS*® products. The company is part of the Gavilon Group, a wholly-owned subsidiary of the Marubeni Corporation. Gavilon's international fertilizer division distributes more than six million tonnes of fertilizers annually. It operates more than 85 storage and handling facilities globally, located in the USA (Gavilon Fertilizer and MicroSource), Mexico (Pacifex), Peru (Inti) and South Africa (Gavilon).

Seferssa

Seferssa (Semillas, Fertilizantes y Servicios SA de CV) was founded in 1960 and

covers Mexico's northwest region, with warehouses and offices in the states of Sonora, Sinaloa, Nayarit and Guanajuato. The company offers a comprehensive fertilizer portfolio, including granular (urea, ammonium sulphate, phosphonitrate, MAP, DAP, MOP, SOP etc.) and liquid products (UAN, phosphoric acid, ammonium thiosulfate, KTS). It is also a distributor for SQM and Yara's water-soluble product lines. Notably, Seferssa provides crop advice to farmers through a team of more than 20 agronomists.

Tepeyac

Tepeyac, a provider of agricultural products and services, was established more than 50 years ago and is located in Obregon, Sonora. This proudly Mexican company specialises in granular and liquid fertilizers, fertilizer blends, agrochemicals, soil analysis and seeds. Beginning as a fertilizer distributor in Sonora's Yaqui and Mayo valleys, the company has since expanded its services and product lines to meet the needs of farmers across Mexico. Fertilizer products include:

- Nitrogen fertilizers: urea, ammonium sulphate, ammonium nitrate, phosphonitrate
- Phosphates: MAP, DAP, TSP
- Potash: MOP, SOP, potassium nitrate
- Liquid fertilizers: UAN, anhydrous ammonia, phosphoric acid, KTS, Nitrosul, Thiosul
- A range of fertigation and foliar fertilizers

Tepeyac is also a supplier of Yara and SQM products.

Tomcompany

Founded in 2014, Tomcompany distributes and markets fertilizers throughout Mexico. Its core business is the import and marketing of nitrogen fertilizers (urea, ammonium sulphate, phosphonitrate) supplemented by the import and distribution of phosphates (DAP, MAP), potash, complex fertilizers and fertilizer blends. With main offices in Mexico City, Tomcompany operates through all of Mexico's major ports, including Veracruz and Altamira on the Gulf coast and the Pacific ports of Topolobampo and Manzanillo. The company describes its business approach as dynamic, proactive and entrepreneurial.

International producers & traders

The following major producers and traders are all active Anacofer members, operating domestic subsidiaries or local offices in Mexico:

- **Fertilizers Samsung C&T:** Samsung currently supplies Mexico with approximately 300,000 tonnes of mainly nitrogen fertilizers annually, largely sourced from China, Korea and the Middle East.
- **Haifa Mexico**
- **K+S Kali GmbH**
- **Koch Fertilizer, LLC:** Koch operates one of Mexico's largest fertilizer terminals, supplying urea to the north and northwest.
- **Nitron:** A leading global fertilizer trader, Nitron's services range from importing to warehousing, blending, packing and logistics.
- **SQM Mexico:** (SQM Mexico, SA De CV). SQM's Mexican subsidiary was founded in 1992. The company is a wholesale distributor of animal feed, fertilizers and agricultural chemicals.
- **Uralkali**
- **Yara Mexico**



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Produquímica & Compass Minerals: together as one

In an exclusive interview, we talk to **Gustavo Vasques**, the president of Produquímica, Brazil's leading manufacturer and distributor of specialty plant nutrient products.

Right place, right time

When Gustavo Vasques was appointed company president at Produquímica, Brazil's leading manufacturer and distributor of specialty plant nutrients, he knew he was in the right place at the right time. Based in São Paulo, Brazil, Produquímica had recently been purchased by Compass Minerals, as part of an ambitious plan to expand its agriculture business throughout the Americas.

Combined strengths

At the time, Produquímica manufactured and distributed a broad range of specialty plant nutrition products. The company had recently launched two new products: *Micro-Active*, an innovative alternative to coating granules of NPK fertilizers with micronutrients, and *Sulfurgran Floresta*, a product that supplies sulphur gradually to reforested areas. Produquímica's portfolio also included micronutrients, controlled-release fertilizers, and a range of specialty products for fertigation, soil and foliar applications and seed treatment.

Compass Minerals, on the other hand, had a thriving sulphate of potash (SOP) business (known as *Protassium+*®), and a loyal following for its industry-leading *Wolf Trax*™ brand – a range of dry dispersible powders for coating fertilizer blends with micronutrients. By joining forces, the newly-combined business is intent on building a crop nutrition powerhouse – one that backs up a sought-after product line with an unwavering commitment to research and innovation.

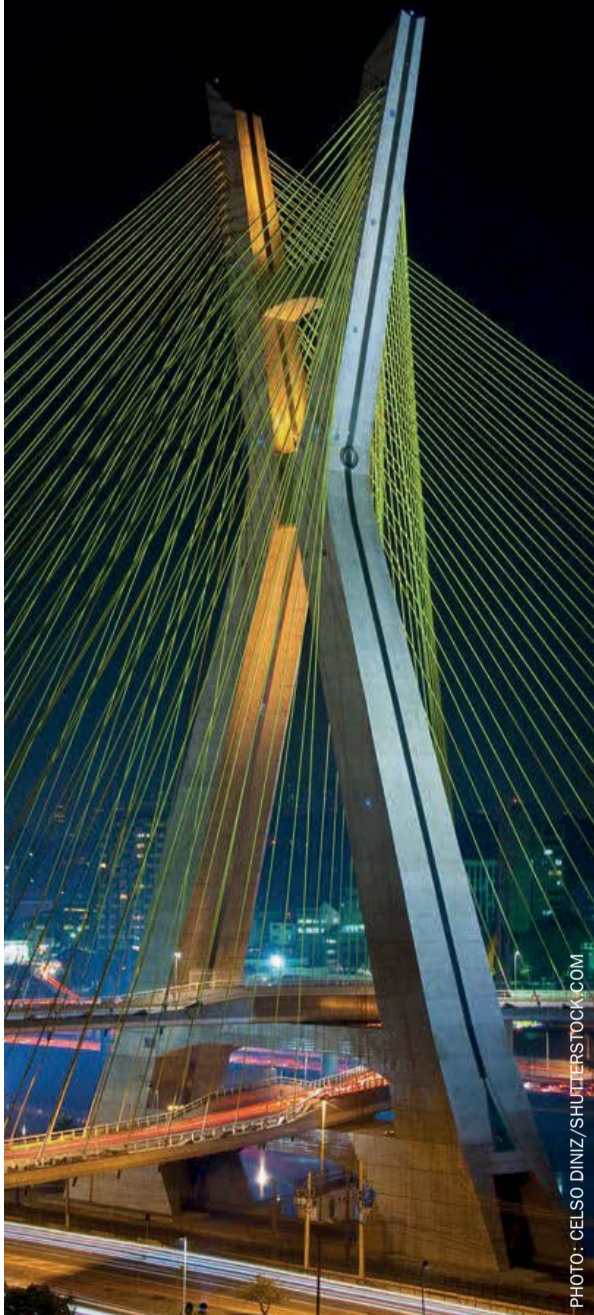
Combining leadership with experience

Vasques brings to the company a great depth of experience in growing agricultural businesses across Latin America, having previously been with Sumitomo Chemical Co., Ltd., the Japanese chemical company, where he served as president, Latin America. Prior to joining Sumitomo Chemical, Vasques spent eight years as the managing director of Georgia-Pacific Corporation's specialty chemicals business. Before that, Vasques served with Monsanto for 10 years in a variety of sales leadership positions.

Compass Minerals credits the leadership shown by Vasques, during its integration of Produquímica, as being instrumental in getting the companies aligned, and ensuring the long-term success of its plant nutrition business in South America. Vasques' current goals include continuing to grow and strengthen the company's South American business, as well as identifying opportunities to fuel growth in North America.

Strategic advantages

When it came to developing plant nutrition products, Vasques knew the joining together of Produquímica and Compass Minerals had distinct strategic advantages. Their collective research and development capabilities were top notch, for one thing. Combined operational capabilities also allowed his team to work as a basic manufacturer – one that was able to go from ideation to formulation to field testing in a very short time. The ability to utilise North American facilities and staff also helped for counter-season field testing. The ability to show growers the company's unique formulation process instils confidence in the quality of products and operations.



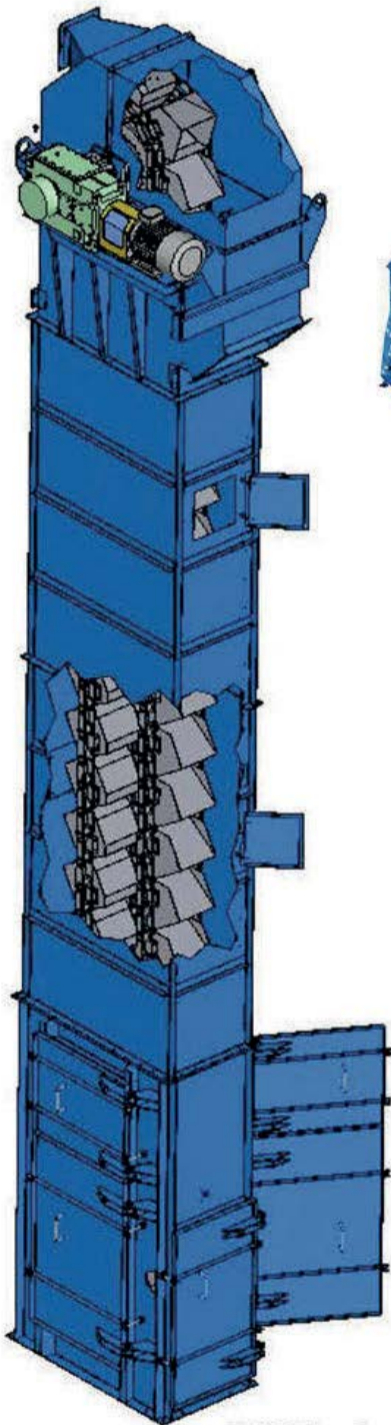
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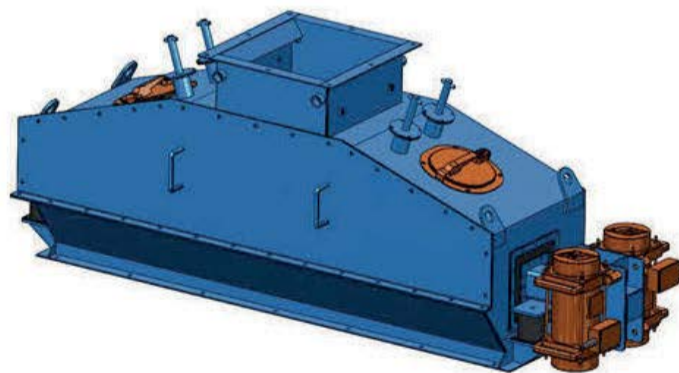
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Fertilizer International talked exclusively to **Gustavo Vasques** about how Compass Minerals and Produquímica are working together, and quizzed him about his vision of the future for specialty plant nutrition.

Compass Minerals acquired Produquímica in 2016. How has that acquisition changed the future of the business?

There haven't really been 'major changes' – only alignment and synergies that have allowed both businesses to thrive and operate more efficiently.

For Compass Minerals, the acquisition immediately expanded the company's portfolio and gave access to premier manufacturing sites and the Innovation Center in South America – although there's now an Innovation Center in North America as well.

For Produquímica, it showcased the company's product expertise – our agronomic and formulation strengths that position us as a global leader in product development, which opened the door with new customers.

In addition to expanding the portfolio, the acquisition also provided better access to higher growth markets like Colombia, Peru, Chile, Bolivia, Paraguay and Ecuador. That meant new business opportunities across hemispheres for both companies, allowing us to operate in different growing patterns and climate conditions. That lessens Compass Minerals' winter weather dependency on the salt side of the business – which is the flagship division, 170 years and running.

The biggest difference, I guess, was distribution. In South America, a large part of our business happens directly with growers. That contrasts with North America, where we move products predominantly through strategic distributors and retailers.

How does the work differ from North to South America?

The biggest difference in the work we do in South America versus North America comes down to growing practices, a reflection of geography. For example, crops like soybeans, coffee, sugarcane and eucalyptus are our focus in South America, and have very different requirements and needs compared to crops in North America. Our research always focuses on essential plant nutrition, while keeping these geographical nuances in mind.

What's currently in the works for plant nutrition research?

We continue to investigate the behaviour of nutrients in the soil, on the seed and



Gustavo Vasques,
president,
Produquímica.

PHOTO: COMPASS MINERALS

on the plant itself. Understanding these unique, but intricately related environments helps us formulate products specific to how growers use them. Ultimately, our job is to help them use plant nutrients more effectively – to maximize yield, decrease crop stress, improve crop quality, and to ensure efficient and sustainable growing practices.

In your view, as an industry, what is going to be the next step forward on comprehensive crop nutrient management?

Getting recognition across the three to five largest ag-input providers is going to be essential. Relying on those trusted companies, by working together, to create credibility for the category and to promote the importance of plant nutrition. This is especially true for our products that produce better vigour and abiotic stress mitigation. Driving that science and discipline to the forefront will ultimately help drive the industry forward.

What is Compass Minerals Plant Nutrition's mission for the future?

As we look to the future, we know we have a strategic advantage when it comes to developing plant nutrition products, and we plan to utilise that advantage to better serve the global agriculture industry. We are confident in the quality of our products and our operations and we will continue to look for collaborators

and partners who also believe that – through technology and innovation – we can improve growing practices, operations and yield.

We've certainly experienced that success with Embrapa – a Brazilian agricultural research company we've worked with to develop soil-based nutrient efficiency applications. Our mission is to deliver holistic, essential plant nutrition solutions to crops more effectively and efficiently. Looking ahead, retailers and growers will continue to see and experience the difference in our products and processes.

Where do you see plant nutrition innovation heading in the next five-to-10 years?

The plant nutrition industry will certainly evolve over this period. Formulations, combinations and application methods are going to be critical to maximising yield, efficiency and sustainability. Recognition from the largest agriculture input companies will become a necessity – to showcase that specialty plant nutrition is a necessary crop input – it's not all just biotechnology and gene editing! This all goes hand-in-hand with ever-evolving precision farming practices, robotics and general agriculture innovation. We certainly don't have a crystal ball. But we are focused on putting the right talent and tools in place to ensure we're changing the global landscape of agriculture. ■

Filling the cup with good coffee

Nutrients supplied by fertilizers are a key influence on the quality of coffee beans, explains, **Lino Furia**, Latin America regional agronomist for Sirius Minerals. By affecting valued attributes such as flavour and aroma, crop fertilization can have a big impact on coffee's market worth.

Coffee, the world's most widely-consumed beverage and a key agricultural export commodity, is grown in more than 70 countries globally. South and Central America contribute more than 58 percent to total world coffee production, delivering some 158 million 60 kg-size bags of coffee annually.

Two countries, Brazil and Colombia, are together responsible for 41 percent of global coffee production. Over the years, the scale of production and land productivity (yields) in both countries have continued to grow. In large part, production improvements (Figure 1) are being driven by two main factors: better crop fertilization and

higher yielding crops, the latter drawing on over 100 years' experience of coffee plant genetics and selective breeding.

Nutrient demand

Coffee has a high demand for K, Mg, Ca and S. Each tonne of coffee berries harvested removes:

- 44.34 kg of K₂O
- 5.96 kg of MgO
- 3.95 kg of CaO
- 3.63 kg of SO₄

(Note that each tonne of harvested berries is equivalent to 100 kg of dried beans.)

On average, based on these soil export levels, coffee crop nutrient demand equates to 300 kg of K₂O, 60 kg of Mg and 60 kg of S per hectare, currently.

While coffee productivity (yield) depends on fertilizer application rates and the amounts applied, nutrients also affect the quality of coffee beans. The use of a low-chloride fertilizer like *POLY4*, for example, can provide a better quality beverage, thereby improving coffee's classification (price) on the international market. *POLY4*'s positive influence on quality is due to its controlled dissolution rate and its ability to match the rate of nutrient supply to the demand from the crop.

Coffee quality

The quality of coffee beans has been linked to the following attributes in laboratory testing:

- Reduced potassium leaching of the bean
- Lower electrical conductivity
- High polyphenol oxidase activity

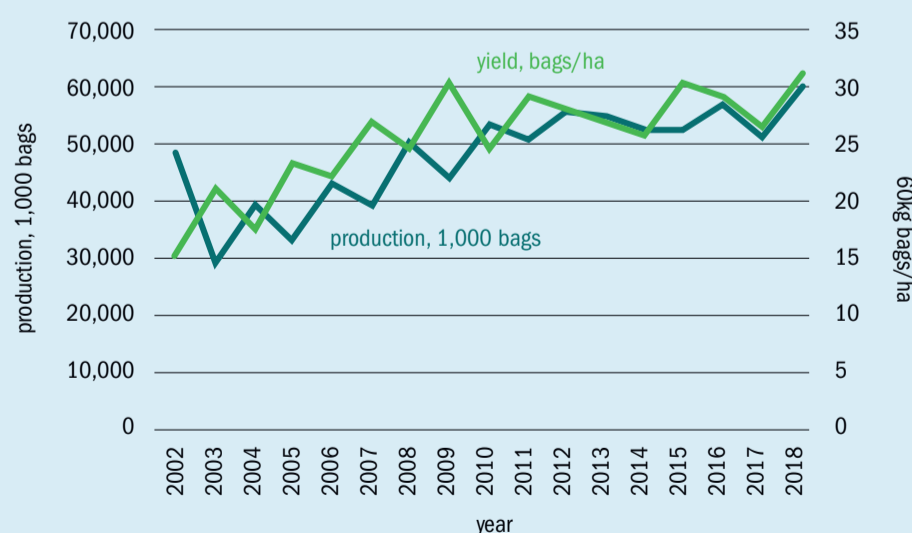
POLY4 has a number of characteristics that are especially desirable under Brazilian savannah conditions – and help to increase both crop quality and yield. Agronomic trials at Brazil's Universidade Federal de Lavras have assessed the performance of *POLY4* as a potassium nutrient source for coffee. These trials applied potassium to coffee as both KCl (MOP, muriate of potash) and in polyhalite form (*POLY4*).

