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JANUARY-FEBRUARY 2018

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Cover: *Close up of papyrus plant. Jerry Lin/Shutterstock.com*

The year ahead

Fertilizers for hard fruits

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A most volatile year

"Well, of course, prices may go up," one eyebrow raised, long pause for effect, "or come down." That was the slightly mocking, wry riposte of a former CRU publishing director, whenever he was asked about the future direction of fertilizer prices.

Anyone who pays good money for price reports will probably recognise an element of truth in this satirical observation. Out of necessity, such reports are phrased in cautiously guarded and highly conditional language. Seemingly concrete assertions are always matched with an opposing counter argument – caveats left safely in place to provide the author with a reassuring get-out clause. If challenged later, he/she can always argue, "Well, I only said definitely maybe, didn't I?"

> **"The future is always fuzzy. So price forecasts, in common with all predictions, need some degree of ambiguity built-in.**

If we're honest, though, this is only fair – as we are dealing with the future indefinite here. The future is always fuzzy. So price forecasts, in common with all predictions – whether from a palm reader or the IMF – need some degree of ambiguity built-in.

The fact that 2017 turned out to be such a roller-coaster year for sulphur, ammonia, urea and phosphate prices highlights an essential paradox. Sudden price volatility, of itself, creates an urgent market need for sound intelligence on future price direction. Yet, being unexpected, analysts are wrong-footed and none-too-wise as to the causes, at least initially.

Market assumptions were confounded, for example, and expectations defied by the remarkable rally in sulphur prices to a four-year high in late 2017. Vancouver and Arab Gulf benchmark prices rocketed to above $180/t f.o.b. in November 2017, having traded in the $80-90/t range during the year's first half. The price for Chinese sulphur deliveries, averaging $209/t in November, was even higher. This upward rally did eventually unwind, however, with the delivered price to China dropping to around $160/t by mid-December.

Analysts eventually identified unexpected supply shortages at key locations, coinciding with buyers scrambling for product, as the driving forces behind the sulphur price spike. The earlier-than-usual closure of rivers and waterways in Russia, due to harsh weather, was a key contributor to the sulphur supply tightness, depressing Russian export availability and causing some sulphur contract cancellations.

A few months prior to this, sharp rises in the urea price – again unexpected – apparently left the market reeling. Demand created by a quick succession of Indian import tenders during 2017's third quarter saw some producers concluding sales as high as $300/t f.o.b. Again, these rises were not sustained and the Black Sea urea price, which remained close to $280/t f.o.b. at the start of November, slid to around $230/t by the month's end.

Ammonia prices were not immune to the market volatility and also moved sharply upwards in the latter part of 2017. Export supply interruptions and stronger demand saw the Black Sea price break through the $200/t barrier in September, ending three consecutive months of price falls.

Ammonia supply tightness continued throughout 2017's fourth quarter. Prices moved steeply upwards due to stronger demand and supply interruptions affecting several key ammonia exporters. Between August and November 2017, the Black Sea price increased by some 49 percent to reach $286/t f.o.b. On the other side of the Atlantic, the Tampa contract price also increased by $118/t over the same period to reach $317/t cfr.

Due to the consumption of ammonia and sulphur as raw materials, the above price hikes had knock-on effects for phosphate producers and finished phosphate prices. Consequently, average phosphate product prices at major export hubs climbed to $360-380/t f.o.b. in November, partly driven upwards by higher raw material costs, to eventually reach the $380-400/t f.o.b. level in December. These price movements also reflected tighter product availability. Many phosphates producers were said to be committed to existing orders, leaving little left for spot market availability.

The fertilizer and raw material price spikes seen in 2017 were all largely unforeseen. What is equally clear, however, is that temporary supply tightness, expected or unexpected, seems to have been the common underlying factor behind market price volatility over last six months.

So the next time someone asks you for advice on price direction, you can always confidently say: "Check for an early Russia freeze, watch out for an abnormal flurry of Indian tenders, and look for unexpected plant shutdowns." ■