A fertilizer plan which supplied two-thirds of potassium as *POLY4* was shown to support better coffee quality, compared to a plan where potassium was supplied by MOP alone. This plan ($\frac{2}{3}$ *POLY4*-K + $\frac{1}{3}$ MOP-K) was found to produce the best quality coffee, based on high polyphenol oxidase activity and low bean potassium leaching (Figure 2).

Deeper roots

Lime applications are important for adjusting soil pH. However, its influence is limited to the first 20 centimetres of the soil profile, especially in a minimum tillage system. To increase the take-up of nutrients and water by the coffee crop, it is necessary to encourage roots to go deeper. Roots tend to grow where available calcium is present (Figure 3). The calcium sulphate present in *POLY4*, being five times more soluble than gypsum, tends to percolate deeper, commonly to 20-40cm, thereby encouraging deeper rooting.

Fig. 1: The growth of Brazilian coffee production



Source: International Coffee Organization

Fig. 2: Variation in the quality characteristics of coffee with sources of potassium, MOP vs POLY4*

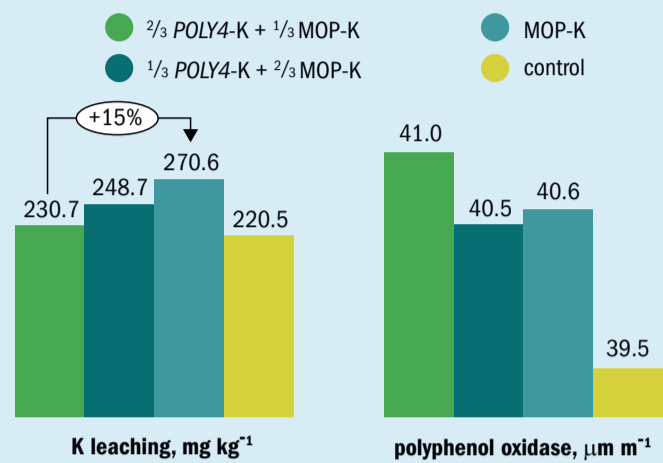


Fig. 3: Development of roots in the soil profile, with and without calcium sulphate

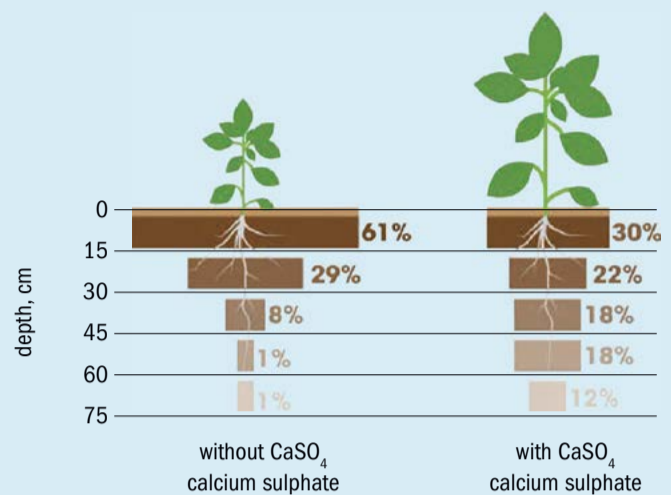


Fig. 4: Soil profile sulphate concentration: irrigated coffee crop with different sources of applied potassium, MOP vs POLY4

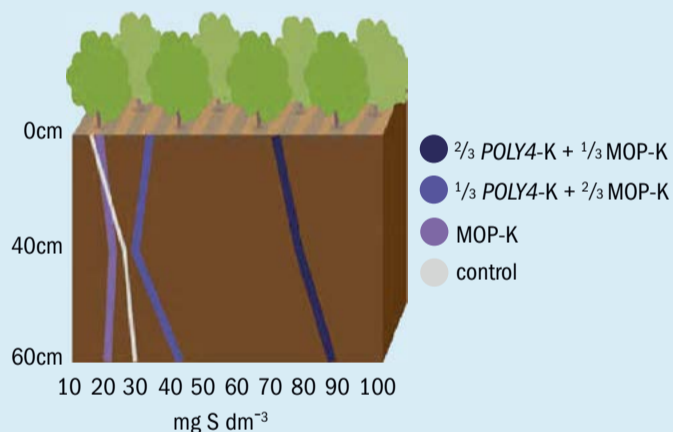
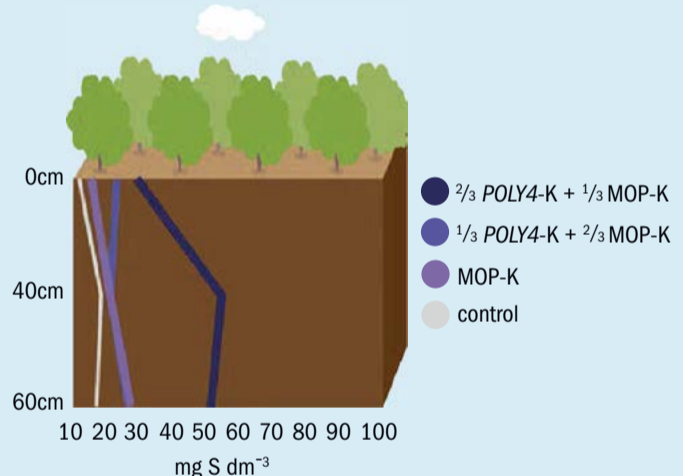


Fig. 5: Soil profile sulphate concentration: rainfed coffee crop with different sources of applied potassium, MOP vs POLY4



The concentration of sulphate in the soil profile was assessed as part of the Brazilian agronomic trials, for both irrigated and rainfed coffee crops. Although sulphate is usually very mobile, POLY4 application left a lasting legacy and benefit, in terms of residual soil sulphate and greater soil sulphate at all depths.

The acidic, weathered tropical soils common in Latin America frequently harbour toxic levels of aluminium, particularly at depth. Another additional benefit of POLY4 fertilization is the detoxification effect of its CaSO₄ and MgSO₄ constituents. These have the ability to counteract and improve resistance to aluminium toxicity, encouraging much

more expansive root growth deeper in the soil profile.

Nutrient availability

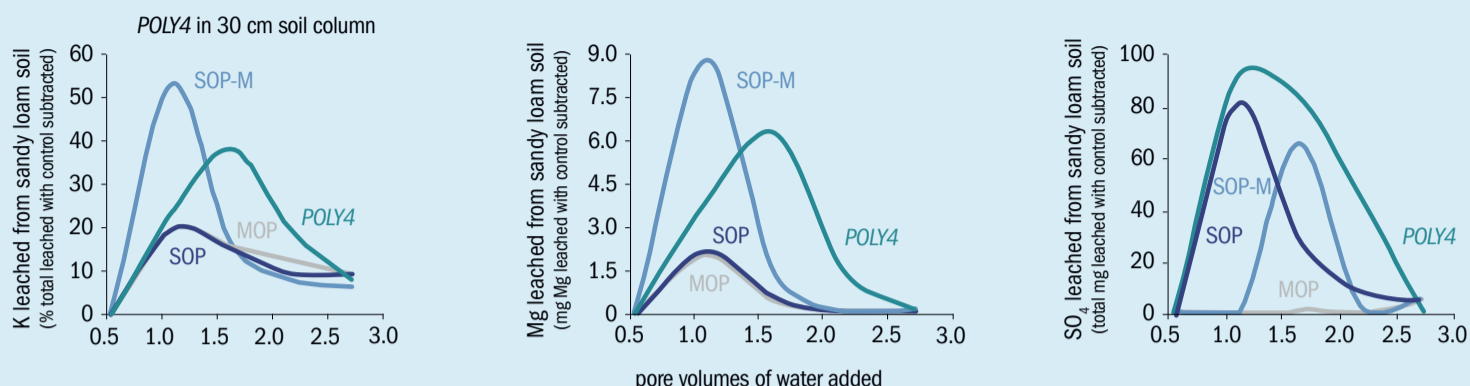
Besides the ability to deepen roots, POLY4 can also help improve soil nutrient balance and achieve better nutrient use by crops. Nutrients such as calcium and magnesium are beneficial to both the physical stability and nutrient status of the soil. Calcium, in particular, helps to increase the resilience of soil to compaction, erosion and runoff, allowing plants to access the nutrients they need.

Common fertilizer practice tends to apply nutrients at sowing. These nutrients can subsequently be lost through erosion or leach-

ing, and are therefore unavailable towards the end of the plant's cycle where nutrient uptake is at its highest. POLY4, in contrast, extends nutrient availability by – strongly and uniquely – prolonging the release of K, S and Mg. Beneficially, the sustained release behaviour of POLY4 allows plants to take advantage of nutrient availability over a much longer period of time (Figure 6).

Inevitably, fertilizers cannot always be applied at the best moment, as the climate or soil moisture may not allow traditional application timings. The naturally-controlled dissolution rate of POLY4 can help overcome this by helping to deliver nutrients at the right time, exactly when required by the crop.

Fig. 6: Soil nutrient availability, POLY4 vs other potash fertilizer*



* POLY4 provided a prolonged K, S and Mg release with increased total availability of these nutrients, more closely matching the requirements of the plant.

Source: Sirius Minerals

Drink better coffee

Chloride levels have negative effects, both direct and indirect, on the quality of coffee. The application of MOP – with a chloride content of around 47 percent – can cause deleteriously high chloride accumulations in coffee crops. By contrast, application of products containing the sulphate form of potassium, such as POLY4, can deliver crop quality improve-

ments. The improvements to coffee quality seen with POLY4 are significant, compared to potassium nitrate or potassium sulphate alone.

The lower carbon footprint of POLY4's production process (mining + crushing + granulation with starch) is also valued by the international coffee market.

In summary, POLY4 is a highly-attractive, natural, multi-nutrient option for coffee fertilization. Applications ensure that

K, S, Mg and Ca are supplied in a more balanced way during the crop's most productive growth stages, complementing other nutrients. Applying POLY4 in physical mixtures with other nutrient sources is also an option. Using POLY4 as part of a fertilizer plan for coffee delivers obvious benefits, including the longevity, stress tolerance, yield and quality of coffee production, both in Latin America and other countries globally.



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Correctly cultivating coffee

PHOTO: TESSENDERLO

Coffee, the world's most widely consumed beverage and a key agricultural export commodity, is grown in more than 70 countries globally. Nutrients supplied by fertilizers are a key influence on marketable characteristics such as flavour and aroma.

The berries produced by several widely-grown species of the genus *Coffea* are harvested for their commercially valuable coffee beans (seeds). These small bush-like evergreen plants prefer to grow in deep, well-drained, slightly acid, organic-rich loamy soils.

Coffee is the most popular beverage in the world, with over two billion cups consumed every day. Today, coffee is cultivated in over 70 countries across the globe, with commercial growing concentrated in Latin America, Southeast Asia, South Asia and Africa. Green (unroasted) coffee beans are one of the world's most widely traded agricultural commodities, forming the basis of a lucrative and flourishing international export market.

Left: A coffee bean is a seed of the coffee plant. It is the pit inside the red or purple fruit often referred to as a berry or cherry.

The coffee tree

Coffee is perennial tree crop that continuously produces berries and fresh wood each growing season. The highest coffee yields are obtained on free-draining soils where water is not limiting. The return of composted pulp as a mulch conserves moisture and provides a source of nutrients.

Maintaining strong roots and plant growth, through careful husbandry and pest and disease control, ensures maximum coffee productivity and fruit fill. Regular pruning strengthens the tree structure, and promotes new branch growth and the abundance of coffee berries.

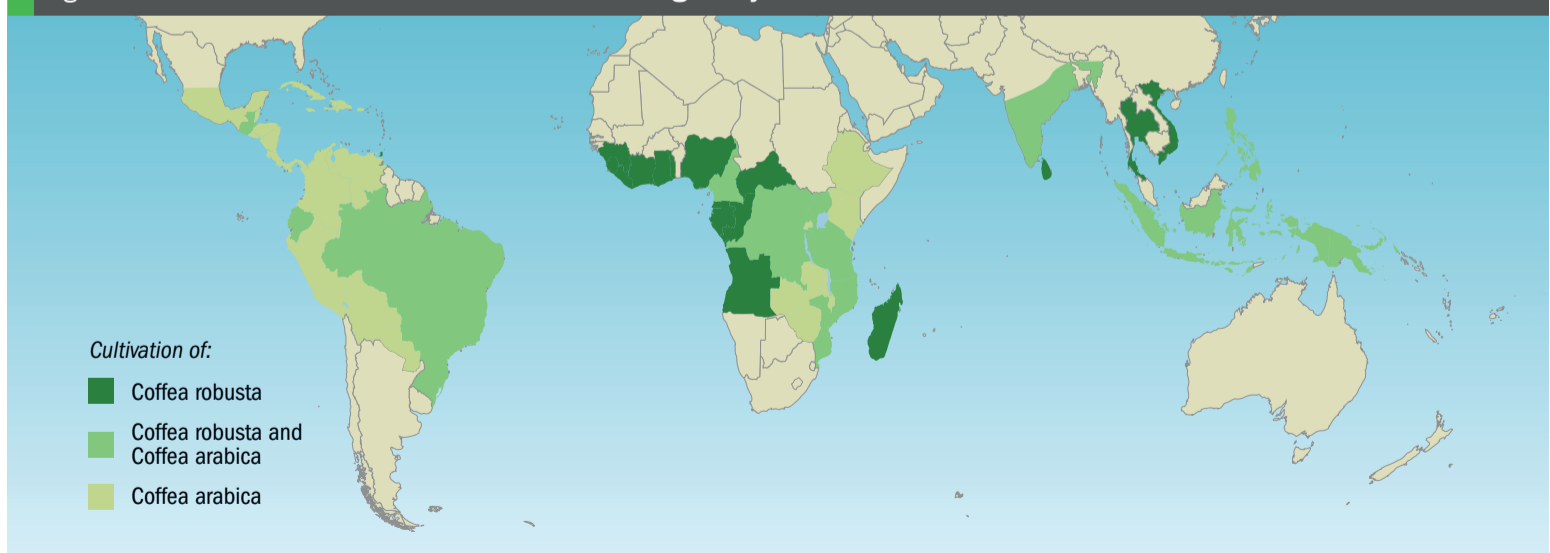
Coffee bean types

The two most commonly grown commercial coffee species are *Coffea arabica* and *Coffea robusta* (Figure 1).

Arabica is a self-pollinating, medium-height tree that originated in the semi-open forests of highland Ethiopia. It favours slightly-acid soils, and is a high yielding species that responds well to high nutrient fertilizer regimes.

Robusta is a bigger, larger-leafed tree that came from the lowland forests of the Congo basin and, as its name suggests, is more robust than Arabica. It favours highly-leached but densely mulched soils, together with a long rainy season and a short dry season. It is typically lower yielding than Arabica and requires cross-pollination from adjacent trees.

Fig. 1: Coffee is cultivated in more than 70 countries globally



Arabica accounts for around 60 per cent of coffee cultivated worldwide and has better 'cup quality' than Robusta. Arabica production is split between 'Brazilian Milds' (52%), 'Colombian Milds' (16%) and other mild types (32%). Arabica is highly-valued by the market, with about 20 percent of the Arabica produced in Latin American countries, such as Colombia, Costa Rica and Guatemala, marketed as 'gourmet' coffee.

Although less widely cultivated, Robusta, being a form of the hardy coffee variety *Coffea canephora*, is advantageously resistant to coffee leaf rust (*Hemileia vastatrix*). Robusta tends to have a more bitter taste and less flavour than Arabica but has better body, and also contains 40-50 percent more caffeine. For this reason, Robusta is generally used as an inexpensive substitute for Arabica in many commercial coffee blends. Robusta nevertheless has marketable characteristics of its own, with good quality beans being used in espresso blends to provide a fuller-bodied taste and a better head of foam.

Coffee beans originating from particular countries are distinguished by distinct differences in flavour, aroma, body and acidity. Consequently, coffee is commonly marketed according to its country or region of origin, such as Colombian, Kenyan and Java coffee, for example.

Production and trade

Around 9.2 million tonnes of green coffee beans are produced annually across a total of 11.0 million hectares worldwide. The majority of production – just under 60 percent of the global total – originates in South and Central American countries, where Arabica is widely-cultivated (Figure 1). Of the remainder, 30 percent of coffee beans are produced in Asia and just over 10 percent in Africa, two regions where Robusta cultivation is more widespread (Figure 1).

Brazil remains the world's largest single coffee grower, producing 3.02 million tonnes – a third of the global total – from a massive 1.99 million hectares of land. Vietnam, Colombia and Indonesia are the next largest growing countries, producing 1.46, 0.70 and 0.64 million tonnes, respectively, from growing areas of 0.60, 0.87 and 1.23 million hectares. Other leading producers and exporters include Honduras, Ethiopia, India, Uganda, Peru, Mexico and Guatemala (Table 1).

Table 1: World coffee production 2014-2017 ('000 60 kg bags)

| | 2014 | 2015 | 2016 | 2017 |
|------------------------------------|----------------|----------------|----------------|----------------|
| Total | 148,565 | 153,569 | 159,061 | 159,375 |
| Arabicas | 86,185 | 90,444 | 103,960 | 97,092 |
| Robustas | 62,379 | 63,125 | 55,101 | 62,284 |
| Leading exporting countries | | | | |
| Brazil | 52,299 | 52,426 | 56,787 | 52,735 |
| Vietnam | 26,500 | 28,737 | 25,540 | 29,500 |
| Colombia | 13,339 | 14,009 | 14,634 | 14,000 |
| Indonesia | 10,862 | 12,535 | 11,491 | 10,902 |
| Honduras | 5,268 | 5,786 | 7,457 | 7,700 |
| Ethiopia | 6,575 | 6,714 | 7,297 | 7,650 |
| India | 5,450 | 5,800 | 5,200 | 5,840 |
| Uganda | 3,744 | 3,650 | 4,962 | 4,800 |
| Peru | 2,883 | 3,304 | 4,223 | 4,280 |
| Mexico | 3,591 | 2,903 | 3,781 | 4,000 |
| Guatemala | 3,310 | 3,410 | 3,684 | 3,700 |
| Nicaragua | 1,898 | 2,130 | 2,555 | 2,500 |

Source: International Coffee Organization

Coffee is an important export commodity, being the top agricultural export for some 12 countries. Production figures for exporting countries, as provided by the International Coffee Organization, are usually expressed in thousands of 60 kg bags (Table 1).