S. Inglethorpe

Simon Inglethorpe, Editor

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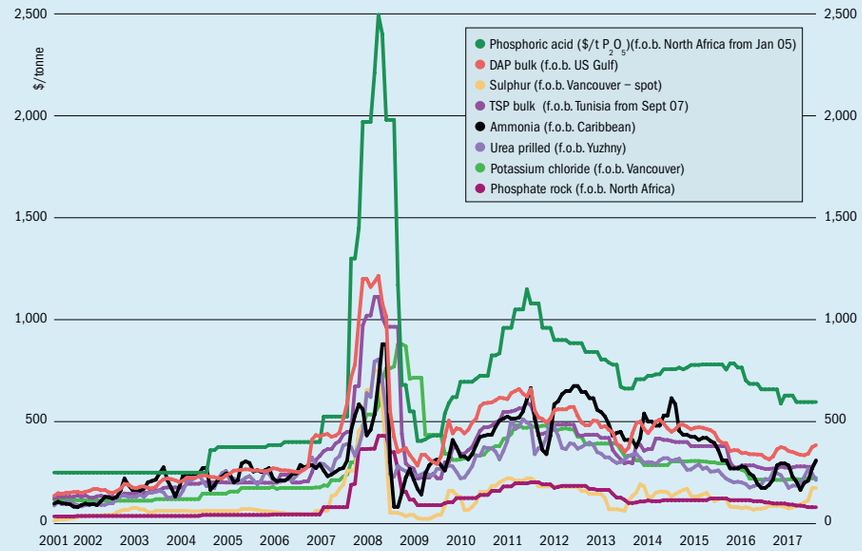
Market outlook

Historical price trends $/tonne



Source: BCInsight

Market insight courtesy of Integer Research

AMMONIA

The global market was tight throughout 2017's fourth quarter. Prices moved steeply upwards due to stronger demand and supply interruptions affecting several key ammonia exporters. Between August and November 2017, the Yuzhny Black Sea price increased by 49 percent to reach $286/t f.o.b. The Tampa contract price also increased by $118/t between August and November, reaching $317/t cfr.

This upwards correction brought ammonia prices back in to line with the values of other nitrogen products. Ammonia had been priced at a discount to urea for much of 2017, relative to long-term averages.

UREA

Market price gains seen in the third quarter of 2017 have not been sustained. In particular, the withdrawal of an important tender by NFL in India contributed to a price slide during November. Consequently, the Black Sea urea price fell from close to $280/t f.o.b. at the start of November to around $230/t by the month's end. Although NFL's final Indian urea import tender of the year was expected to support price sentiment heading into 2018, Black Sea urea prices remained largely unchanged by the end of December at around the $220/t f.o.b.

PHOSPHATE

After spending much of 2017's first half in the $330-350/t range, finished phosphates found some price support in November and December. Average prices at the major export hubs climbed to $360-380/t f.o.b. in November, rising further to $380-400/t f.o.b. through December. These price movements reflected tighter product availability. Most producers were committed to existing orders and had little spot availability. Phosagro in Russia was also operating at a lower utilisation rate due to planned maintenance.

Higher phosphate prices have not necessarily translated into higher margins and increased producer profits, as they were linked to hikes in ammonia and sulphur raw material prices. Sulphur prices, in particular, surged in October and November, peaking at their highest price level in almost four years.

POTASH

2017 is expected to be a record year for global potash demand. Integer is forecasting overall demand for the year of more than 63 million tonnes, a 3.3 percent increase on 2016. Demand has been boosted by stronger buying in the US, China, Brazil, India and many smaller markets. As a result, potash imports in the first nine months of 2017 increased by 27 percent year-on-year.

Vancouver and the Baltic MOP price benchmarks have remained relatively low throughout 2017, compared to recent years. Southeast Asian prices did however recover in the final quarter of 2017. Availability has become short with high freight rates contributing.

SULPHUR

Prices have continued to defy expectations. The November Vancouver and the Arab Gulf sulphur reference prices averaged around $181/t f.o.b., having traded in the $80-90/t range during the first half of 2017. The price for Chinese sulphur deliveries averaged $209/t in November. The upward price rally did eventually begin to unwind in December. The average price for sulphur delivered to China dropped to around $160/t mid-month, although this level remains substantially higher than prices seen during most of 2017.

The price spike has been spurred by sulphur supply shortages at key locations, some of these unexpected, combined with buyers scrambling for product. Sulphur buying activity in China was steady during September-November in response to declining stock levels. On the supply side, harsh weather and earlier-than-usual river and waterway closures in Russia led to lower-than-expected exports and the cancellation of some contract volumes.

Market price summary $/tonne – end-December 2017

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phosphoric Acid
f.o.b. Caribbean	320	n.m.	f.o.b. E. Europe 110-120	f.o.b. US Gulf	385	n.m.	n.m.
f.o.b. Yuzhny	310-327	215-235	-	f.o.b. N. Africa	390-410	295-315	492-700
f.o.b. Middle East	340	230-258**	-	cfr India	395-400	-	567-572*
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**		**Sulphur**		
f.o.b. Vancouver	210-237	-	cfr US Gulf	55-65	f.o.b. Vancouver	135-155	
f.o.b. Middle East	206-233	-			f.o.b. Arab Gulf	140-160	
f.o.b. Western Europe	-	€420-450			cfr North Africa	98-119	
f.o.b. FSU	192-229				cfr India	170-180+	

Prices are on a bulk, spot basis, unless otherwise stated. (= contract ** = granular). Phosphoric acid is in terms of $/t P_2O_5 for merchant-grade (54% P_2O_5) product. Sulphur prices are for dry material. (+ Quotes for product ex-Arab Gulf)*

MARKET DRIVERS

- **Ammonia:** Although prices remained firm as 2017 ended, due to steady US demand and residual supply tightness, Integer expects ammonia price sentiment to soften heading into 2018, as the market returns to its underlying state of oversupply. Looking ahead, the anticipated return of some operators from maintenance and other shutdowns should increase supply availability. Prices are unlikely to dip much below $300/t f.o.b. Although this assumes that key exporters will shift some nitrogen production away from the ammonia market into higher-margin downstream products instead.
- **Urea:** The expected December rebound in response to the final Indian tender of the year failed to materialise. But spring buying in North America and Europe should add some demand-side stimulus to prices in 2018's first quarter. That said, new supply-side additions are likely to cap any price inflation. The commissioning dates of new production projects will be a key influence on prices. Koch's new 900,000 t/a Enid, Oklahoma plant in the US was reported to be up and running in November 2017. The delayed Bulo Bulo urea plant in Bolivia has also signed sales agreements for granular urea, with material thought to be moving in November.
- **Phosphate:** We expect global phosphate market activity to pick up in the first quarter of 2018, as the northern hemisphere enters its period of high seasonal demand. Indian DAP purchasing for the upcoming *kharif* season crop will be closely watched. West of Suez, we expect robust Brazilian MAP buying, as the country's farmers secure inputs for the *safrinha* crop season.

  Despite the expected uptick in demand, it unlikely that prices will rise much above current levels in the first quarter. The finished phosphates market remains fundamentally oversupplied. Significantly, Ma'aden has added three million t/a of additional finished phosphate capacity to a market which was already long. To improve market balance, Mosaic recently announced the indefinite curtailment of two million t/a of phosphates production capacity at its Plant City, Florida site in 2018. But this move may not be sufficient to bring substantial upsides to prices. Instead, phosphates prices could track downwards if sulphur prices weaken, as expected.
- **Potash:** The demand outlook for 2018 is mixed. Integer's view is that demand is likely to decrease in some markets in 2018 because of stock building, the US being one example.

  On the supply side, some of the additional potash supply from new greenfield capacity, such as EuroChem's Usolskiy mine, will be balanced by capacity closures. Significantly, K+S plans to close its Sigmundshall mine in Germany in 2018. Despite these changes, the potash market is expected to become longer on supply in 2018 and beyond. Price movements will therefore be partly contingent on the supply management strategies of incumbent producers.
- **Sulphur:** Prices moved downwards in December as the factors which contributing to the recent price spike began to ease. The market is also seeing some price-related destruction of sulphur demand, as key phosphates buyers, already struggling on thin margins, have been unable to fully pass on higher sulphur spot prices.

  The 2018 outlook remains fundamentally unchanged, though, with the arrival of additional sulphur supply from new projects due to create an imminent supply surplus. Sulphur prices are expected to be significantly depressed when this additional supply emerges. We therefore expect f.o.b. prices to move further downwards in January. However, uncertainties over the start-up date of new projects remains a wild card factor.

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CANADA

Agrium and PotashCorp merge to become Nutrien

Agrium and PotashCorp successfully completed their merger at the beginning of January.

Nutrien, the new company created by the merger, will occupy a dominant market position as the world's largest fertilizer manufacturer and retailer. It will be a massive international player with nearly 20,000 employees and operations and investments in some 14 countries.

The proposed Agrium-PotashCorp merger was originally unveiled in September 2016, with the unanimous blessing of the boards of both companies, and promised to create a new fertilizer giant valued at around $36 billion.

The drawn-out regulatory review and approval process for the merger in Brazil, Canada, China, India, Russia and the US has lasted 15 months. The merger finally received the all-clear and overcame its last hurdle with the regulatory approval of the US government in late December 2017.

Confirmation of the merger's success came from Chuck Magro, Nutrien's new president & CEO, at the start of January:

"Today we are proud to launch Nutrien, a company that will forge a unique position within the agriculture industry. Our company will have an unmatched capability to respond to customer and market opportunities, focusing on innovation and growth across our retail and crop nutrient businesses. Importantly, we intend to draw upon the depth of our combined talent and best practices to build a new company that is stronger and better equipped to create value for all our stakeholders."