Average coffee yields worldwide are around 0.4 t/ha. But much greater yields are achievable under more intensive cultivation regimes in countries such as Vietnam (2.44 t/ha) and Brazil (1.51 t/ha).

Quality

Coffee's taste and aroma is controlled by a number of volatile phenolic, fatty acid, protein and enzyme compounds. The presence of the enzyme polyphenoloxidase, in particular, has a major influence on coffee quality. Enzyme activity in turn is strongly influenced by the nutrient regime at the coffee plantation – making fertilization a key determinant of coffee quality.

Nutrient uptake

Fertilization prior to planting is aimed at promoting good rooting and rapid plant development. The supply of phosphorus and high soil organic matter are particularly vital at this early stage. Later, during the first 2-3 years of tree life, small but

frequent applications of N, P and K are commonly recommended.

Coffee trees require an N:P:K balance of 1:0.2:1.0 when they finally reach maturity and are ready to start cropping. For mature coffee plants, this translates to typical nitrogen (N) and potassium (K₂O) application rates of 200-300 kg/ha and a rate of 40 kg/ha (P₂O₅) for phosphorus.

Yara International confirms broadly similar nitrogen and potassium uptake rates of between 150-250 kg/ha in mature trees. In practice, however, fertilizer programmes at intensive plantations in high rainfall regions may apply as much as 250-450 kg/ha of nitrogen and potassium annually. Lower rates are advisable at high soil potassium levels, or when a high nitrogen content is shown by leaf analysis.

Yara reports the following major and secondary nutrient uptake rates, based on averages for 3-6 year-old Arabica trees in Brazil, Costa Rica and Kenya:

- Nitrogen: 163 kg/ha N
- Potassium 154 kg/ha K₂O
- Calcium: 74 kg/ha CaO
- Magnesium: 33 kg/ha MgO
- Phosphorus: 26 kg/ha P₂O₅
- Sulphur: 14 kg/ha S

Similarly, the following micronutrient uptake rates are reported for six-year old Arabica trees in Brazil:

- Iron 2.2 kg/ha
- Mn: 746 g/ha
- Zn: 489 kg/ha
- Cu: 360 kg/ha
- B: 199 kg/ha

Crop fertilization

Fertilizers are usually applied close to the coffee plant stem, within the limits of the canopy, and generally split into three or four applications. Some sources report that nutrient demand and removal by Robusta berries (35 kg N, 7 kg P₂O₅ and 89 kg K₂O per hectare) are typically much higher than for Arabica berries (34 kg N, 5 kg P₂O₅ and 45 kg K₂O per hectare).

Realising coffee's high yield potential requires a balanced and well-designed fertilization programme throughout the growing season, with nutrients playing the following key roles during the crop cycle:

- **Potassium** is a key driver of coffee yield, being important for respiration, photosynthesis and water regulation. It promotes vigour, boosts cell strength and improves plant resistance to stress. Potassium is particularly important during the berry growth stage. Much of the potassium offtake at harvest (over 50 kg/ha) resides in coffee pulp.
- **Nitrogen** maintains strong berry fill and is essential for high coffee yields and strong vegetative growth. Uptake mostly occurs earlier in the season during new leaf growth and flowering. Although supplies should be maintained throughout the season, excess nitrogen during later growth stages can reduce bean size.
- **Calcium** is the third most important nutrient in terms of coffee plant demand (75-100 kg/ha) and is required through to the berry-fill stage. Calcium is necessary for berry production and strong tree, root and leaf growth.
- **Phosphorus** is required in smaller amounts (25 kg/ha) but is still important for early growth and rooting, particularly at the nursery and transplanting stages, and for bean fill later on. Larger applications (up to 100 kg/ha) are permissible to overcome the tie-up from soil fixation. Foliar applications can also be effective at increasing coffee yield, when applied during periods of peak demand.
- Although required in lower amounts, **magnesium** (30-60 kg/ha) and **sulphur** (14-20 kg/ha) both have positive

effects on coffee yield and need to be adequately supplied as they can be yield-limiting.

- **Zinc** and **Boron** are particularly important at the flowering stage to improve berry set and overall coffee yield. Poor micronutrient availability will limit coffee plant growth – the area of productive leaves in particular – and reduce yield.

The right type of potash

Although coffee plants are not particularly chloride-sensitive, the accumulation of chloride nevertheless affects coffee quality. Beans produced under high-chloride conditions are generally more hygroscopic and vulnerable to damaging micro-organism attack.

In Brazilian crop trials, the application of potassium sulphate (SOP, K₂SO₄) improved coffee yields by 4-20 percent, compared to potassium chloride (MOP, KCl) applied at the same rate. Average crop yields with SOP were 10 percent higher on average. At all application rates, SOP also improved coffee bean quality – in terms of polyphenoloxidase activity and total acidity – versus equivalent MOP applications. The highest coffee quality was obtained by applying SOP at a rate of 200 kg/ha. The application of MOP, in contrast, led to increased total acidity and reduced total sugar content of beans.

A high correlation is typically observed between soil sulphate levels and coffee yield. In a decade-long field trial, an annual application of sulphur (66 kg/ha S) in sulphate form almost doubled average coffee yields from 1,320 kg/ha to 2,400 kg/ha.

The application of SOP largely covers coffee plant sulphur requirements. Indeed, the combined potassium and sulphur content of SOP enhances quality during coffee production. This is reflected by greater polyphenoloxidase activity, better colour index, a higher total sugar concentration, less acidity and less reducing sugar. The range of granular (*GranuPotasse*), fertigation (*SoluPotasse*) and foliar (*K-Leaf*) SOP products from **Tessenderlo Kerley International** are well-suited to coffee cultivation.

Polyhalite is also being marketed as a suitable and effective multi-nutrient source for coffee crop fertilization, including the supply of potassium (see page 25). ICL offers the following practical guidelines for fertilizing coffee with its UK-mined *Polysulphate* polyhalite product:

- Coffee beans remove very large amounts of potassium at harvest and the proportion not supplied by *Polysulphate* can be applied as MOP.
- Both *Polysulphate* and MOP must be applied during rainy periods to allow the gradual release and continuous supply of nutrients to the growing crop. This will also increase K, Mg, Ca and S uptake by coffee plantations.
- An application of 400-600 kg/ha of *Polysulphate* is generally a suitable dressing for supplying all the Ca and S requirements of coffee crop, ensuring maximum productivity, as well as complementing the nutrients supplied by other fertilizers.
- *Polysulphate* can be included as a constituent of an NPK blend and surface-applied near the trunk two to three times a year.

Expected benefits of *Polysulphate* application to coffee include

- More balanced nutrition
- Increased nitrogen use efficiency
- Higher yields
- Improved fruit size and weight
- Better cup quality

Secondary nutrients and micronutrients

As the pressure to raise coffee yields at plantations mounts, attention is increasingly turning to reversing yield-limiting secondary and micronutrient deficiencies. Micronutrients can be supplied through routine foliar spray treatments. If deficiencies are severe, this approach can be used in combination with, or separately to, the soil-application of more concentrated, dry granular products.

Boron and zinc are among the most commonly encountered micronutrient deficiencies in coffee crops. Boron deficiency may be addressed through applications of boron plant nutrition products such as granular *Granubor* and water-soluble *Solubor* fertilizers offered by **U.S. Borax**. (*Fertilizer International* 486, p18).

UK-based **Omex Agrifluids** markets *Omex CalMax*, a foliar fertilizer for fruit and vegetable crops including coffee beans. Its high water-soluble calcium content (22.5%) improves fruit firmness, storability, colour and skin finish. Foliar application of water-soluble calcium also helps avoid the deficiencies commonly caused by the lock-up of calcium in soils.

Coffee trials with *Omex CalMax* in Vietnam reported improvements in the growth of coffee bushes and the yield and quality

of the coffee harvest. Benefits of foliar-applied *Omex CalMax* included:

- Higher coffee cherry and bean yields per tree
- Increased branch extension growth
- Higher bean quality as measured by bean size
- Reduced frequency of green coffee bean defects including black, mouldy and broken beans

“Some coffee growing areas in Vietnam have inherently low pH soils, so enhanced cell and tissue strength afforded by the extra calcium, and translating into lower levels of berry disease with reduced berry drop and fungicide usage, offers exciting opportunities for farmers using *Omex CalMax*,” comments Peter Prentis, Omex’s export director.

Omex CalMax is expected to deliver similar benefits to Arabica coffee grown in Kenya on moderately acidic soils.

Coffee’s magnesium requirements can be met by applying kieserite ($MgSO_4$). Germany’s **K+S Group** is a leading supplier, marketing the kieserite product *ESTA Kieserit*. The company reports that coffee berry yields can be increased by two tonnes per hectare by applying *ESTA Kieserit* at the recommended application rate of 110-140 kg/ha.

The International Plant Nutrition Institute (IPNI) also reports that potassium magnesium sulphate (langbeinite, 22% K_2O and 11% MgO) – marketed by **The Mosaic Company** as *K-Mag* – improves the beverage quality of beans, compared with plants fertilized with MOP only.

Water-soluble fertilizers

Chile’s **SQM** markets a range of potash-based water-soluble NPK fertilizers specifically tailored to meet the requirements of coffee growers. The company has performed field trials in Mexico assessing coffee plant yield response to different granular and water-soluble NPK treatments. SQM’s *Ultrasol* NKS water-soluble fertilizers produced the highest yields when applied at a rate of 3.25 kg/tree. Trial results showed that, by using water-soluble fertilizers, it was possible to reduce nutrient inputs (N, P, K, Ca and Mg) by 50 percent yet still obtain higher yields, compared to traditional granular fertilizer applications.

The SUPERA programme

Produquímica has been actively providing fertilizer products for the Brazilian coffee industry for the last decade. Years of

research and engagement with the industry has culminated in the *SUPERA* programme for coffee growers. This is designed to help growers achieve maximum yields in a sustainable manner.

SUPERA provides a complete, season-long fertilizer programme that brings together the most well-researched and advanced fertilizer technologies currently available in the Brazilian market. The programme applies a number of different and innovative types of fertilizer product during the coffee growing season. Examples include:

- Controlled-release/coated fertilizers
- Sulphur- and magnesium-based fertilizers
- Foliar-applied macro and micronutrients
- Tailor-made combinations of nutrients and biostimulants

SUPERA, by capturing years of experience and using this to create an ideal and bespoke coffee fertilization programme, has increased both return on investment and customer satisfaction. For Produquímica, the programme is ultimately about delivering the perfect cup of coffee. ■

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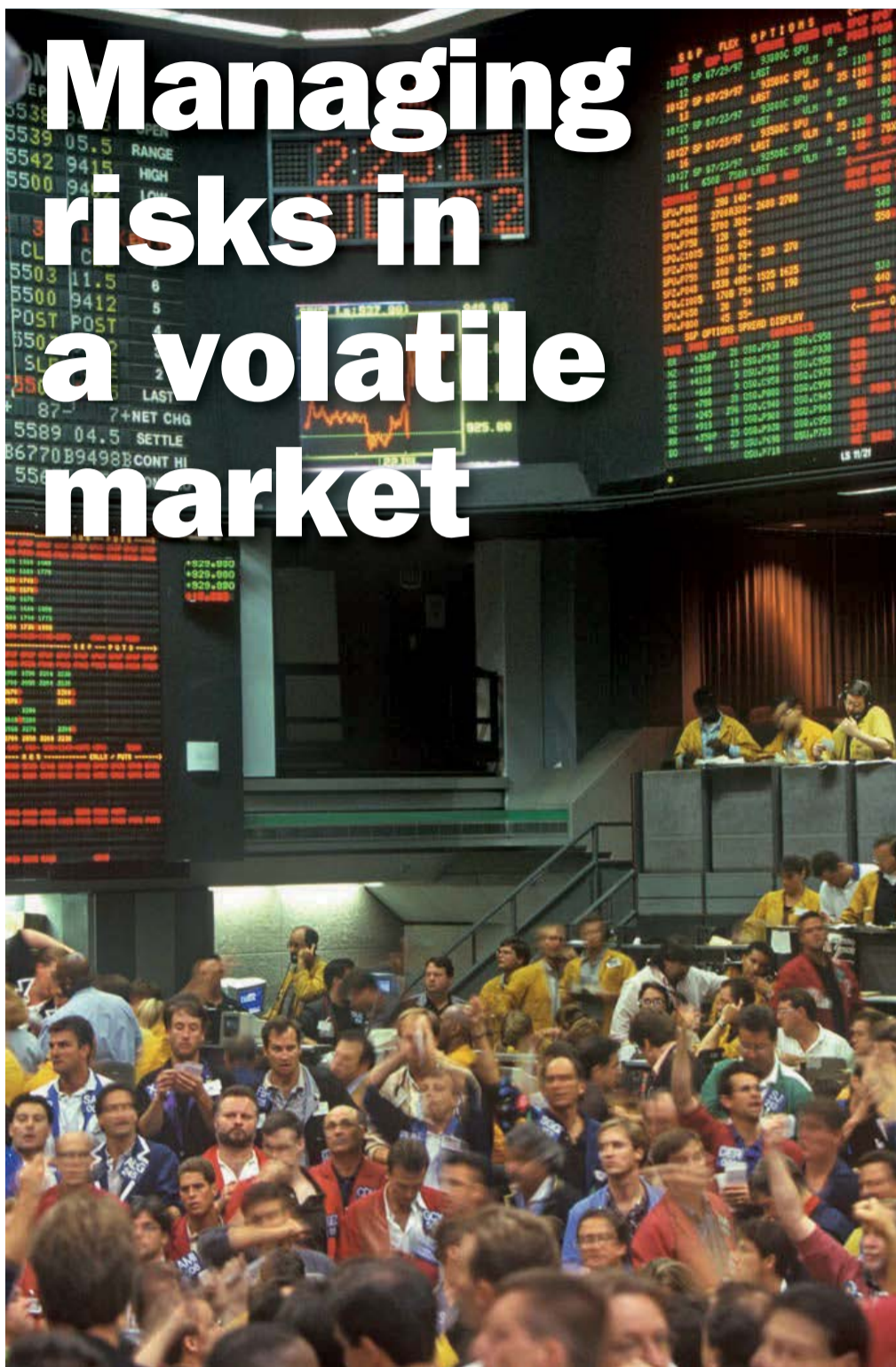
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Cash-settled swaps, a type of derivative contract, can be an effective way of managing price risk in volatile, large-volume commodity markets such as fertilizers. We take a look at the growing fertilizer swaps market and its attractions to both buyers and sellers.

Price volatility is a recognised feature of the fertilizer market. This inevitably exposes fertilizer buyers and sellers to price risk.

For a number of years now, forward price agreements have been offered by the derivatives market to help avoid and reduce price exposure. These allow sellers and buyers to agree on a future price for commodity fertilizers as part of so-called 'cash-settled swaps'.

Three main brokerages are currently offering clearing services for these type of swap agreements: CME Group, Freight

Investor Services (FIS) and Direct Hedge. FIS defines a fertilizer swap as:

"An agreement between a buyer and a seller, to pay the difference between a price agreed today and the future price of a specific reference price at an agreed point in time."

Direct Hedge's definition is similar: "These financial contracts enable parties to buy or sell an underlying commodity for a forward date at a price agreed today. At maturity, the contract settles by referencing a recognised benchmark price or index."

Cutting through the jargon

To financial outsiders, the derivatives market is seemingly shrouded in impenetrable jargon. Yet the underlying ideas and concepts are essentially simple ones. To fully understand cash-settled swaps and their usefulness in fertilizer trading, an explanation of basic terms is first required:

- A **derivative** is a contract that derives its value from the performance of an asset, index or interest rate
- Derivatives can be used for a number of purposes, including insuring against price movements (**hedging**)
- A swap is a particular type of derivative contract based on a financial exchange between a buyer and seller (the **counterparties**)
- Most swaps involve a cash settlement based on a notional value agreed by the counterparties
- However, unlike futures contracts, for these **cash-settled swaps**, neither the notional value or a physical commodity is ever exchanged
- Instead, the buyer and seller swap cash, as a hedge against price fluctuations
- Swaps can be traded 'off-exchange', as a direct **over-the-counter** (OTC) transaction between counterparties, or traded via an exchange such as the Chicago Mercantile Exchange (CME)

Although fertilizer swaps are a paper trade in which no product actually changes hands, they do usually mirror a physically-held buying position. Therefore, in practice, swaps are generally agreed in tandem with actual product trades to hedge against volatility in the real market. This has the benefit of allowing price risks to be managed separately from physical supply.

Cash-settled swaps for fertilizers, as their name suggests, are eventually

settled through an exchange of cash. This is calculated from the difference between the price agreed in the swap contract and the actual market price.

A commonly-agreed market reference price is fundamental to swap transactions and final cash settlements, as it allows these to be concluded openly and fairly. Confidence in fertilizer swaps requires reference prices that reflect and represent real fertilizer market activity and trades. The prices also need to independently arrived at, soundly-based and authoritative (see box).

Whether the buyer or the seller will profit from the swap depends on the direction of price movement in the market. However, swaps still deliver price certainty because, regardless of who gains or loses, the cash exchanged always moves in the opposite direction to the market, thereby offsetting any change in the physically-traded fertilizer price.

Cash-settled swaps offer advantages to both buyers and sellers. In the fertilizer market, they allow buyers such as farmers to hedge their input costs, for example. By improving price discovery, swaps also allows sellers such as fertilizer producers to obtain a clearer picture of their future profits and costs.

How fertilizer swaps work

The following example, courtesy of Freight Investor Services (FIS), illustrates how fertilizer swaps work in practice. In their example, a trader has agreed to a June purchase of 10,000 tonnes of urea from China, and wishes to guarantee a target price of \$285/t for this deal. Therefore, to cover their physical position, and limit exposure to market volatility, the trader also buys a urea swap at \$285/t for June. Depending on whether the market rises or falls, these trades have two possible outcomes, as follows:

- Market firms.** Reference price rises to \$295/t f.o.b. for June. Physical position vs swap position:
 - Physical cost to buyer/trader (10,000 t @ \$295/t) = \$2,950,000
 - Notional cost of the fertilizer swap (10,000 t @ \$285/t) = \$2,850,000
 - Cash settlement for swap, calculated from the difference between agreed swap price and reference price (10,000 t @ \$10/t) = \$100,000
 - Buyer/trader **'in-the-money'** – as paid \$100,000 by swap seller

Trader maintains an overall neutral position:

- Physical cost (10,000 t @ \$295/t) – swap cash settlement (\$100,000) = \$2,850,000/10,000 t (\$285/t average)

Outcome: trader 'in-the-money' from the swap and achieves a target value of \$285/t f.o.b., despite the price rise in the physical market.