To gain regulatory approval, Potash Corp has agreed to divest itself of its stakes in rival potash producers SQM, Arab Potash (APC), and Israel Chemicals Limited (ICL). Agrium has also divested US nitric acid and phosphate production assets (*Fertilizer International* 481, p 10).

Despite these sell-offs, Nutrien still emerges as the world's largest standalone fertilizer producer, selling over 25 million tonnes of potash, nitrogen and phosphate products annually – into worldwide agricultural, industrial and feed markets.

Notably, Nutrien will control a massive 22 million t/a of Canadian potash production capacity. This is combined with almost 11 million t/a of nitrogen production capacity, making it the third-largest nitrogen fertilizer producer globally. Its phosphates operations, by adding a further 4.3 million t/a of production capacity, also make Nutrien North America's second-largest phosphates producer.

The new company's manufacturing might is married to equally impressive retail reach. Nutrien has come into possession, via Agrium, of the world's largest agricultural retail network, spread across some 1,500 sites in North America, Australia, and South America. This network is capable of generating around $12 billion in annual sales. Nutrien also gains global distribution and market access for its potash output through Canpotex, Canada's highly successful potash export partnership.

Nutrien began trading on the Toronto Stock Exchange and the New York Stock Exchange on 2 January under the ticker symbol NTR.

Chuck Magro highlighted some of Nutrien's immediate priorities in a video message on the company's website: "2018 will be our first full year, and of course we have ambitious plans. We made a public commitment, when we announced the deal, to deliver $500m of annual operating synergies. There will [also] be a strong focus to grow the retail business in North America, but we also have plans to grow the network in Brazil."

Nutrien has committed itself to cutting its annual operating costs by $500 million by the end of 2019. This includes initial savings of $250 million this year. These will be delivered through distribution and retail integration, procurement savings and optimisation of production and SG&A. ■

AUSTRALIA

Agrium acquire Macrofertil from Louis Dreyfus

Commodities merchant Louis Dreyfus is to sell its Macrofertil fertilizer distribution subsidiary to Landmark, the Australian retail arm of Agrium.

Macrofertil's operations include six Australian fertilizer storage and distribution sites. These are equipped with coating and blending capabilities and have the capacity to handle 300,000 tonnes of fertilizers annually.

Landmark is a leading Australian agribusiness company that serves over 100,000 customers from around 400 outlets. As well as supplying crop inputs and agricultural merchandise, the company offers agronomic advice and services, as well as finance, insurance and real estate to farmers.

"This network of high quality assets will complement our existing retail footprint in Australia, and allow us to enhance our product and service offering for new and existing Landmark customers," commented Chuck Magro, Agrium's former president and CEO.

Louis Dreyfus has been cutting costs and divesting fertilizer and metals assets as it concentrates on its core grains and oilseeds business. The group sold its African fertilizer distribution business to Helios Investment Partners earlier this year (*Fertilizer International* 480, p14).

"This transaction is another step towards the implementation of our strategic roadmap, enabling us to concentrate on businesses with closer ties to product sourcing and strong farmer relationships," commented Gonzalo Ramirez Martiarena, the CEO of Louis Dreyfus.

The Macrofertil purchase was announced in December, prior to the close of the Agrium-PotashCorp merger. The terms of the sale have not been disclosed, although Macrofertil has annual sales of around $120 million.

The acquisition is expected to close in the first quarter of 2018, subject to conditions.

Orica launches fertilizer business

Orica Agriculture is to start building a new urea ammonium nitrate (UAN) plant in Moree, New South Wales, later this year.

The new liquid fertilizer plant will supply grain and cotton growers across New South Wales and Queensland. Its construction is part of a wider fertilizer business launch by Orica.

From April, Orica will start supplying growers on Australia's east coast with anhydrous ammonia, sourced from its plants in Newcastle, New South Wales, and Yarwun, Queensland. The company also says it will supply and make UAN available immediately, prior to the completion of the Moree plant.

"These investments will bring increased competition, as well as a secure and consistent supply of liquid and gas nitrogen fertilizer, to growers on the east coast of Australia," Orica said in a statement. The company also confirmed it will not be selling solid urea to farmers.

Liquid fertilizers have been applied with great success in Western Australia, with growing interest in the country's eastern states, according to Orica's senior business manager, Paul Scutt.

"We believe the market is ready to embrace the benefits of UAN including precision application during specific crop growth stages, reducing passes over paddocks and the reliance on pending rainfall for incorporation of fertilizer. We are building on Orica's extensive manufacturing footprint and proven track record in safe and reliable transport to provide direct delivery to farms," he said.

Resellers will also stock Orica's nitrogen fertilizer products, including *Precision UAN* and *Precision Ammonia*.

BRAZIL

Yara buys Cubatão Fertilizantes from Vale

Yara International is to buy the Cubatão fertilizer complex for $255 million.

Cubatão's sale is part of a cash-raising divestment programme by Vale, the world's largest iron ore exporter.

The large-scale complex has the capacity to produce around 200,000 tonnes of ammonia, 600,000 tonnes of nitrates and 980,000 tonnes of phosphate fertilizer annually. A nearby import terminal supplies the complex with ammonia, phosphate rock and sulphur raw materials. Locally-sourced natural gas is also used in ammonia production.

Cubatão sold 1.3 million tonnes of nitrogen and phosphate products in 2016, generating revenues of $413 million and earnings of $30 million. The complex, which employs 970 permanent and 930 contract staff, is notable for supplying Brazil's huge sugarcane industry – the world's largest – with nitrogen fertilizers such as ammonium nitrate.

The purchase of Cubatão is expected to double Yara's annual fertilizer production capacity in Brazil to three million tonnes.

"I am pleased to announce this agreement, which will bring nitrogen production assets into our growing portfolio in Brazil, strengthening both our industrial and fertilizer production and sales," said Svein Tore Holsether, Yara's president and CEO.

"The nitrogen assets have a strong competitive position, as Brazil is a net importer of nitric acid and nitrates. This deal… strengthens our position as a long-term competitive industry player, committed to developing and investing in Brazilian agriculture and industry," he added.

Yara is set to invest $80 million in upgrades at the complex between now and 2020. It expects this investment to generate $25 million in annual savings by optimising the site's costs, assets and product portfolio.

Yara has been buying-up Brazilian fertilizer assets since the turn of the century. Notable acquisitions include the purchase of Fertibras in 2006, Bunge's fertilizer business in 2013, and the part-purchase of Galvani in 2014.

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The sale of the Cubatão complex is expected to close in the second half 2018, subject to regulatory and competition authority approvals.

MOROCCO

ADNOC and OCP sign sulphur supply deal

Morocco's OCP Group has entered into a long-term sulphur supply agreement with the Abu Dhabi National Oil Company (ADNOC).

Under the agreement, ADNOC will supply OCP with granulated sulphur until 2025. ADNOC exported more than two million tonnes of sulphur to Morocco in 2016. Both parties have agreed to consider increases to contracted annual volumes in future.

OCP's sulphur requirements have grown rapidly in recent years, due to the massive expansion of its phosphate fertilizer production capabilities. As a consequence, Morocco's sulphur imports from the UAE, which have more than doubled since 2014, climbed from 1.53 million tonnes in 2015 to 2.22 million tonnes in 2016.

The latest one million tonne capacity fertilizer production unit at OCP's Jorf Phosphate Hub is due to come on-stream during the first quarter of 2018, raising the company's sulphur needs even further.

The agreement is a highly significant market development, given that it brings together ADNOC, the world's largest exporter of sulphur, and OCP, the largest global sulphur importer.

Abdulla Salem Al Dhaheri, ADNOC's marketing, sales and trading director, said: "This landmark agreement, which is unique in the sulphur industry, strengthens ADNOC's position as one of the world's largest exporters of sulphur. It will reinforce the sustainable supply of sulphur to Morocco and enhance our ability to achieve positive margins."

Mustapha El Ouafi, OCP's managing director, said: "Since 2008, OCP has initiated the largest investment programme in the fertilizer industry with the objective of doubling its mining capacity and tripling its fertilizer capacity. Our ambitious programme will see OCP further strengthen its position as the world's largest fertilizer producer. We are committed to further developing a reliable and strategic partnership with ADNOC, the world's largest sulphur exporter."

ADNOC currently generates more than six million tonnes of sulphur annually, a by-product of its large-scale sour gas operations. The company exports major volumes of sulphur to international customers from a state-of-the-art sulphur handling facility in Ruwais.

Sulphur export availability out of Abu Dhabi looks set to increase over the next decade as ADNOC continues to develop new sour gas projects, under the country's plans to achieve gas self-sufficiency by 2030.

UNITED STATES

Koch brings new nitrogen inhibitors to market

Koch Agronomic Services is on-track to launch its new *Centuro* nitrification inhibitor and *Anvol* urease inhibitor in the US this year.

Registration for *Centuro* under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is pending. The registration process for *Anvol* at the Environmental Protection Agency is also currently in progress.