- Market softens.** Reference price falls to \$275/t f.o.b. for June. Physical position vs swap position:

- Physical cost to buyer/trader (10,000 t @ \$275/t) = \$2,750,000
- Notional cost of the fertilizer swap (10,000 t @ \$285/t) = \$2,850,000
- Cash settlement for swap, calculated from difference between agreed swap price and reference price (10,000 t @ \$10/t) = \$100,000
- Buyer/trader **'out-of-the-money'** – as swap seller paid \$100,000

Trader maintains an overall neutral position:

- Physical cost (10,000 t @ \$275/t) + swap cash settlement (\$100,000) = \$2,850,000/10,000 t (\$285/t average)

Outcome: trader still achieves their target value of \$285/t f.o.b., despite being 'out-of-the-money' on the swap.

Imperfect hedging

It is important to recognise that the elimination of price risk is not always guaranteed. For example, the fertilizer reference price, being an average spot price, may not necessarily be exactly equivalent to the booked price for a given physical trade. That leaves open the possibility of imperfect hedging ('basis risk') where the physical spot price and the fertilizer reference price diverge. This problem, however, is often eliminated in practice by contracting physical volumes at the fertilizer reference price, so providing perfect hedging.

CME Group

The Economist notably described CME Group as: "The biggest financial exchange you have never heard of." Its subsidiaries include Chicago Mercantile Exchange (CME), Chicago Board of Trade (CBOT) and New York Mercantile Exchange.

CME has been offering *CBOT Fertilizer Swaps* for urea, urea ammonium nitrate

THE MARKET REFERENCE PRICE

The settlement of swaps for any given fertilizer commodity depends on an agreed market reference price. These prices are critical as they provide buyers and sellers with confidence that swaps transactions are being concluded openly and fairly. Market reference prices therefore need to be authoritative, objective and representative of physical trading activity.

Freight Investor Services (FIS), for example, calculates its reference prices – the Fertilizer Index – from the low-to-high weekly price ranges provided by three independent panellists, CRU/Fertilizer Week, Fertecon/Informa and FMB/Argus. Each panellist posts its price ranges weekly every Thursday. These reflect actual business concluded in the market.

The Fertilizer Index is calculated from a simple arithmetic mean. For each benchmark, the highest and lowest values for the six prices provided by panellists are discarded, with the average then calculated as the mean of the remaining four prices. Take the following illustrative example:

| | Fertilizer price range | |
|-------------|------------------------|--------|
| | Low | High |
| Panellist 1 | \$353* | \$360 |
| Panellist 2 | \$355 | \$365* |
| Panellist 3 | \$356 | \$360 |

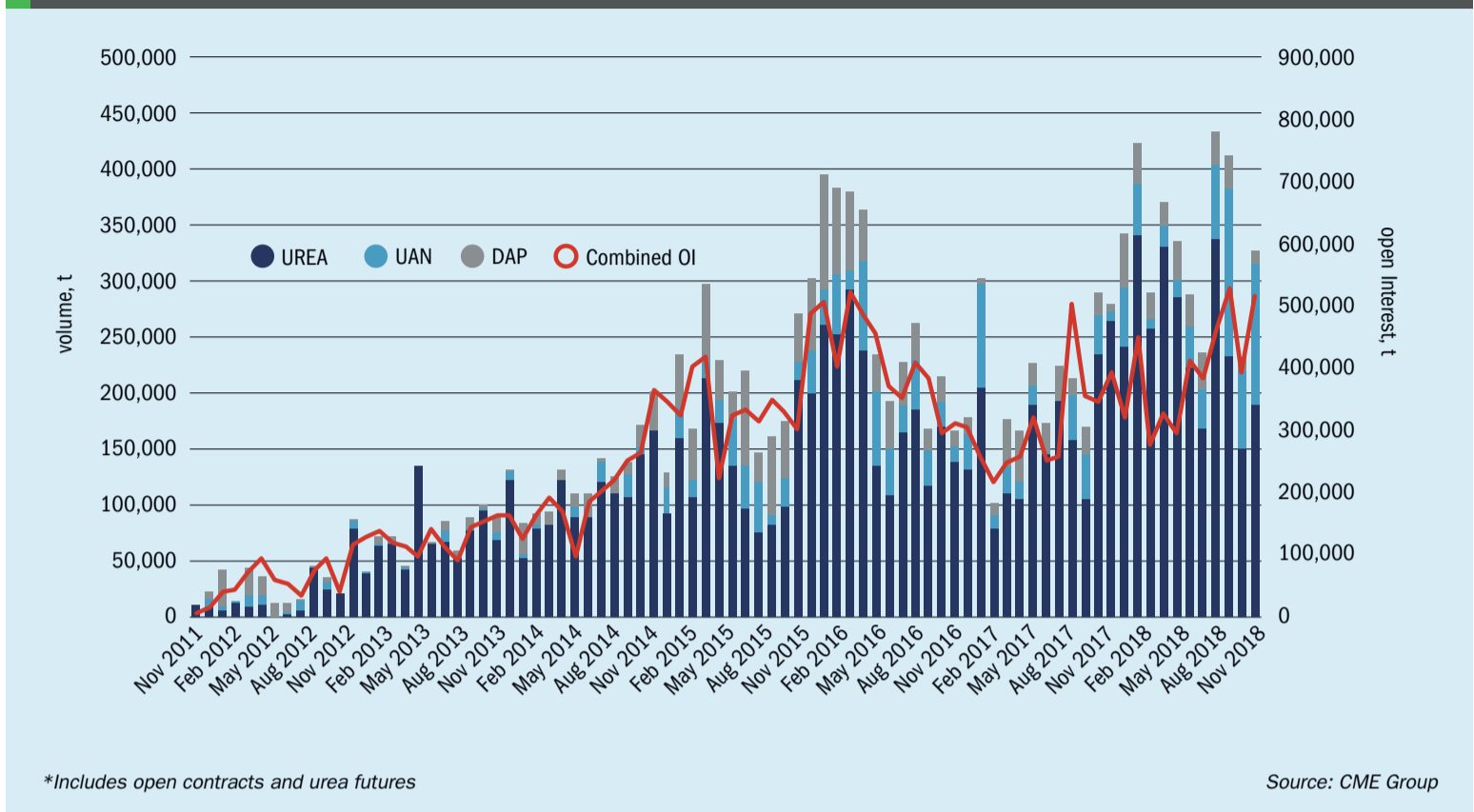
Fertilizer Index (reference price) = (355+356+360+360)/4 = \$357.75

*discarded.

Note: In those cases where two or more of the panellists submit the same high and/or low price, only one of these is discarded.

Similarly, the fertilizer swap contracts offered by CME Group are financially settled against weekly price assessments reported every Thursday by ICIS and Profercy. Again, the highest and lowest price values are discarded, with the weekly price average calculated as the arithmetic mean of the remaining data points. ■

Fig. 1: Total monthly traded volumes for CBOT Fertilizer Swaps and Open Interest*



(UAN) and diammonium phosphate (DAP) since 2011. These give market participants a way to manage price volatility, hedge their price exposure and reduce counterparty credit risk.

The following six CBOT-listed fertilizer swap contracts are currently available.

- Urea (Granular) f.o.b. US Gulf Swaps
- Urea (Prilled) f.o.b. Yuzhny Swaps
- Urea (Granular) f.o.b. Egypt Swaps
- UAN f.o.b. NOLA Swaps
- DAP f.o.b. Tampa Swaps
- DAP f.o.b. NOLA Swaps

CME also offers another fertilizer derivatives product, Urea (Granular) FOB Middle East Futures, as a futures contract for urea.

Fertilizer swaps are submitted through CME's ClearPort system and cleared by its Chicago-based clearing house, CME Clearing. They can also be cleared by CME Clearing Europe, the Group's London-based clearing house.

Central clearing – and the safety and security this offers – is a key feature of CME Group's swap contracts. CME Clearing, by acting as "the buyer to every seller and the seller to every buyer", takes on the credit risk for both counterparties. CBOT Fertilizer Swaps also offer the ability to:

- Manage price risk
- Enter into transactions with the more than 10,000 registered users of CME ClearPort

- Vary the tonnage size of contracts to match customer needs and offer more precise hedging
- Trade off-exchange and negotiate own prices

Contract sizes are either:

- 100 metric tonnes for DAP f.o.b. Tampa, Urea (Prilled) f.o.b. Yuzhny and Urea (Granular) f.o.b. Egypt swaps; or
- 100 short tons for DAP f.o.b. NOLA, Urea (Granular) f.o.b. US Gulf and UAN f.o.b. NOLA swaps

Monthly traded volumes (including open contracts), which started below 50,000 tonnes in 2011, have grown substantially year-on-year to exceed 400,000 tonnes this year (Figure 1).

Freight Investor Services (FIS)

London-based Freight Investor Services (FIS) is another of the three brokers in the specialised fertilizer swaps market. It has successfully established cash-settled fertilizer swaps in markets worldwide and covers contracts in key US, Middle East and Chinese markets. The company is targeting growth in Asia, and opportunities in the Chinese market in particular.

As a volatile market trading in substantial volumes, FIS believes there is a clear requirement for price risk management in the fertilizer market.

"The future is uncertain leaving producers and traders at the mercy of ever-changing fundamentals such as grain prices, weather conditions and inventory levels," comments FIS, adding: "Price volatility in international fertilizer markets can be a particular issue."

FIS cash-settled fertilizer swaps are cleared via CME, or through LCH on the London Stock Exchange Derivatives Market. This eliminates counterparty risk and guarantees the settlement of fertilizer swap contracts.

Cash-settled swaps for fertilizers from FIS offer a number of attractions for market participants:

- **Proven market:** The liquidity and volumes of FIS swap trades continues to grow steadily.
- **Price discovery:** The swaps market provides forward price discovery and enables a forward price to be secured without a commitment on physical product.
- **Swap positions:** While swap contracts need to be settled at the end of a defined period, they can be 'closed out' early to determine the exact profit or loss on a position, or left open to settle at maturity.
- **Cut capital commitments:** Securing a forward price in the swaps market minimises the commitment of capital and preserves cash flow.

- **Locked-in margins:** Building a swaps book allied to physical trading commitments minimises exposure to price swings.

Fertilizer swaps help manage price risk, FIS emphasises, by hedging physical positions in the forward market. Specific objectives can include:

- **Hedging:** Taking a position opposite to a position held in the physical market, with the aim of minimising the risk of financial loss from an adverse price change.
- **Positioning:** Leveraging physical and market knowledge, by taking short term positions where you believe the market is mispricing, with the aim of making a profit through the buying and selling of positions.

According to FIS, companies participating in the fertilizer swaps market include leading producers and traders such as:

- Trammo
- CHS crop nutrients
- Koch
- The Mosaic Company
- Gavilon
- Ameropa
- Helm
- Growmark
- ADM
- Scotts
- Interchem
- Yara International
- Orascom

Direct Hedge

Copenhagen-headquartered Direct Hedge is the third broker offering cash-settled fertilizer swaps. Established in 2000, this

specialist commodity trading company helped pioneer derivatives contracts for products ranging from fertilizers to farmed salmon to edible oils. It also offers physical transactions in selected markets.

Direct Hedge currently offers swaps for phosphate and nitrogen fertilizers, as well as a range of edible oils. Its client list includes many of the world’s largest commodity traders, asset managers and hedge funds. The company is regulated by the Danish Financial Supervisory Authority and has offices in Florida, the UK, Spain and Brazil.

Cash-settled swaps make up the core of Direct Hedge’s business, and provide an efficient way of managing forward price exposure, in its view. Transactions are over-the-counter (OTC) with some contracts cleared through CME. “Cash-settled swaps are financial hedging tools which offer users a quick and efficient way to reduce, or increase, price exposure to a specific product,” advises Direct Hedge.

The future of futures

The clearing of cash-settled fertilizer swaps by exchange owners such as CME Group, which began in the summer of 2011, has generally been welcomed – for bringing transparency to what was formerly seen as a shadowy and opaque over-the-counter (OTC) market.

“When you don’t have to be focused on the risk, it opens up the ability to trade with a greater number of people,” CME Group’s Tim Andriesen, managing director, agricultural products, told ICIS, adding: “And when you’re dealing with smaller firms or [agricultural] co-ops,

sometimes accessing the swaps market can be laborious,”

Analysts always expected the number of transactions to grow once major brokerages such as CME Group, FIS and Direct Hedge started clearing fertilizer swaps, a forecast that has since been proven correct (Figure 1).

If insulating against price volatility is marketed as the key advantage of fertilizer swaps then the strong upwards price movements seen in 2018 should have been good for business. In the year-to-date, Middle East granular urea prices are up 18 percent on last year, according to analysts Profercy, while the average US Gulf urea barge price is up 25 percent. French UAN prices are also 45 percent higher than one year ago. Figures from The Mosaic Company also show the current Tampa DAP price (\$435/t f.o.b.) has risen by \$90/t in the last 12 months.

Whenever derivatives, futures and hedging are mentioned, concerns are immediately raised about undue speculative influences creating greater volatility in the market – ironically, almost the exact opposite of what these financial instruments are supposed to protect against. But with fertilizer swaps still making up only a very small portion of the global traded market, insiders such as Tim Andriesen believe these worries are unwarranted. It would be impossible for swaps to artificially inflate or deflate prices in his view.

“That would be like the tail wagging the dog,” Andriesen told ICIS. “The supply and demand for the physical is what drives those swaps. The swaps markets are very much secondary and get their value from physical market participants.” ■

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Changing the paradigm



PHOTO: U.S. BORAX

The fertilizer industry needs to create a new generation of ‘NPK-premium’ compound fertilizers, argues **Jordi Bru**, to offer farmers the completely balanced crop nutrition products they require.

Food security is one of today’s largest global challenges. With growing populations and changing weather patterns, we need to increase crop productivity, if we want to have a sustainable world. Society and industry have the opportunity to collaborate in order to solve this problem. The fertilizer industry has a responsibility to provide economically-sustainable solutions that maximize productivity without negatively impacting the environment.

The future of fertilizers

Agriculture technology is evolving with:

- Better trained and prepared farmers
- Modern, more effective farm machinery
- The use of unmanned aerial vehicles (UAVs, drones) in soil and crop mapping
- Precision agriculture techniques, including variable rate application (VRA) and controlled traffic farming (CTF)
- Nitrification inhibitors that reduce nutrient losses and the environmental impact of nitrogen fertilizers
- Controlled-release fertilizers (CRFs)

- Biostimulants
- New, more productive and genetically-modified crop varieties

With all of these fantastic new tools, we run the risk of relying on new technologies to solve all of our problems. While forgetting one important factor: the basics of nutrition.

Change of thinking

The fertilizer industry needs to adapt and evolve to keep pace with agricultural technology. Can you imagine a new, productive crop variety, cultivated using the latest technology, but still grown in a soil suffering from boron (B) and zinc (Zn) deficiencies, and fertilized only with the macronutrients nitrogen (N), phosphorus (P) and potassium (K)? Unfortunately, this is quite common. In some countries, B and Zn micronutrient deficiencies affect 80 percent of the arable land, and yet farmers are still not using the right fertilizers to correct these deficiencies.

Our industry needs to fundamentally change the way farmers think about fertilizers – making it automatic and second

Above: Borax mine and processing complex, California.

nature to always incorporate other valuable nutrients within compound NPKs, such as magnesium (Mg), sulphur (S), B, and Zn. The inclusion of a wide range of nutrients in each single granule offers farmers big advantages. So why limit fertilizer formulations to only N, P, and K? This is neither a complete nor balanced nutrition solution!

When fertilizers are produced by physical blending, all of the required nutrients are added. So, why not do the same with compound fertilizer manufacturing? At the very least, the new generation of compound NPKs should offer a much more complete and balanced plant nutrition solution, including Mg, S, B, and Zn – to provide farmers with a safe and sustainable value-added fertilizer.

Cost-efficient nutrient supply

While the industry is supposedly very interested in value-added products, today only a few producers are adding valuable nutrients like B and/or Zn to dry, soil-applied fertilizer formulations, and then only in specific production campaigns.

Why is there such a disconnect? Cost is certainly one explanation. The majority of fertilizer users will opt for lower-price NPK products when comparing prices. Yet, these users are missing the fact that the other essential nutrients that deficient soils cannot provide are also absent from these NPK products.

This is not the case in high-tech agriculture involving fertigation or foliar applications. The farmers in this sector do not miss-out on any nutrients in their fertilization programmes. Water-soluble NPK fertilizers used in drip irrigation, for example, all contain Mg, S, and micronutrients such as B, iron (Fe), manganese (Mn) or Zn as standard. Drip irrigation needs to apply *all* of these nutrients to the wet bulb.

So, why is extensive agriculture not doing the same when we know that many soils are deficient in essential crop nutrients? Extensive agriculture (soybean, oilseed rape, cotton, alfalfa, corn, sugar cane, and other crops) must maximize productivity. Small additions of micronutrients like B and Zn can contribute to this at a minimum cost and with an attractive return on investment.

In some countries, the use of NPKs with micronutrients can be economically favourable, even for broad acre cereal crops such as rice and barley. Other crops, including coffee, palm oil, and eucalyptus, have even higher requirements for some micronutrients such as boron. Yet, it's not only about adding nutrients in the *right* place at the *right* time. It's also about adding the *right* source in the *right* quantity. The quantity of micronutrients required by crops is small but needs to be applied using plant-available (water-soluble) sources.

Adding value

The fertilizer industry needs to create and offer farmers new and more efficient solutions to change their whole mind-set about nutrition. Crop nutrition is no longer simply about N plus P plus K.