"US farmers and ranchers apply roughly 13 million tons of nitrogen fertilizer to their fields each year," said Justin Hoppas, executive vice president of Koch Agronomic Services. "Yet… as much as half of it is lost through ammonia volatilisation, leaching and denitrification. We are discovering new solutions that increase agricultural efficiency. Our goal is to deliver proven technologies that can make every ton of fertilizer more efficient and optimise our customers' crop nutrition investments."

Applications of anhydrous ammonia are popular in North America – but require careful planning to guard against leaching and denitrification, especially during winter. Koch's new *Centuro* nitrification inhibitor is designed to work with anhydrous ammonia to protect against such losses. It also offers handling flexibility.

BELGIUM

Tessenderlo merges business units

Belgium-headquartered Tessenderlo Group has restructured its international crop nutrition business to create a single fertilizer business unit. Kerley International and the company's SOP Plant Nutrition arm have merged to become Tessenderlo Kerley International, with immediate effect.

The merger is designed to improve customer focus by bringing together 500 employees from both businesses to form one global team. In future, the new entity, Tessenderlo Kerley International, will offer global marketing and sales support for all of the Group's fertilizer products under the 'Crop Vitality' banner.

"This exciting merger of these two business units will enable us to provide the best possible levels of support and the finest products from our combined portfolio based on the specific requirements of our many customers throughout the world," explained Geert Gyselinck, Tessenderlo's global commercial director. "All of our fertilizer product brands will also be bundled under one all-encompassing brand promise: Crop Vitality."

Tessenderlo Kerley International will offer a wide range of speciality, liquid, soluble and solid fertilizers to customers globally, outside the US. These include the company's well-known and established value-added brands such as *SoluPotasse*®, *K-Leaf*®, *Thio-Sul*®, *KTS*® and *CaTs*®.

The Group's separate US crop nutrition business, Tessenderlo Kerley, Inc, is unaffected by the merger.

FRANCE

Completion of Dunkirk feed phosphates plant

The new €75 million, Aliphos-owned feed phosphates plant in Dunkirk, France, is ready to start-up, following the completion of construction.

The 220,000 tonne capacity *Dical+* (dicalcium phosphate dihydrate) plant has entered commissioning and is expected to ramp-up to full production by mid-2018.

It will initially serve the local French and European feed phosphates market, with the potential to eventually export production surpluses outside the continent through the port of Dunkirk.

Construction of the Dunkirk plant began in spring 2016 and was completed in the third-quarter of last year. Around 200 workers and technicians helped build the plant. The new operation will create 45 local jobs and generate an estimated turnover of €100 million annually.

Aliphos, part of the innovative phosphate technology and engineering group EcoPhos, will become Europe's largest feed phosphates producer with a total capacity of 620,000 t/a, once its new French plant enters production. Aliphos already operates two other European feed phosphate plants in the Netherlands and Bulgaria.

"Our objective is to take back our market position we had before the closure of the Belgian site previously owned by Tessenderlo," John Gustin, head of investor relations at Aliphos, told market analysts ICIS. "Our *Dical+* is 82 percent digestible while standard product is around 55 percent digestible. In addition, our product is a microcrystalline, free flowing with no dust, and is the purest on the market, being nearly cadmium free."

"This Aliphos product [*Dical+*] has the best digestibility of inorganic phosphates. It enables farmers to feed animals with high-quality products, while reducing the release of phosphates into the environment," Aliphos said in a statement.

INDIA

KBR wins ammonia plant contract

Houston-based KBR has secured a revamp contract for the Trombay ammonia plant in Maharashtra, India, owned by Rashtriya Chemicals & Fertilizers (RCF). Under the contract, KBR will provide a technology license and basic engineering design for the revamp project.

The revamp will incorporate KBR's proprietary *Purifier* technology. According to KBR, *Purifier* sets the benchmark for lowest proven energy consumption in the industry, and reduces capital costs as well as improving overall plant operations.

Energy savings from the revamp of the 'Ammonia 5' plant will help RCF meet new national requirements in India.

"Partnering with a government fertilizer company such as RCF to help them meet their new energy requirements is an important milestone project for KBR in India," said John Derbyshire, KBR's technology & consulting president. "This shows the immense amount of confidence and faith that clients have in KBR ammonia technology solutions."

TURKEY

Fertilizer DNA-tagging expected

Turkey's government will start to introduce mandatory DNA-tagging for all domestically-manufactured fertilizers during 2018, according to Applied DNA Sciences, the US-based company behind the technology.

The need to guarantee the security and purity of fertilizers throughout the supply chain is thought to be behind the move.