There was a time when farmers were able to achieve good harvests by only applying N. Then, researchers found that some soils could not supply enough P and K. And now, after many years of cultivation, soil mining by crops means that even nutrients required in small amounts have become deficient and yield-limiting. These are nutrients that are traditionally classified – wrongly in my view! – as secondary nutrients or micronutrients. This nomenclature is belittling and counterproductive as it makes them seem less important. Whereas, in fact, the failure to supply these 'other nutrients' is mainly responsible for the unbalanced fertilization that is holding back crop productivity currently.

By offering premium products, the fertilizer industry has a fantastic opportunity to demonstrate the knowledge and experience accumulated over many years. NPK compound fertilizers will be considered premium products only if other nutrients such as Mg, S, B, or Zn are added during the compound fertilizer production process. If not, NPKs will remain increasingly unsuitable commodities with no added-value, and will not provide farmers with the right solution. The era of NPK-only fertilization may be finished, to be replaced by a new generation of more sophisticated compound fertilizers which, similar to water-soluble fertilizers, will contain at least seven nutrients: N, P, K, Mg, S, B, and Zn.

New generation NPK+ products

This new generation of NPKs should be named NPK-premium (or *NPK+*), indicating the added value of the other essential nutrients. In the future, perhaps only *NPK+* products will be produced and marketed commercially.

Hopefully, in the next few years, we will see new NPK compound formulations for dry application to soil including Mg, S, B, Zn, Mn, and other essential nutrients. The needs of soils and farmers are different, country-by-country, so the concentrations of micronutrients present will vary. Companies need to take the lead and implement field research to meet and satisfy these different user needs.

What levels of micronutrients should the new generation of *NPK+* fertilizers for dry application contain? One possible formulation, in addition to the appropriate N, P and K levels, is as follows:

- 0.8% Mg
- 0.8% S
- 0.02% B
- 0.05% Zn
- 0.015% Cu
- 0.15% Fe
- 0.01% Mn
- 0.001% Mo

Although this will add more complexity to the production process, the required adjustments in manufacturing plants will be worthwhile and cost-effective – because of the extra value being created.

While fertilizer producers and agronomists will need to decide on the exact formulations, the overall concept is a clear and viable. The new generation of *NPK+* fertilizers should include sufficient amounts of all essential nutrients to maintain minimum levels in soils and avoid crop deficiencies.

From this point onwards, compound fertilizers should in some cases, include higher amounts of some elements like B and Zn for those crops with higher demand. In others, higher amounts of Mg or S will be required. This is the right path and the necessary way forward for efficient fertilization that replaces the application of standard NPK products.

In conclusion, differentiation of compound fertilizers by value is needed and possible.

And this is just the first step. ■

About the author: Jordi Bru is the global market development director for agriculture at U.S. Borax.

The International Fertilizer Association (IFA) is helping to fully develop the career potential of younger employees through its Young Professionals initiative. This is providing a new generation of industry professionals with access to mentoring and career development advice. It also gives individuals a chance to network with their peers, as well as subsidising attendance and participation at international conferences.

To support IFA's new initiative, *Fertilizer International* magazine is running a series of profiles featuring industry young professionals. These highlight the wide range of attractive and rewarding career options available to young people in the fertilizer sector. In this issue, Sara Ormaza Calderon of Anacofer, Mexico's fertilizer industry association, talks to us about her career.

Sara Ormaza Calderon, 36, general manager, Anacofer

How did your career in the industry start?

I joined Anacofer in November 2017. My family is from Mexico's Sinaloa region, where 50 percent of our vegetable exports come from. My grandfather, father and two of my uncles were all involved in agriculture. So I did know fertilizers were important to growing better and healthier vegetables. But, when I was interviewed by Anacofer's president, it was primarily the value of my business and administrative skills that helped me enter the sector.

What achievement are you most proud of?

Supporting our member companies as a group by having better communications with government. I've been able to work much more closely with the regulator Cofepris to standardise criteria for fertilizer products, for example, and to speed-up company registrations. That requires patience as it's a slow process with small advances – politics is not fast! I've also represented Anacofer at international conferences in Argentina and Berlin and put a face to an organisation that many people didn't know existed before.

What do you find most rewarding about your job?

Everything, really! I enjoy all parts of my job and working with Anacofer's new president. I'm an organised person who definitely likes putting things in order. For me, it's about having a vision, how far we can go as an association, what we can achieve. Contributing to my country and making a difference is important to me. By raising awareness about the proper use of fertilizers, I know we can help agriculture to grow in Mexico.

Young professionals

What hurdles have you had to overcome?

Nationally, the agricultural sector is changing a lot and, internally, Anacofer is also making positive changes. I've needed to overcome my lack of experience and quickly get on-track with both the sector and our members, find out what they do, what their goals are, what they need. But these are surmountable challenges. It's just a matter of having patience, asking questions, listening, prioritising and then acting.

How do you get the best from yourself and colleagues?

Always appreciating everyone's efforts. Sharing and communicating these as team achievements. That is what inspires my colleagues and myself to work harder and better. I have a saying: if you want to go fast, go alone, if you want to go far, go together. Achieving a challenge, even a small one, is a moment to be savoured. It's what motivates me. Challenges should always motivate people, as they're a chance to grow personally and professionally every day.

Has mentoring been important to you?

Mentors are essential. As we never finish learning. And each person has different experiences to share. From the Mexican fertilizer sector, Thomas Hultin and Juan Beron have both been key to my progress in Anacofer. I've also been lucky enough to have received support from IFA and from David Roquetti at Anda, Brazil's fertilizer association. My grandfather and both my hard working parents are a great inspiration to me as well. They taught me a 'yes you can' attitude to life, to never stop learning and, if you fall, get up and give 100 percent.



PHOTO: IFA

Will your job and the industry change in future?

A lot is already changing in Mexican agriculture. With a new government, new rules, new players, it's a whole new game. I think that fertilizer trading in Mexico will become easier in future. At the same time, fertilizers will become more complex in their composition too. So we will have to update our own knowledge to be able to train other people about the benefits of new products.

Would you recommend a career in the sector to others?

Of course, yes! For me, as a beginner, it's a noble career in an interesting industry. You can make an impact – a good impact – in your city, region and country. There is a lot of work to do, reaching out and changing perceptions, informing people about what fertilizers can do, how they produce more food, better food and make land healthier. That's what makes careers in the fertilizer sector so interesting and important – and why fertilizers are flourishing worldwide.

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phosphates & potash

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Filtration equipment selection

What are the best types of vacuum filtration equipment for phosphoric acid production plants? We explore the options available from manufacturers Andritz, FLSmidth, Hasler Group, Prayon, Technip, Tenova and WesTech.

Thickening and clarification steps are integral to the phosphoric acid production process. In phosphoric acid plants, thickeners are used to concentrate phosphate rock slurry prior to the reactor stage, while clarifiers remove fine gypsum from the phosphoric acid product, typically by vacuum filtration.

Plant economics and performance

Process flowsheets for phosphoric acid production are offered by companies such as Prayon and Jacobs, the latter being responsible for the design of around 40 percent of phosphoric acid plants currently operating globally. Process selection is a primary design consideration, as is production output – with an industry trend towards constructing larger capacity phosphoric acid plants (1,000-1,500 t/d P₂O₅) since the early 2000s. Once the production process has been selected, and the scale of operation decided upon, the selection of suitable vacuum filtration equipment then becomes a vital technical and economic consideration for any phosphoric acid plant¹.

Vacuum filtration

Essentially, there are three options when it comes to selecting vacuum filtration equipment for phosphoric acid plants:

- Table filters
- Tilting pan filters
- Horizontal belt filters

Although they vary in terms of capital outlay, operating/maintenance costs and performance characteristics, all three types of filter are capable of producing phosphoric acid efficiently and economically.

It can be tempting to select the lowest capital cost equipment, as a straightforward and clear-cut way of discriminating between the options on offer. However, selecting filtration equipment primarily on the basis of the capital cost is often a false economy, as the initial savings can be outweighed by poor performance and recurring costs during subsequent years of operation¹.

Although less obvious at the outset, a range of other factors – such as equipment quality, installation cost, and ongoing operational and maintenance costs – also need to be taken into account when selecting filtration equipment.

To further complicate matters, choosing a filter based on its good performance at an existing phosphoric plant of similar design can also be unwise, due to differences in phosphate rock properties and maintenance and operating practices.

Table filters

Table filters, also known as horizontal pan filters, are designed for continuous vacuum filtration of relatively coarse, granular, fast-settling solids. They consist of a circular filtration surface rotating in a horizontal plane. The filtration surface is excellent for both cake washing and drying. After moisture has been reduced by an applied vacuum, the cake is removed by a wear-resistant cake discharge scroll.

The main applications of table filters include the filtration washing of coarse-grained slurries in bauxite and phosphate processing. Their advantages and potential drawbacks are summarised in Table 1.

Originally developed in the early 1960's, the *UCEGO® Filter* marketed by **Technip** is specifically designed to filter phosphogypsum slurry generated by the dihydrate and hemihydrate production processes. The filter has been adopted throughout the global phosphates industry with worldwide sales to some 28 countries. More than 90 *UCEGO® Filter* units have been installed in plants responsible for over 35 percent of the world's phosphoric acid production.

The main performance and cost advantages of the *UCEGO® Filter* are listed in Table 2.

The *UCEGO® Filter* is also suitable for retrofits at existing plants. Its compactness and high per-unit-area filtration capacity helps to optimise throughput for a given space. These characteristics make the *UCEGO® Filter* an ideal replacement.

Table 1: Table filters: advantages & potential drawbacks

| ADVANTAGES | DISADVANTAGES |
|--|--|
| Technical | |
| <ul style="list-style-type: none"> ● Good cake washing and dewatering ● Minimal acid dilution ● Maximum filtration area | <ul style="list-style-type: none"> ● Low cycle times: maximum 0.75 rpm ● Incomplete cake discharge |
| Economic | |
| <ul style="list-style-type: none"> ● Acid clarity ● Maintenance costs | <ul style="list-style-type: none"> ● Capital investment ● Operating costs: particularly with high scale build-up ● Cloth blinding: cannot wash continuously |

Source: Summerhays & Gaspar (2016)

ment for tilting pan filters, according to Technip, especially when additional production output is required. Technip claims that replacing certain types of tilting pan filter with an *UCEGO® Filter* can increase filtration area by up to 100 percent for the same construction footprint. Retrofit installations only requires a short shut-down and the costs are minimal, according to Technip.

Tilting pan filters

Tilting pan filters consist of series of independent trapezoidal pans mounted on a rotating circular support structure (Figure 1). Pans are kept horizontal and under vacuum as they rotate during the filtration cycle. The cake is washed counter-currently during filtration, generally in three stages, with filtrates collected by separate vacuum receivers. The cake is eventually discharged dry at the end of the cycle. Following cake discharge, pans are tilted through 180 degrees and pass over radial manifolds fitted with high pressure jets to clean the cloth and dislodge any remaining cake.

The advantages and potential drawback of tilting pan filters are summarised in Table 3.

Prayon, through its PROFILE equipment division, is a leading supplier of tilting pan filters to the phosphates industry.

Table 2: Advantages of Technip’s *UCEGO®* table filter design

High filtrate recovery:

- Even and uniform distribution of slurry and wash liquors
- Efficient filtrate separation
- Easily movable washboxes
- Efficient filter cloth washing

High quality product acid

- No acid dilution

Low investment cost

- High capacity per unit of filtration area
- Maximum filtration area for minimal floor space
- Low level installation reduces construction cost

Minimum operating cost

- Heavy-duty construction – built to last 20-30 years
- Acid-contacting parts made of thick, high-quality stainless steel
- Moving parts are few and designed for long life
- Fast and easy cloth replacement

Wet and dry discharge capability

- No loss of active filtration area with dry discharge
- Separate cloth washwater recovery avoids additional water consumption
- Dry cake discharged directly onto conveyor from the hopper

High capacity and production rate

- High rotation speed due to mechanical simplicity
- Short filtration cycle
- Filtrate has a short report time to the central valve
- A large section central valve prevents blockages
- Vacuum kept high by the central valve’s air-tight, self-lubricating seal
- Patented ‘floating table’ design maintains a horizontal filtration surface at all temperatures

Source: Technip

Fig. 1: Prayon’s tilting pan filter



Source: Prayon

Around 250 of the 300 tilting pan filters sold by Prayon since the 1950s have been installed in phosphoric acid production plants worldwide.

According to Prayon the main benefits of tilting pan filter include:

- High level of reliability due to their robust design, with some 1960s filters still in operation
- On-stream factor of over 95 percent
- Excellent capacity/extraction yield ratio, due to batch filtration and a high maximum vacuum level
- Energy efficiency
- Cake discharged contains very little free water

- Prayon's proven track record with very large filters, e.g. the 30-240 filter with a surface area of 275 m²

Prayon has improved its tilting pan filter design over the years. The main developments are:

- A special compact vacuum box for separating gases and filtrates
- A fast-drain filtration cell (pan) to increase filter capacity and filtration yield
- An automatic system to keep the pans horizontal
- A new tilting-track design for higher rotation speed and filtration capacity
- Support rollers designed for heavy loads

- A robust rotating frame with a replaceable wear plate
- A new waterproof cloth-fixing system for quick cloth replacement
- A high-filter surface-to-base-area ratio

Prayon also developed a new *TDI* tilting pan filter design in 2002. In a *TDI* filter, the pans invert by tilting sideways to a vertical position. The *TDI* unit can be installed on the base plate of an existing tilting pan filter to provide 30-50 percent additional surface area. This new design offers the same benefits as Prayon's classical tilting pan filter, while also enabling the filtration of very thick cakes. The main benefits are:

- Compactness
- Batch filtration
- Fewer mechanical parts
- Lower energy consumption
- Lower investment costs
- More efficient cloth washing

ANDRITZ has been selling tilting pan filters for over 50 years. The company has over 300 units installed worldwide, primarily for phosphoric acid manufacturing via the dihydrate, hemihydrate, and combined hemihydrate and dihydrate processes. Its tilting pan filters treat more than 80 percent of all phosphoric acid in the US, for example.

With a large filter area in excess of 200 square metres, the **ANDRITZ** tilting pan filter has the capacity to perform the same task as a number of smaller filters. The filter has the flexibility to discharge solids as either a wet cake or dry cake. It also offers exceptional wash efficiencies, according to **ANDRITZ**, with a flood-washing capability that extracts the maximum amount of water-soluble P₂O₅ at the lowest possible operating cost.

Horizontal belt filters

Horizontal belt filters have become increasingly commonplace due to their operational flexibility, large throughput and ability to handle corrosive slurries. They have largely replaced table filters and tilting pan filters in many industrial applications requiring a large filtration area and efficient washing.

The horizontal belt filter combines a perforated rubber drainage belt, travelling continuously in a loop around two rollers, with an underlying longitudinal vacuum box (Figure 2). The top of this box forms a moving seal with the bottom of the belt. Slurry is fed onto a filter cloth overlying the drainage belt.

Table 3: Tilting pan filters: advantages & potential drawbacks

ADVANTAGES

Technical

- Good cake washing and dewatering
- Minimal acid dilution
- Maximum filtration area

Economic

- Acid clarity

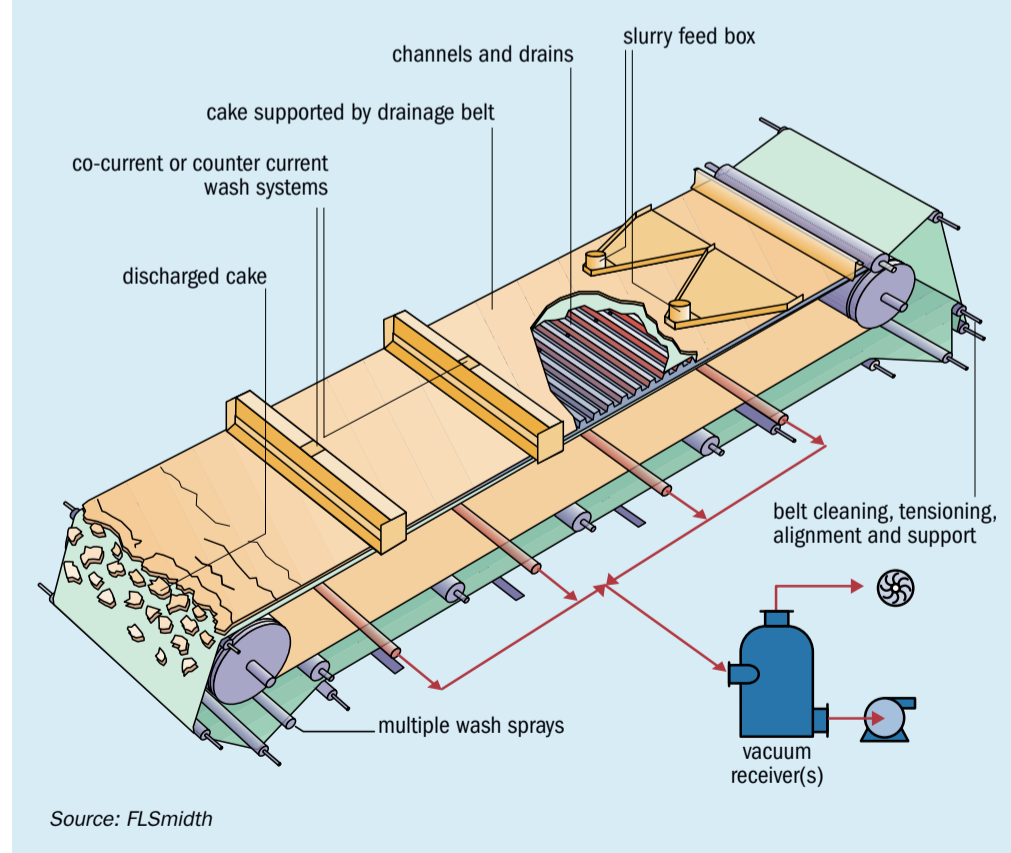
DISADVANTAGES

- Low cycle times: maximum 0.5 rpm
- Many rotating parts
- Less compact than table filter for the same active filtration area

- Capital investment
- Operating costs: particularly with high scale build-up
- Cloth binding: cannot wash continuously

Source: Summerhays & Gaspar (2016)

Fig. 2: Schematic of FLSmidth's *EIMCO*® *Extractor*® horizontal belt filter



Source: FLSmidth

Most manufacturers offer a choice of belt materials including natural rubber, SBR (HT or LT), EPDM, Chlor-Butyl and Neoprene. Pneumatic systems for lowering and raising the vacuum box are also commonplace, enabling fast and reliable maintenance and cleaning.

Filtrate is drawn down through the filter cloth under vacuum, entering channels/holes in the drainage belt, and then flows into the vacuum box beneath. Spray nozzles or a flood weir box are used for filter cake washing. The filter cake eventually separates from the cloth surface at the far end of the filter as the belt moves downward over the discharge roller.

Horizontal belt filters are used to filter calcium sulphate from phosphoric acid (counter-current washing) and to dewater phosphate rock (co-current washing). Advantages and potential drawbacks are summarised in Table 4.

Notable manufacturers include:

- Tenova/Delkor
- FLSmidth/EIMCO
- RPA Process/Filtres Philippe
- Prayon/Profile
- WesTech
- Outotec Larox RT
- Gaudfrin

Delkor has been manufacturing horizontal belt filters for 40 years, supplying more than 950 units globally over this period with a combined filtration area of 37,500 m² (Figure 3). The solid/liquid separation company is also the supplier of the world's largest individual horizontal belt filter unit. Delkor has often led the way in horizontal belt filter design and was the first manufacturer to introduce:

- Ripple curbing with superior vacuum sealing and longer life
- Wear strips and wear belts for vacuum sealing

Following the 2012 buy-out by Italy's **Tenova**, Delkor equipment is now offered as part of the mineral processing portfolio of Takraf, a German-based subsidiary of Tenova.

ANDRITZ also offers horizontal vacuum belt filters. These offer a number of advantages including:

- High filtration rates and large tonnage capabilities
- Excellent washing efficiencies and lower cake moisture
- Long service intervals and low maintenance costs

Table 4: Horizontal belt filters: advantages & potential drawbacks

| ADVANTAGES | DISADVANTAGES |
|---|---|
| Technical | |
| <ul style="list-style-type: none"> ● High filtration rates ● Effective filtrate extraction: <ul style="list-style-type: none"> ○ More challenging with wider belts ● Multi-stage cake washing ● Excellent cloth washing on both sides | <ul style="list-style-type: none"> ● Limited filtration area ● Few qualified belt suppliers: <ul style="list-style-type: none"> ○ Elastomer selection (material and supplier) is critical to a reliable filter ○ Extra care required in hemihydrate ○ Some not suitable for hemihydrate use |
| Economic | |
| <ul style="list-style-type: none"> ● Low capital investment ● Higher filtration rates ● Operating costs | <ul style="list-style-type: none"> ● Improper drainage belt and/or curb selection can lead to high maintenance ● Power costs from vacuum leakage, particularly if seals are not maintained |

Source: Summerhays & Gaspar (2016)



PHOTO: DEKLOR/TENOVA

Fig. 3: Delkor horizontal vacuum belt filter

FLSmidth supplies the *EIMCO® Extractor®* horizontal belt filter. More than 700 *EIMCO®* units have been shipped worldwide since they first became available in 1961. FLSmidth says it provides more choices of elastomer materials for drainage belts than any other horizontal belt filter supplier. The *EIMCO® Extractor®* is available in sizes up to 257 m². Its main features are:

- Low maintenance, heavy duty frame construction
- Belt speed of up to 200 feet/minute to reduce cake thickness and maximise production and cake washing efficiency
- Two types of belt-edge seal design
- Drainage belt carcasses encapsulated in elastomer to protect against chemical attack and delamination
- Hot vulcanised belt splices to maximise strength and protect the belt carcass
- Choice of water-lubricated or air-supported belt deck supports

Filtres Philippe® is a market pioneer having introduced one of the earliest horizontal vacuum belt filters to the market in 1948.

The company, now part of RPA Process/Hasler Group, has since installed over 500 units worldwide in a wide range of applications. Filtres Philippe® units are available in size up to 200 m². The main features are:

- Structural steel frame with no welded parts
- Factory-vulcanised endless belt with patented belt curbs that flex
- Pneumatically-driven cloth tensioning and guiding system
- Corrosion-resistant, vulcanised rubber pulleys with one-piece steel shafts
- Belt support system featuring endless wear belts and replaceable HDPE slide rails

Filtres Philippe® says it aims to supply the best belts in the industry, as these are the most critical component of the filtration system, in its view. The company's factory-vulcanized endless rubber belts last for 10-15 years, for example, compared to the average 5-8 year life of field-spliced belts.

Utah-headquartered **WesTech Engineering** has a long track-record as a major

Table 5: Vacuum filtration equipment summary

| Type | Table | Tilting pan | Horizontal belt |
|--|----------|-------------|-----------------|
| Production throughput | Mid | Mid | High |
| Purchase price | Mid-High | High | Low |
| Installation cost | High | High | Mid |
| Operating cost | Mid | Mid | Mid |
| Maintenance cost | Low-Mid | Mid-High | Low-Mid |
| Life cycle cost | Mid-High | Mid-High | Low-Mid |
| Cake wash efficiency | High | Mid | High |
| Dilution | Low | Low | Mid |
| Largest installed size (m ²) | 284 | 240 | 110 |
| Largest possible size (m ²) | 338 | 330 | 254 |
| Number of installations** | 200 | 150 | 150 |

* Note: Cloth life can drastically affect operating costs. Belt filters may have a significant advantage if cloth blinding is a problem. Conversely, the smaller amount of cloth required for table and pan filters – and the fact that cloths don't move – can work to their advantage, if cloth blinding is not problematic.

** At phosphoric acid plants globally, 2015 estimate

Source: Summerhays & Gaspar (2016)

supplier of vacuum filtration, clarification, and thickening equipment to the global phosphates industry. The company manufactures a wide range of horizontal belt filters. These are generally able to outperform traditional tilting pan and table filters, in terms of throughput and final cake moisture. The company is able to provide horizontal belt filters as a complete operational package, with vacuum pump, cake wash and cloth water skids, filtrate receivers and filtrate discharge handling equipment all included.

Design flexibility helps WesTech meet different application and process needs, and satisfy individual customer requirements. Various size horizontal belt filter units are offered, for example, with filter areas of up to 150 m² and with belt widths of up to 4.2 metres. Notable design features include:

- Co-current or counter-current washing
- Choice of mild steel, stainless steel and higher-grade alloy frame construction
- Monolithic, welded or bolted frame construction
- Belt frames up to 200 feet long can be welded prior to shipment, reducing on-site assembly time by 80 percent
- Bolted frame construction for rapid disassembly and reassembly and easy replacement of (and repairs to) the drainage belt and other components
- Four different belt support systems depending on the application, belt speed and resulting cake thickness

Prayon's equipment subsidiary PROFILE has also developed its own horizontal belt filter with the following characteristics:

- A polygonal vacuum box for pre-separating gases and filtrates
- A single centred wear belt with grooves allowing transverse displacements of the main filtering belt, enhancing vacuum tightness
- A main carrier belt with sloping grooves supported with water-lubricated rollers
- An automatic system for maintaining filter cloth tension and position

Discussion: no universal panacea

Horizontal belt filters are able to outperform traditional table and tilting pan filters, according to Tenova, due to their lower capital, running and maintenance costs. This holds true for large capacity applications requiring a combination of efficient cake washing and minimal liquor dilution.

Cake washing efficiency is a key factor affecting the profitability of phosphoric acid production. Horizontal vacuum belt filters can attain wash efficiencies of more than 99.8 percent by using multi-stage counter-current washing.

Nevertheless, there is no universal panacea: no single type of vacuum filter can outperform all others in every application. All have their own strengths and weakness (Table 5). However, it is possible to reach some general conclusions about their relative merits and operational performance¹:

- Horizontal belt filters offer high economic performance, at least in the short term
- Tilting pan filters typically lead the way, from a strictly technical point of view, but come with a correspondingly high price tag

- A table filter may be a reasonable compromise between the two other options, especially where space is limited, and for those processes without high scale build-up, and for applications which require little or no acid dilution

Conclusions

Vacuum filtration equipment needs to be selected according to individual plant needs using the best engineering solution available, while aiming for the lowest life-cycle cost. The main considerations when choosing equipment are¹:

- Equipment quality
- Service quality
- Spare parts availability
- Expected equipment life
- Capital, installation, operating and maintenance costs

Fertilizer International will review thickening equipment options in the phosphates industry in a forthcoming companion article. ■

Acknowledgement

The starting point for this article was the 2016 Procedia Engineering paper by Wes-Tech Engineering's Roger Summerhays and Abilio Gaspar¹, originally presented at the Symphos 2015 conference, Marrakech, Morocco, in May 2015.

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Cadmium removal technology

Tanja Schaaf and **Andreas Orth** of Outotec, and Proman Consulting's **Ludwig Hermann**, introduce a newly-developed thermal process for cadmium removal, and explain the wider policy context in Europe.

Proposed EU legislation

Acting on major health and environmental concerns, the European Commission is proposing to drastically decrease cadmium limits for mineral fertilizers in its draft regulation for fertilising products. This was published in 2016 as part the European Commission's Circular Economy Package. Under the Commission's proposals, limits would begin at 60 mg Cd/kg P₂O₅ but eventually fall to 20 mg Cd/kg P₂O₅ or below, 12 years after enforcement began. Proposed legislation on fertilizing products has yet to be implemented, however, being subject to lengthy 'trilogue' negotiations since January 2018.

Fiercely contested evidence

Cadmium is typically present in sedimentary phosphate rock at levels of around 25-200 mg/kg (P₂O₅). Such concentrations are largely transferred from phosphate rock to finished phosphate products during the manufacturing process. However, the extent to which phosphate fertilizers contribute to cadmium accumulation in soils – and what constitutes a safe and acceptable limit on the cadmium content of fertilizers – has become fiercely contested.

A recent study¹ concluded that there is no statistically significant changes (95% confidence level) in average EU soil cadmium levels for scenarios where average fertilizer cadmium content varies between

20-60 mg Cd/kg P₂O₅. While a previous study by Agroscope² came to a very different conclusion for Swiss soils. It calculated a much lower concentration (17 mg Cd/kg P₂O₅) as an acceptable cadmium threshold for fertilizers. Soil accumulations are unlikely for concentrations below this threshold, according to the Agroscope study, as soil outputs for cadmium will exceed inputs.

Cadmium transfer to humans

Despite the lack of consensus over acceptable cadmium limits for fertilizers, most studies generally agree that cadmium is transferred from soil to crops – to subsequently enter the human food and animal feed chains. There is also general agreement that the application of phosphate fertilizers supplies about 60 percent of the cadmium input to European soils.

The European Food Safety Authority has set the tolerable weekly intake level (TWI) for cadmium at 2.5 µg per kg of bodyweight. Vegetarians are likely to exceed this TWI, with an estimated average weekly exposure of up to 5.4 µg/kg. The consumption of food produced in areas with high soil cadmium concentrations could potentially lead to even higher exposure levels. Furthermore, there is concern about higher dietary exposure for children, who consume larger amounts of food relative to their bodyweight.

Consequently, the overall evidence suggests that interventions to reduce or

avoid the contribution phosphate fertilizers make to cadmium accumulation in soils are justified, particularly if effective cadmium reduction technologies are already available.

Existing processes

Cadmium removal technology is already relatively commonplace in the manufacturing of EU feed phosphates. Cadmium is removed from phosphoric acid to produce feed phosphates complying with EU regulatory limits (Directive 2002/32/EC). A cadmium limit of 0.75 mg per one percent of phosphorus (total maximum cadmium content of 7.5 mg/kg) is enforced for feed phosphate products.

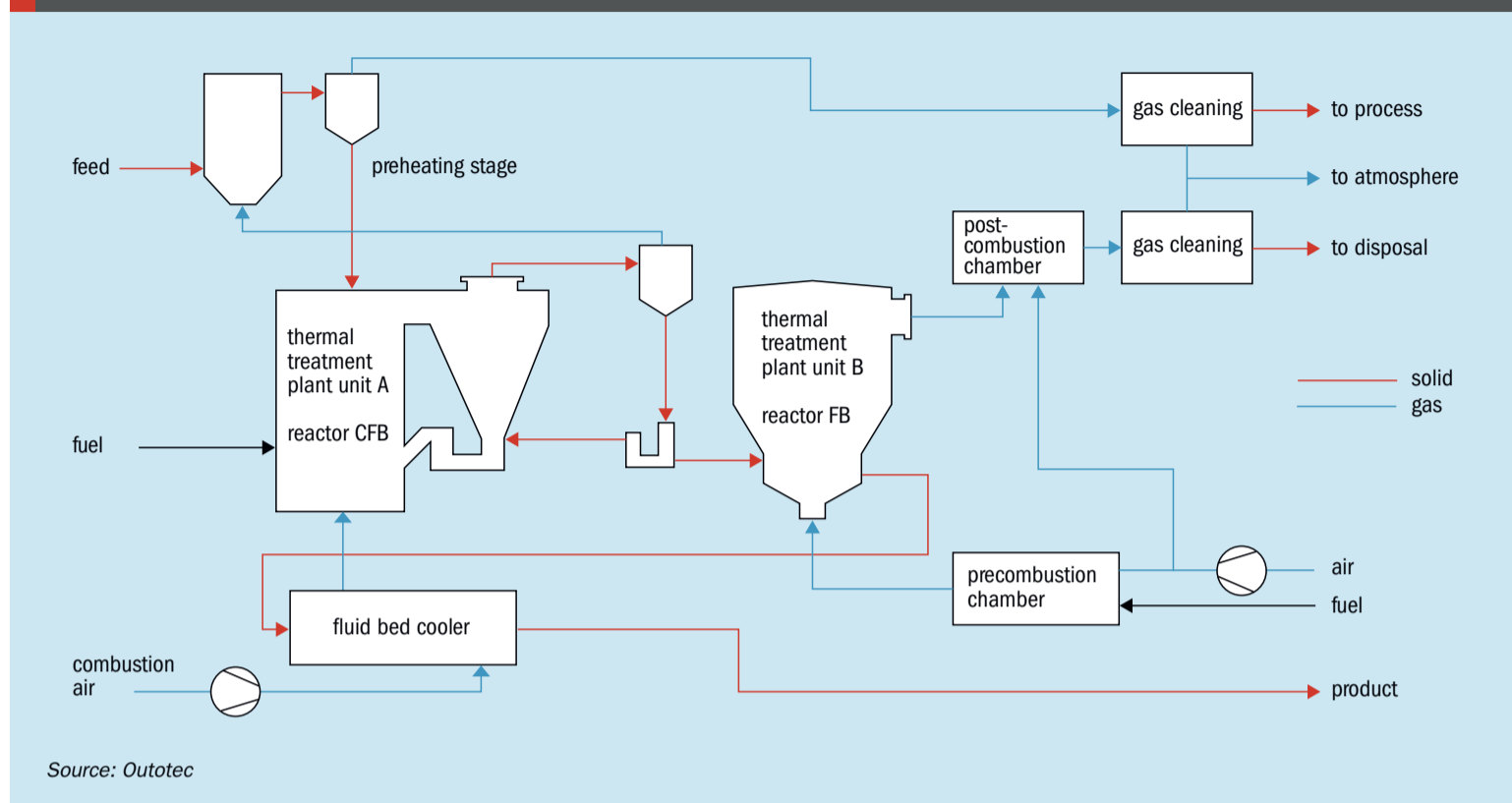
To achieve these limits, one of the following removal processes is generally applied to merchant-grade phosphoric acid:

- **Co-crystallisation** of cadmium in anhydrite (CaSO₄)
- **Precipitation** of cadmium as cadmium sulphide – which is then removed by filtration – through the addition of sulphur-containing reactants (H₂S, Na₂S etc.)
- **Ion exchange** removal of cadmium using cationic or anionic resins in fixed-bed, pulsed-bed or combined reactors, producing a cadmium-rich solution
- **Solvent extraction** of cadmium using an organic solvent, producing solids with cadmium contents of around 20 percent, with subsequent re-extraction to the aqueous phase

Although effective at removing cadmium, with extraction yields of up to 95 percent, alongside other undesirable elements, the above processes have a number of drawbacks and carry extra costs. These include the generation of cadmium-rich waste streams and the consumption of additional chemicals and energy.

Completely counterproductively, they can also add to fertilizer cadmium content. In solvent extraction, for example, the most widely-applied industrial removal process, the waste stream, instead of being disposed of, is re-added to merchant-grade acid destined for fertilizer production, i.e. the impurities from feed- and food-grade acid production end up being transferred to fertilizer products to avoid the need for waste disposal. Separate treatment and disposal of these waste flows will eventually become necessary, if and when strict cadmium limits are introduced for EU fertilizer products. This will create extra

Fig. 1: Outotec thermal process for cadmium removal



technical challenges and introduce further cost burdens.

The Outotec thermal process

Outotec has developed an effective thermal process for cadmium removal. This comprehensively-tested process involves calcination in a fluidised bed reactor at temperatures above 800°C.

The process incorporates Outotec's extensive experience with fluidised bed reactors and *AshDec* phosphorus-recycling technology. Uniquely, Outotec's thermal process, in contrast to the acid-based treatment processes described earlier, is applied directly to phosphate rock, the primary raw material.

Outotec's calcination-based process is particularly well-suited to those phosphate ores with high levels of organic matter and carbonate. The process helps eliminate these unwanted constituents, as well as cadmium and other volatile heavy metals, delivering a dry phosphate rock concentrate with very low organic and carbonate levels. It also improves the qualities desired in downstream phosphoric acid production by increasing the P_2O_5 content of the phosphate rock concentrate, and reducing the foaming caused by undesirable impurities.

Less waste, in the form of a dry cadmium concentrate, is generated by Outo-

tec's process, compared to wet-chemical cadmium removal processes. Encouragingly, the addition of selective, high-temperature filtration to the process has the potential to reduce waste levels even further.

Heating phosphate rock to more than 800°C does consume additional energy. But the results of a holistic life cycle assessment show that the benefits of Outotec's thermal process, namely the lowering of cadmium concentrations in fertilizers, generally outweigh the impact of higher energy consumption. The reduction in the surface area of phosphate rock concentrates as a consequence of calcination does, however, remain one drawback of the thermal cadmium removal process.