Applied DNA announced in December that it will introduce DNA-tagged fertilizer to Turkey and other countries in West Africa and Asia, due to strong interest in the ability of its molecular tagging technology to prevent the adulteration of fertilizers.

The first DNA-tagged fertilizers may enter Turkey's domestic market early this year, although the contracts needed to deliver this have yet to be placed. However, Applied DNA says it has been in discussion with Turkish fertilizer manufacturers since early 2016.

Applied DNA successfully demonstrated its molecular tagging technology on crop nutrients last year, after completing a large-scale pilot project which tracked the transit of fertilizer shipments along a West African supply chain (*Fertilizer International* 480, p10).

Turkish legislators will mandate DNA-tagging of all domestically produced fertilizers this year, according to Applied DNA. The proposed legislation is in response to a series of terrorist acts in Turkey using fertilizer-based explosives. Additional safety measures will include the introduction of secure, bar-coded packaging.

Tony Benson, Applied DNA's European managing director, is confident there is large unmet demand in the marketplace, from both farmers and governments, for technology able to track fertilizers within complex trading systems.

"Our solution is practical, and readily implemented. The significant benefits to… countries where many people are already disadvantaged cannot be overestimated. There are many published examples of fertilizers being adulterated leading to crop failures," he said.

The Turkish government has yet to make an official announcement confirming plans to introduce the mandatory DNA-tagging of domestic fertilizers.

SYRIA

Fertilizer production resumes at Homs

Syria's General Fertilizer Company (GFC) has resumed production of single superphosphate (SSP) fertilizer at its 350 t/d capacity plant in Homs, after a halt of two years, according to the Syrian Arab News Agency.

The restart of production followed the securing of raw material supplies, and was confirmed by Syria's industry minister, Ahmad al-Hamo, during a tour of the plant in early December. A second line at the plant is expected to resume production in January.

The minister praised the efforts of the company's employees and their determination to stay and provide for the needs of farmers. He said the resumption of production was timely and significant, given Syria's imminent requirement for crop nutrients at the start of the agricultural season.

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China News Round-up

Courtesy of Kcomber, owner of CCM and Tranalysis

Fertilizer production falls in 2017

China's overall fertilizer production fell in the first 10 months of 2017, according to figures released by the National Bureau of Statistics in November.

The Bureau reported a five percent year-on-year fall in total fertilizer output to 54.60 million tonnes for this period. The country's fertilizer production was down on 2016 in every month, with the exception of June.

Urea production declined most sharply, falling by 12.6 percent y-o-y in the first ten months of 2017. This is being blamed on three main factors: firstly, production suspensions due to new environmental protection measures; secondly, the withdrawal of outmoded production capacity as part of structural supply-side reforms; and, finally, a production shift to ammonia and methanol due to better margins.

China's potash production, in contrast, increased by 4.2 percent in the year to November 2017, linked to higher operating rates and better equipment utilisation. Phosphate fertilizer production, in contrast, remained stable in the first ten months of 2017, down by just 0.2 percent on a year ago.

These latest statistics confirm that, with the exception of potash, China's fertilizer production is on a downward trajectory. 2017's overall fall in fertilizer output follows zero growth in 2016.

Hubei Xingfa suspends phosphate production

Hubei Xingfa shut down two production lines in Hubei province in October 2017, one temporarily and one indefinitely.

The first production line, for phosphate rock, was closed for about one month due to urgent safety work. The incident is believed to have cost the company more than $8 million in lost sales.

Elemental (yellow) phosphorus production at the company's Shennongjia Wushan Mining subsidiary was also affected. Production from electric furnaces at the 10,000 t/a capacity site has been suspended due to a failure to meet local environmental standards.

Government reprimands industry for unfair pricing

China's fertilizer industry was told to stop price fixing, and encourage fair competition instead, in a rebuke from the National Development and Reform Commission in late November.

The Commission also urged China's fertilizer producers, and their trade associations, to behave with more self-discipline. Fertilizer pricing needs to be transparent, reflecting operating costs and the market supply and demand situation, the Commission said. The reasons for product price hikes or discounts should also be clear, it added.

Domestic prices of monoammonium phosphate (MAP), diammonium phosphate (DAP) and compound fertilizers in China have risen sharply since September 2017, partly due to higher raw material costs.

But regular conferences convened by China's main phosphate producers also seem to have spurred a rise in prices. Such conferences have been held every two months since the last quarter of 2016. Participants are known to agree their future production and pricing plans at these conferences. They also share production and operational information and discuss domestic and overseas sales.

Heavy industries on the Yangtze River.