Cadmium removal feasible

For certain end markets, the industrial-scale removal of cadmium is technically and economically feasible, as has been conclusively demonstrated by the wet-chemical processes employed in feed phosphates manufacture. Calcination has also been successfully applied commercially in mining and mineral processing at several locations, albeit for purposes other than decadmiation.

Cadmium removal would undoubtedly increase fertilizer production costs, if implementation was widespread. Nev-

ertheless, the ultimate impact on overall food and animal feed prices is likely to be modest. For example, the costs of thermal cadmium removal (estimated at €20/t of phosphate rock concentrate, 33% P_2O_5) would translate to an increase in farm-level fertilizer application costs of around €1.8-3.0/ha, assuming a typical per hectare application rate of 30-50 kg P_2O_5 .

Consequently, given a reasonable transition period for industrial implementation, the key question regarding the introduction of cadmium limits for EU fertilisers is not: is it technically or economically viable? Neither is it question of limiting supply to low cadmium igneous sources of phosphate rock. Instead, the real question is: does European society as a whole accept the marginal additional cost to food and animal feed, as a price worth paying in order to reduce the risks cadmium poses to human health, and protect EU soils from long-term cadmium accumulation? ■

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33rd FLSME Regional Mining Conference

Sharing the message in Lakeland

Hosting its 33rd annual conference, the Florida Section of the Society for Mining, Metallurgy & Exploration (FLSME) joined forces with the American Institute for Chemical Engineers (AIChE), the American Institute of Professional Geologists (AIPG) and the Association of Fertilizer and Phosphate Chemists (AFPC). The venue was the RP Funding Center, Lakeland, in the historic heartland of Florida's phosphate mining and processing industry, and today a centre of excellence for industry technology and research. The theme of the two-day meeting between 3-4 October was 'Share the Message'.

The conference agenda started with a plenary General Session on the first morning. This was followed by a series of parallel Technical Sessions, covering:

- Public relations
- Reclamation
- Innovations in technology
- Chemical processing
- Health & safety
- Mining
- Analytical and regulatory issues
- Mineral processing
- Geology

In the opening General Session, chairman Todd Parker of ArrMaz introduced the keynote presentations. **Mike Williams**, public affairs manager for Nutrien at White Springs Phosphate, kicked-off proceedings by addressing the conference's main theme in his talk on 'Sharing the Message: Phosphate Public Relations'. Mike noted that the fertilizer industry has three particularly good messages:

- It has helped to enhance food security around the world
- Farmers do a great job in this respect, but they do need nutrient inputs
- World population growth continues, ensuring a continuing food security challenge

"We have the noble mission of helping to feed the world, and 55 percent of food supply relies on nutrient inputs," Williams said.

Our US correspondent **Mark Evans** reports on the 33rd Annual FLSME Regional Mining Conference, 3-4 October, Lakeland, Florida.



He also pointed to the industry's good record on environmental stewardship, with the restoration of mining lands following best management practices. At Nutrien's White Springs complex, the company has planted 18 million trees, while Mosaic with its larger holdings has planted even more. "In this way, we are no longer just mining companies, but have responsibilities to the wider community," said Williams.

Mike also outlined the industry's economic message. This is of ever greater significance, given the payment of around \$86 million in local taxes, plus severance taxes. Phosphate mining and downstream fertilizer production have directly created

around 6,000 local jobs, with five times that number in indirect jobs. The annual payroll, an estimated at \$500 million, also benefits the local economy significantly.

Brazil: phosphates market dynamo

Oliver Hatfield, director of fertilizers at Integer Research, gave an overview and outlook for Brazil, a key phosphates market. This examined what's driving demand growth and its impact on phosphates supply from imports and domestic sources.

Oliver highlighted the strong link between phosphate demand in Brazil and the country's role as a major soybean

supplier to China. China's demand for soybeans has reshaped the global soybean market. Since 2000, world soybean production has doubled, while Brazilian production has increased fourfold, almost entirely for export. Brazil has increasingly exploited its soybean competitive advantage, based on improved yields and an expansion of the cultivated area, notably in the Cerrado region. The area sown to soybean in the Cerrado is around 16 million hectares, accounting for about half of Brazilian production, but the Cerrado soils have a relatively low nutrient content.

Brazil today ranks as the world's fourth largest fertilizer market, with consumption in 2014/15 estimated at about 14 million nutrient tonnes. In particular, phosphates demand which totalled an estimated 4.8 million tonnes P₂O₅ in 2014/15 is heavily skewed towards soybeans, accounting for some 57 percent of total P demand. Brazil's phosphate demand has increased fourfold since 1990, and the country is increasingly dependent on international supplies to meet the demand for P and other products.

These imports are on a scale that significantly influences global trade in phosphate fertilizers. For example, of an estimated 15 million tonnes P₂O₅ of global trade in DAP/MAP in 2017, Brazilian imports accounted for 6.2 million tonnes. Brazil has become the most important market for TSP and MAP and is a key destination for all the leading phosphate players.

Brazil's domestic production of phosphate fertilizers is relatively stable, at between 1.5-2.0 million t/a P₂O₅ overall. Phosphate rock imports are also important, totalling around 1.8 million tonnes (mainly from Morocco and Peru). Domestic rock capacity is an estimated 5.9 million tonnes, accounted for by Mosaic and China Molybdenum Co Ltd (CMOC). Mosaic has now become the country's leading phosphates producer, boosted earlier in 2018 by its \$1.1 billion acquisition of the assets of Vale Fertilizantes. These include five open-pit phosphate rock mines and over 4 million t/a of finished fertilizer production capacity.

Mosaic's acquisition effectively ended Brazil's efforts to formulate a national fertilizer production strategy. CMOC likewise bought into the Brazilian market, buying the Copebras business from Anglo American in 2017 for \$1.5 billion. As Brazil's second largest phosphates producer, Copebras' capacity includes a 1.3 million t/a phosphate concentrate facility and phosphoric acid production of 350,000 t/a P₂O₅.

Yara has also been a consistent investor in Brazil, most recently buying Bunge's fertilizer assets for \$750 million and a 60 percent stake in Galvani's SSP production and distribution business.

Brazil's phosphate demand prospects are robust. China's demand for Brazilian crops will also continue, strengthening trading links between the two countries. China is forecast to require an additional 90 million tonnes of corn and soybeans for feedstock, for example, requiring an additional 15 million hectares of agricultural land. Much of this new land is expected to be in the nutrient-poor Cerrado region, thus ensuring a vigorous demand for fertilizers. With a typical phosphate application rate of 60 kg/ha, this demand is expected to translate to 1.25 million t/a of additional P₂O₅.

Environmental advocacy

Emily Cooper, senior director of environmental policy at the National Stone, Sand & Gravel Association (NSSGA), discussed the 'Mining View of Federal Environmental Policy'. Her presentation outlined NSSGA's primary environmental advocacy issues, focusing on the Environmental Protection Agency's withdrawal and redrafting of the Waters of the United States Rule and changes to the Endangered Species Act.

Is the red dragon going green?

Robert Snashall, CRU's phosphate market analyst, reviewed China's phosphate industry and the market outlook for 2018. Robert traced the present global scenario back to 2016. Phosphate prices collapsed at the time, as low-cost Moroccan and Saudi tonnes pushed their way into the market. Chinese f.o.b. prices fell further as producers liquidated their stocks at prices lower than the cost of production. Since then, Chinese producers have been more controlled, cutting production and helping to tighten the market.

Today, phosphate prices stand some 40 percent higher than their 2016 lows. But as the low-cost Middle East and North African (MENA) producers expand, higher-cost producers will further retreat. Thus, Nutrien and Mosaic have cut capacity in North America, while higher phosphoric acid import prices have led to cuts in Indian DAP production. The Chinese phosphate industry has not fared well either, having to address such policy issues as:

- Environmental protection issues
- Shrinking domestic demand
- Producer consolidation
- High costs

Chinese environmental measures, in particular, are now starting to bite, notably in Hubei, Guizhou and Sichuan. These provinces together account for 58 percent of Chinese wet phosphoric acid capacity and 21 percent of world capacity. The authorities in Guizhou have imposed severe restrictions on the disposal of phosphogypsum waste, while the measures in Hubei require the relocation of two producers, Yichang New Yangfeng and Zhongfu Chemical. Phosphate rock mines have been shut down in Sichuan as part of policies to protect the panda, leading to higher prices for non-integrated phosphate producers.

Chinese phosphate fertilizer demand has also contracted in the wake of previous excess applications, having reached close to an average 80 kg/ha P₂O₅, 90 percent higher than in the United States. The Chinese government is now targeting a zero growth in chemical fertilizer consumption from 2020, and farmers will receive less state support as agricultural markets are liberalised. Farms in China are also using fertilizers more efficiently as they become larger and more commercial.

Consolidation is also the watchword among China's leading phosphate producers. Wengfu and Kailin look likely to merge, thereby creating the world's third-largest phosphates producer, while in Hubei, Xingfa is planning to take over Yihua's phosphate assets. Chinese phosphate rock mines are generally competitive, but facing mounting costs. These come from rising beneficiation costs, wage inflation, environmental compliance, depleted reserves of high-quality rock and producer indebtedness. Downstream production is under threat among the non-integrated producers, especially in the MAP sector, and up to 70 percent of present capacity could be shut down between 2018 and 2022. China's wet process phosphoric acid capacity is also expected to contract. A retreat from export markets would ease pressure on US producers, although new supplies from Morocco, Saudi Arabia and Russia could make up for lost Chinese tonnages.

Education plays its part

Dr Randy K Avent, founding president of Florida Polytechnic University in Lakeland, discussed 'Education and Industry: Role of

Florida Polytechnic University'. As a leading provider of STEM (science, technology, engineering and mathematics) education, the university has teamed up with Lakeland-based FIPR (Florida Industrial & Phosphate Research Institute) to undertake phosphate-related studies to improve the environment, protect public health and increase mining and processing efficiency. Mosaic is one of several industrial partners. In this way, the Florida Polytechnic University is helping to create a high-tech economy that will keep Central Florida in the forefront of phosphate technological know-how in the decades to come.

For the parallel technical programme sessions, this correspondent focused on phosphate industry presentations.

The biggest phosphate news you've never heard of?

In addition to chairing the 'Innovations in Technology' session, **John Wing** presented a paper entitled 'The Biggest Phosphate News You Never Heard Of'. This outlined the ultimately unsuccessful plan to convert the 2,650 t/d Oswal phosphoric acid plant in Paradeep, India, from the dihydrate process to the Yara hemi-dihydrate process. Yara was promising a 98 percent recovery rate.

As head of HiTech Solutions, John Wing helped develop conversion plans and basic engineering for the project, while an Indian company undertook detailed design. Construction was well under way before the project was abandoned. This deprived the complex of the benefits of a major reduction in rock and sulphur requirements, in John's view, as well as the generation of much electric power, the elimination of rock grinding requirements, and production of premium-quality phosphogypsum. IFFCO eventually acquired the operation.

Confessions of a phosphate engineer

Sam Houghtaling related his many decades of experience as a phosphate engineer, at home and abroad. His major contributions to the industry include the invention of:

- Wet rock grinding
- Conical strainers for phosphoric acid evaporators
- Dual-diameter DAP pre-neutraliser

His advice to industry engineers and managers was to take care in treating people well. Recalling how he was not always rewarded for his efforts, Sam stressed the need to share bonuses fairly with every project partic-

ipant, as they all are part of the same company team. Successful project delivery, in his view, requires making the fullest information available to both clients and colleagues. Sam reminded delegates that, despite their familiarity with US weights and measures, the metric system is today's global standard.

Wastewater treatment and management

Wastewater treatment at the Piney Point plant was reviewed by **Mike Mies** of Nclear Inc. Piney Point underwent five ownership changes from its opening in 1966 until its closure in 2001. Water management at the site continues to be an environmental concern. While the present system attempts to keep water on-site, there is a limited water storage capacity and continuing gyp-stack seepage. Previous attempts to treat wastewater at Piney Point have included double-liming and reverse osmosis (RO). More recently, Nclear Inc undertook a pilot trial to reduce the nutrient content of process water using *NanoClear*. This technology uses calcium-silicate nanocrystals to promote hydroxyapatite (HAP) formation in P-rich aqueous solutions. *NanoClear* can be applied as dry powder or slurry. The P present is permanently sequestered by adsorption onto the surface of *NanoClear* crystals. The Nclear trial successfully met discharge stipulations set by the Florida Department of Environmental Protection (FDEP) over a prescribed period.

UAVs and USVs

David O'Brien of SurvTech Solutions explained the increasing use of UAVs (unmanned aerial vehicles, drones) and USVs (unmanned surface vehicles) in mapping applications. These unmanned vehicles now make major contributions to the mapping market and are also useful aids in inspection operations. A low-priced UAV with camera and image processing software can offer a highly cost-effective solution. The technology will continue to boost productivity, reliability and efficiency as its developed and refined further.

Rare earth recovery

Ghazaleh Allaedini of FIPR reviewed rare earth element recovery via the treatment of phosphoric acid sludge. This focussed on polymeric flocculants and the effects of their molecular weight on filtration and rare earth recovery. FIPR has previously carried-

out extensive research on recovering rare earth elements (REEs) from various phosphate mining and processing streams, including tailings and wastewaters.

The phosphoric acid sludge generated from the evaporation of filter acid is a promising source of yttrium and heavy REEs, with a total REE concentration of 2,000 ppm present in sludge solids. Efficient solid-liquid separation is critical to the economic recovery of these REEs. Polymer-based flocculants help coagulated particles to coalesce into larger aggregates (flocs), preparing these for settling or enhanced filtration.

After testing a total of nine polymers, FIPR observed correlations between molecular weight, sludge settling rates and polymer type (neutral, anionic or cationic). The study concluded that:

- Higher molecular weight polymers resulted in faster slurry settling due a bridging effect
- Non-ionic flocculants of medium molecular weight trapped more REEs
- For cationic flocculants, less flocculation activity was observed, as molecular weight rose

The Farim phosphate project

Olga Kovalik of Itafos described the geology and mine design of the Farim phosphate project in Guinea-Bissau, West Africa. Itafos recently completed a detailed feasibility study (DFS) for the project. This reported reserves of 44.0 million tonnes (30% P₂O₅) and measured and indicated resources of 105.6 million tonnes (28.4% P₂O₅).

Itafos and its partner GB Minerals plan to produce 1.3 million t/a of phosphate rock from the project for an estimated mine life of 25+ years, with commercial production beginning in 2020. Drying, storage and shiploading operations at the port of Chugue will be connected to the Farim mine and processing plant via a well-constructed road.

Paste thickeners

A joint presentation by **Jerold Johnson** and **Les Webb** of WesTech Engineering looked at the benefits of paste thickeners. Such thickeners are a cost-competitive option for phosphate tailings treatment. Paste thickeners recover 30-40 percent more water, with rapid drying resulting in stable deposition within weeks. The benefits of thickened tailings include rain collection and removal and the avoidance of standing

surface water. It is important to design the sides of the tailings pit to ensure that rain collects properly, with an angle of repose of between 1-3 degrees.

Stack absorber performance

Rama Iyer of ERM explained how to estimate the emissions performance of stack absorbers from test data. The performance of absorbers can change over time, diverging from the original design specification, due to process modifications. The main purpose of compliance tests at stacks is to check on whether air permit limits are being met. Stack tests normally consist of three one-hour runs. This allows checks to be carried out on parameters such as absorber inlet and outlet compositions, to establish if these are unchanging and that process production rates are also constant. In this way, stack test data can be used to estimate absorber performance. Comparing the results obtained under operational conditions with design values and parameters also provides valuable insights.

Lab waste management

Ann Wortman of Mosaic explored the options for managing laboratory waste. Her starting-point was the aphorism that “dilution is the solution to pollution”. Most laboratories analysing chemicals, soil, water or air use a variety of toxic, corrosive or potentially flammable materials. Special consideration is required when managing expired chemicals, excess samples and analytical fluids. Unfortunately, the historical practice of flushing waste down a drain may no longer be good lab practice, or even a compliant one. To minimise waste generation, best practice is to:

- Choose a method with less hazardous reagents
- Reduce inventory
- Return excess samples
- Train lab personnel
- Replace mercury devices

Additionally, Ann recommended adding steps to lab procedures, including neutralisation, separation, fixation, oxidation and precipitation. Developing and following a laboratory waste management plan also reduces the risk of non-compliance with environmental regulations and adverse impacts on sewer systems and waterways.

Getting chemistry set for the future

William Hall of N-P-K Consulting LLC looked ahead at chemical method development and the skills chemists are likely to need in future. He observed that bodies such as AOAC, AFPC or ISO have done little to improve methods, after the surge of method improvements and new instrumentation introduced in the 1970s and 1980s. This included the introduction of automated wet chemical methods and ICP technology.

“Are we satisfied with the current methods and the data they generate?”,

Hall asked. In particular, co-operation to improve the accuracy, safety, speed and efficiency of fertilizer methods has generally been lacking, in his view. Little has been done to update and improve sampling and sample preparation methods, for example. “It is time to bring us into the 21st century,” urged Hall.

Regrettably, resources for the training of chemists and technicians also remain limited. A new collaboration between The Fertilizer Institute (TFI), AAPFCO and the AOAC should, however, start to change this. ■

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Potash project listing 2018

| Plant/project | Type | Company | EPC/EPCM contractor(s) | Location | Product | Capacity ('000 t) | Status | Start-up date |
|-----------------------|--------|--|---|-----------------------|------------|-------------------|--------|---------------|
| AUSTRALIA | | | | | | | | |
| Goldfields Salt Lakes | G, LBE | Salt Lakes Potash | | Western Australia | SOP | 50 | S | 2019* |
| Beyondie | G, LBE | Kalium Lakes | | Western Australia | SOP | 82 | FS | 2020 |
| BELARUS | | | | | | | | |
| Soligorsk III/IV | B, CM | Belaruskali | | Minsk | MOP | 100 | C | 2017 |
| Petrikov | G, CM | Belaruskali | | Gomel | MOP | 1,500 | UC | 2019 |
| Nezhinsky GOK | G, CM | Slavkaliy | China State Engineering Corp Deilmann-Haniel | | MOP | 2,000 | UC | 2019 |
| BRAZIL | | | | | | | | |
| Cerrado Verde | | Verde AgriTech | | Minas Gerais | TP** | 40 | C | 2017 |
| CANADA | | | | | | | | |
| Bethune mine | G, S | K+S Canada | Amec FW (Wood) | Saskatchewan | MOP | 2,000 | C | 2017 |
| Belle Plaine | B, S | Mosaic | Mosaic Engineering | Saskatchewan | MOP | 1,100 | C | 2017 |
| Esterhazy K3 | B, CM | Mosaic | Hatch/AMC | Saskatchewan | MOP | 900 | UC | 2019 |
| Rocanville | B, CM | Nutrien | Amec FW (Wood) | Saskatchewan | MOP | 500 | C | 2017 |
| Jansen | G, CM | BHP | DMC Mining | Saskatchewan | MOP | 2,000 | UC | 2023 |
| Wynyard | SM | Karnalyte Resources, GSFC | Amec FW (Wood) | Saskatchewan | MOP | 625 | FS, P | N/A |
| Southey project | G, S | Yancoal | | Saskatchewan | MOP | 2,800 | P | 2022 |
| ERITREA | | | | | | | | |
| Colluli | G, CM | Danakali, CMSC | DRA Global | Danakil Depression | SOP | 472 | P | 2021/22 |
| ETHIOPIA | | | | | | | | |
| Yara Dallol | G | Yara, Liberty Metals & Mining, XLR Capital | SNC-Lavalin | Afar | SOP | 600 | FS, P | N/A |
| Danakil Potash | G | Circum Minerals | | Danakil | MOP/SOP | 2,750 | FS, P | N/A |
| PERU | | | | | | | | |
| SalSud | G, LBE | Salmuras Sudamericanas | | Sechura desert | SOP | 100 | P | On hold |
| RUSSIA | | | | | | | | |
| Solikamsk II/III | B | Uralkali | | Perm | MOP | 600 | | 2017 |
| Berezniki II/III/IV | B | Uralkali | | Perm | MOP | 400 | | 2017 |
| Usolskiy | G, CM | Eurochem | | Perm | MOP | 2,300 | | 2017 |
| Volgakaliy | G, CM | Eurochem | | Volgograd | MOP | 2,300 | | 2018 |
| Talitsky | G, CM | Acron (Verkhnekamsk Potash Company) | | Perm | MOP | 2,000 | P | 2021 |
| SPAIN | | | | | | | | |
| Muga | G, CM | Highfield Resources Geoalca | | Navarra & Aragón | MOP | 1,100 | DFS | N/A |
| Cabananas | B | ICL | | Suria | | 300 | UC | 2018 |
| TURKMENISTAN | | | | | | | | |
| Garlyk | | Turmenchimiya | OAQ Belgorkhimprom | Lebap | MOP | 1,400 | C | 2017 |
| UNITED KINGDOM | | | | | | | | |
| Woodmsith Mine | G, CM | Sirius Minerals | DMC Mining STRABAG AG Jacobs | North Yorkshire | Polyhalite | 10,000 | UC | 2021 |
| UNITED STATES | | | | | | | | |
| Sevier Playa | G, LBE | Cystal Peak Minerals | | Utah | SOP | 27.5 | FS | 2022 |

Notes: Greenfield projects (G): generally, these must have reached feasibility study (FS) stage for inclusion. Brownfield expansions (BE): capacity indicates incremental additions, not total capacity. The following projects have not been listed as their current status is unknown: ThaiKali, Thailand, SinoAgri, Laos, Kalium Mineracao, Brazil, Ochoa, New Mexico. * Demonstration plant ** Super Greensand product initially

KEY
MOP Muriate of potash, KCl
SOP Sulphate of potash, K₂SO₄
TP ThermoPotash, glauconite
G Greenfield
B Brownfield expansion
CM Conventional mine
SM Solution mine
LBE Lake brine extraction
S Scoping
FS Feasibility study
P Permitted
UC Under construction
C Completed
N/A Not available or provided

Woodsmith Mine, United Kingdom

UK company **Sirius Minerals** is bringing a new multi-nutrient polyhalite fertilizer product to market. The polyhalite will be extracted at the under-construction Woodsmith Mine, near the town of Whitby, North Yorkshire, England, and sold to customers around the world under the name *POLY4*. The mine's initial capacity will be 10 million t/a, with the ability to double that output. First production tonnages are due in 2021 under the current project timetable (*Fertilizer International* 481, p56). Woodsmith Mine has a verified mineral resource base of 2.66 billion tonnes.

The Woodsmith Mine's twin 1.5-kilometre deep shafts, the deepest in Europe, will connect with an underground mineral transport system (MTS), located some 360 metres beneath the surface. A 23-mile long conveyor in the MTS will then convey the polyhalite ore to a new port-side granulation and shipping facility at Teesside on England's North Sea coast. The project is setting a new standard in sustainable design for a European mining venture. All the major mine infrastructure is hidden beneath the ground, for example, and the mine site itself is being landscaped to blend in with the natural environment. The project will have some of the lowest operating costs and smallest carbon footprint in the industry.

DMC Mining Services Ltd will use Herrenknecht Shaft Boring Roadheaders (SBRs) to construct the main shafts. The SBR, which marries together tunnel-boring and vertical cutting technology, delivers high sinking rates and has an excellent safety record. **STRABAG AG** will construct the MTS tunnel using three tunnel boring machines: one from surface at the port-end, one from the mine-end, and another at an intermediate site. The latter two will be launched from underground caverns, accessed via 360-metre deep shafts.



Vertical shaft sinking machine (VSM).

Jacobs Engineering Group has been selected as the contractor for the construction of the materials handling facility at Teesside, which will granulate the polyhalite ore.

Sirius has already achieved peak aggregate 'take-or-pay' contract volumes of 8.2 million t/a of production output. Customers include **Archer Daniels Midland Company (ADM)** in North America, **Wilmar** in Southeast Asia and **Cibra** in Brazil, as well as partnerships in China and Nigeria. Negotiations with a major European customer are also well-advanced. An extensive agronomy programme has already demonstrated the efficacy and benefits that *POLY4* will deliver. The programme includes 339 trials on 36 crops in 25 different countries. ■

Colluli potash project, Eritrea

Danakali Limited is developing the world-class Colluli potash project in the Danakil region of Eritrea, East Africa. Colluli is one of the most advanced and economically-attractive greenfield sulphate of potash (SOP) projects globally.

The project is 100 percent owned by the **Colluli Mining Share Company (CMSC)**, a 50:50 joint venture between Danakali and the **Eritrean National Mining Corporation (ENAMCO)**. Colluli benefits from an impressive SOP ore reserve of more than 1.1 billion tonnes. CMSC plans to develop this large, high grade resource to its full potential through a de-risked development approach, initially focusing on the production of SOP, a premium, chloride-free, multi-nutrient potash with limited sources of production globally. Colluli is an evaporite deposit and, with mineralisation starting at just 16 metres, among the shallowest potash projects in the world. This allows for open-cut mining – a simple, low-cost and water-efficient method of potash extraction.

Colluli will be developed in two stages. Module I will produce 472,000 t/a of SOP, with Module II ramping up production to 944,000 t/a. Even at this high level of production, the mine is estimated to have a 200 year life. Taking the project into production is expected to take approximately two years, once funding is secured.

A recently completed front end engineering design (FEED) study confirmed that a post-tax net present value (NPV) of \$902 million could be achieved with an internal rate of return (IRR) of 29.9 percent for Modules I and II. In June, Danakali also secured cash flow from future production by signing an offtake agreement with major producer **EuroChem**. EuroChem will take-or-pay up to 100 percent of the production from Module 1 (minimum 87 percent) for ten years, with an option to extend for a further three years. This news was followed by Danakali's dual listing on the London Stock Exchange in July, and the appointment of **DRA Global** as the project's engineering, procurement and construction manage-



Colluli evaporite.

ment (EPCM) contractor. These important milestones signify growing confidence in Danakali as it seeks to advance the project and secure funding.

Eritrea has a mature, proven mining industry, and has become more attractive for foreign investment following the signing of the landmark peace accord with Ethiopia. With Module I expected to create more than 500 permanent local jobs, the Colluli project has strong support from local communities in Eritrea. ■

Making a case for quality

When it comes to fertigation, the quality of water-soluble potassium sulphate (SOP) is of paramount importance. But how is quality best defined and measured? **Nicolas White**, portfolio and knowledge director at Tessenderlo Kerley International, outlines a unique quality index (QI) system for water-soluble SOP.

Quality: more important than price?

The selection of SOP products for fertigation is often driven by price. The product's characteristics and its various benefits and disadvantages are either not taken into account or are secondary considerations. Yet the physical and chemical properties of SOP are paramount when it comes to ensuring safe and easy handling, optimal plant nutrition and the preservation of soil quality.

Ensuring consistently high product quality has always been a primary motivation for Tessenderlo Group. Drawing on a 100 years of experience, we have been able to develop a special production process for our high-quality water-soluble *SoluPotasse*® SOP product. In parallel with this, we have also developed a sophisticated and unique quality index/scoring system for soluble SOP products.

Scoring system/quality index

Tessenderlo has independently identified eight important quality parameters for soluble SOP products, based on workshops and surveys with distributors and growers globally. From these customer consultations, a ranking system was agreed that prioritises four chemical and four physical parameters according to their importance (Table 1).

Each parameter was then weighted by distributors and growers according to their relative importance in a fertigation system. Based on the values observed in real samples, upper and lower levels were set for each parameter, corresponding to a maximum and minimum score. The resulting quality index (QI) scores SOP samples on a scale from 0 to 200, based on a weighted sum of values from eight parameters. Combining all these parameters gives a total maximum score of 200 points. A 'traffic light' scorecard showing high (green), average (amber) and low (red) thresholds for each of the eight parameters is shown in Table 2.

Table 1: Ranking of chemical and physical parameters

| Ranking, high to low | Chemical | Physical |
|----------------------|------------------|--------------------|
| Priority 1 | K ₂ O | Insolubles |
| Priority 2 | Cl | Dissolution speed |
| Priority 3 | pH | Maximum solubility |
| Priority 4 | Na | Dust |

Source: Tessenderlo Group

Table 2: 'Traffic light' scorecard system for measuring soluble SOP quality

| Chemical | Priority (1-4) | Scoring range | | | SoluPotasse® Average |
|---|----------------|---------------|---------|------|----------------------|
| | | high | average | low | |
| K ₂ O (%) | 1 | 52 | 51 | 50 | 51.5 (51 min) |
| Cl (%) | 2 | 0.3 | 0.65 | 1 | 0.6 (1 max) |
| pH (1% solution) | 3 | 2.5 | 3.5 | 4.5 | 2.9 |
| Na (%) | 4 | 0.2 | 0.6 | 1 | 0.34 |
| Physical | (1-4) | | | | |
| Insoluble (%) | 1 | 0.01 | 0.055 | 0.1 | 0.03 |
| Dissolved after 3 mins (%) | 2 | 95 | 90 | 85 | 90 |
| Max solubility (kg/100L) at 20° in pure water | 3 | 12 | 11.5 | 11 | 12 |
| Dust (%) | 4 | 0.03 | 0.1 | 0.17 | 0.05 |

Source: Tessenderlo Group

Chemical scoring

It goes without saying that any high-grade, water-soluble SOP product should have a high K₂O content. Products with a K₂O value below 50 percent are scored zero in our system, and are best avoided. The maximum score is only awarded to products with a very high K₂O content – 52 percent or above. Products with chloride levels of more than one percent should not be used in fertigation and score zero, while those with an extremely low chloride content of 0.3 percent receive the maximum score. Solution pH should be acidic to prevent dripper blockage and to optimise plant nutrient absorption. Products with

pH 2-3 receive the highest score, while neutral to basic products (pH >4.5) score zero. Sodium levels are a good indicator of product purity. High levels should also be avoided as the presence of salts near plant roots negatively affects nutrient uptake. Products with sodium levels above one percent are judged inferior and score nothing, while those with 0.2 percent sodium or less generate the maximum score.

Physical scoring

To prevent drippers being blocked, amounts of insoluble material are critically important from a grower's perspective. SOP products therefore need to have less than 0.1 percent

Fig. 1: Variation in the quality index (QI) of water-soluble SOP, based on analyses of 200 samples from different producers.

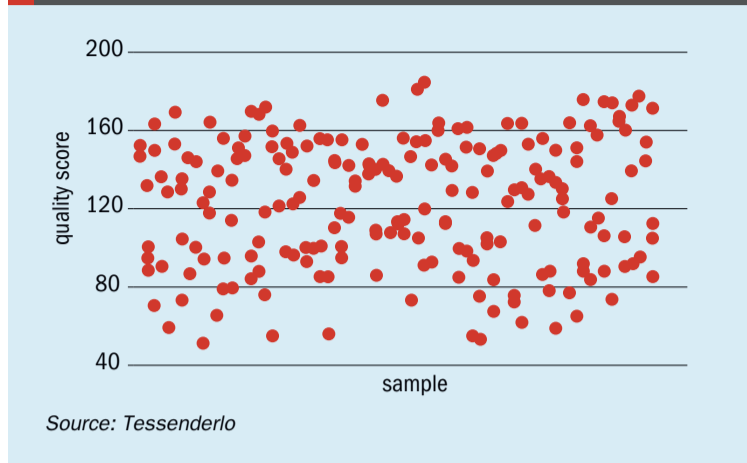
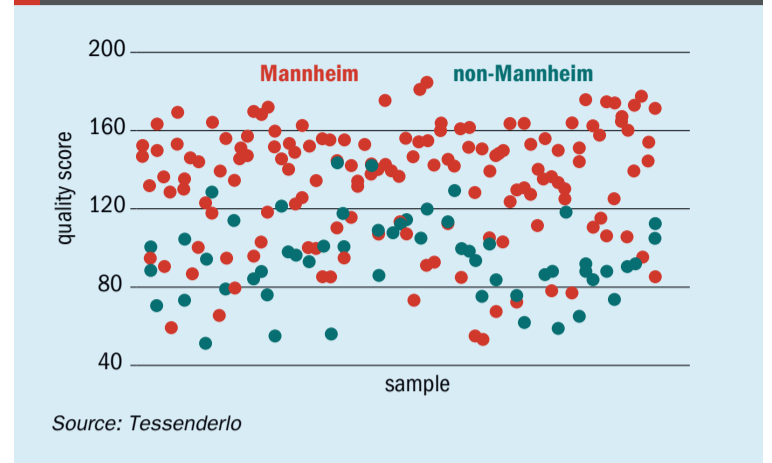


Fig. 2: Quality index (QI) of water-soluble SOP samples: classification by production process.



insoluble matter to be acceptable. Those products containing 0.01 percent receive a perfect score. Speed of dissolution is also a key criterion, as slow-dissolving products can increase costs and undissolved material may clog drippers. SOP products that are more than 95 percent dissolved after three minutes receive the maximum score, whereas products that are less than 85 percent dissolved score zero. Maximum solubility is an important parameter too, as it ultimately controls nutrient concentration. The maximum solubility of SOP is around 11-12 kg/100L at room temperature. Products with values below 11 kg/100L are of inferior quality and receive no points. High dust levels make products more difficult to handle and more difficult to dissolve. High quality products with dust levels at or below 0.03 percent receive excellent scores, whereas products with dust levels above 0.17 percent are of poor quality and do not score at all.

Inevitably, not every quality factor is captured by the scoring system. For example, most people agree on the need to exclude heavy metals such as cadmium and mercury from water-soluble SOP, both of which are below detection limits in *SoluPotasse*[®].

Results

Over the past five years, Tessenderlo Group has analysed more than 200 soluble SOP products against the above eight criteria. The quality index (QI) was determined on a wide range of samples collected from growers, distributors and retailers in different countries and regions globally. QI values varied widely, reflecting significant differences in the eight parameters (Figure 1).

Results confirm that QI is highly effective at capturing major variations in the most pertinent properties – and is therefore a valuable

way of defining and categorising soluble SOP product quality. Based on these results, we were able to define three different grades of soluble SOP:

- QI >140: products are suitable for use in all types of fertigation, particularly drip irrigation or hydroponics. The highest quality products generally score 150 or above.
- QI = 100-140: products are potentially suitable for fertigation, if serious precautions over composition and solubility are taken. But their use may be inadvisable under certain conditions, e.g. in drip irrigation, in hydroponics, with hard irrigation water, at certain crop growth stages, if incompatible with other mixing tank components etc.
- QI <100: products resemble standard grade SOP powder and are not suitable for any type of fertigation.

Influence of production process

We were able to identify the production process used for many of the samples analysed. Results suggest that part of the variability in product quality is attributable to the different production routes used in SOP manufacture (Figure 2).

Results clearly show an association between the Mannheim production process and good product quality. Mannheim is also the only process that gives an acidic product – one of the most important parameters for fertigation.

However, the Mannheim process – of itself – is not necessarily a guarantor of good quality, as many Mannheim products score below 140, some even scoring 100. The use of lower quality Mannheim products with these scores should be avoided in situations where they are likely to pose a risk, such as in greenhouse fertigation. Similarly,

a significant number of other products with a QI below 100 that are currently being sold on the market for use as water-soluble SOP will prove unsuitable.

Tessenderlo Group guarantees its customer that *SoluPotasse*[®] is a consistently high-quality product. The Mannheim production process at our factory in Ham, Belgium, is both computer-controlled and subject to regular in-house quality control checks.

Conclusion: quality matters

A wide range of fertigation products are available on the market. But their quality varies widely and many, unfortunately, are not suited to all types of fertigation. Also, their quality cannot be judged solely on the manufacturers' specification sheets or product declarations on bags.

We have concluded that products with a score below 100 should not be used in fertigation systems, whereas products with a score up to 120 are best avoided in high-tech irrigation systems. Products with a score above 140 can generally be considered the best reference products as they combine the best of all criteria simultaneously.

Only reliable partners with considerable production experience can offer high-grade water-soluble SOP of consistent quality. Mannheim technology, combined with Tessenderlo's unique production process for *SoluPotasse*[®], means we can maintain and guarantee a very high standard of quality. This is demonstrated by its superior quality index. *SoluPotasse*[®] has scored around 150 on average over the last five years, a score that our competitors are unable to equal consistently. This explains why *SoluPotasse*[®] remains, after more than 20 years, the reference product in the soluble SOP market. ■

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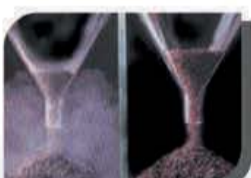
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