PHOTO: MANX_IN_THE_WORLD/ISTOCKPHOTO.COM

2018 fertilizer import quotas announced

The Chinese government has confirmed official fertilizer import quotas for 2018. The total quota for the year is 13.65 million tonnes. This is divided between 3.30 million tonnes for urea, 6.90 million tonnes for phosphates, and 3.45 million tonnes for compound fertilizers.

More than 60 percent of the quota has been awarded to state-owned enterprises. Importers enjoy favourable tariffs on imports, provided they keep within the quota, while import volumes in excess of the quota incur higher tariffs.

Winners and losers in latest company results

China's nitrogen and phosphate fertilizer manufacturers improved their financial performance during the first nine months of 2017, thanks to buoyant market conditions, while compound fertilizer producers suffered profit falls, due to higher costs and greater market competition. These contrasting fortunes were revealed by third quarter results released by China's listed fertilizer companies at the end of October 2017

Luxi Chemical, Sichuan Meifeng and Hualu Hengsheng saw their profits rise by 497 percent, 230 percent, and 32 percent, respectively. These favourable results are partly attributable to improving fertilizer prices and sales volumes. Supply-side factors, such as higher raw material costs, lower industry operating rates and the effects of environmental policies on production, were also responsible.

Many small- and medium-sized manufacturers have been forced to halt production due to the introduction of more stringent environmental policies in 2017. Additionally, rising sulphur prices have also forced up MAP and DAP production costs.

In contrast, many producers of compound fertilizers saw year-on-year falls in their profits during the first three quarters of 2017. Kingenta's profits fell by 19 percent, while Shenzhan Batian saw its profits decline by 86 percent. The higher prices of straight fertilizers imposed heavier cost burdens on these operators. Profitability was also hit by fierce market competition limiting the ability of producers to raise quotations. ■

The Homs plant was said be producing 20 tonnes of fertilizer per hour in December, a rate that will gradually be increased to 25 t/h.

QATAR

Muntajat to market Qatari sulphur

The Qatar Chemical and Petrochemical Marketing and Distribution Company (Muntajat) has added sulphur to its product portfolio.

State-owned Muntajat, etablished in 2012, is a chemical and petrochemicals giant. The company exclusively exports and distributes more than 11 million t/a of Qatari products, including fertilizers, to some 2,000 customers in 135 countries. Qatar's sulphur output was added to this impressive portfolio at the start of 2018.

Qatar currently produces and exports more than 2.3 million tonnes of sulphur annually, much of this coming from the 'Common Sulphur Facility' at Ras Laffan. The country's sulphur output is forecast to rise to four million t/a by 2020, when Qatar reaches its LNG production target of 100 million t/a.

Muntajat said in a statement: "Bringing sulphur into our fertilizer product portfolio supports the increased demand we are seeing from fast growing market segments, particularly the fertilizer industry."

CHINA

Gas shortages shutdown nitrogen plants

Yunnan Yuntianhua has stopped urea production due to natural gas shortages. These forced the company to idle a 500,000 t/a ammonia plant and downstream 800,000 t/a urea plant at its Yunnan Shuifu subsidiary in early December.

Yuntianhua does not expect to re-start the plant before 2018, and says that the disruption will cost $3.8 million in lost revenues. China's gas producers have suspended supplies to a number of major industrial consumers in southwestern regions, as the country's winter heating crisis deepens.

One state-owned producer has diverted gas supplies to residential heating because of the shortages. PetroChina sent 5-10 million cubic metres of gas from the southern provinces of Zhejiang, Fujian and Guangdong to help relieve shortages in northern China.

The gas shortages have been exacerbated by a number of industries switching from coal to gas this year, in keeping with China's clean air and environmental protection policies. The country's gas deficit is expected to reach 10.5 billion cubic metres this winter, some 10-20 percent of total demand.

Industrial gas consumers in many provinces are experiencing supply disruptions. Chemical producers in Hebei were scheduled for supply cuts at the end of November, after an 'orange warning' from the province's government signalled a severe gas shortage. Other provinces such as Henan, Shandong, Anhui and Hubei have taken similar measures. Henan-based Zhongyuan Dahua shut its 600,000 t/a ammonia-urea plant on 27 November. Chongqing-based Jianfeng Chemicals has cut operating rates at its 1.4 million t/a urea plant, firstly to 50 percent in November and then to zero in December. PetroChina Daqing also shut down its 800,000 t/a urea plant in mid-November.

Chinese urea prices have risen to their highest levels in four years due to a combination of the winter gas curtailments and environmental restrictions at coal-based nitrogen plants. ■

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People

Nutrien, the new company created by the Agrium-PotashCorp merger, has announced its board of directors. In keeping with this 'merger of equals', the board has equal representation from both companies. As expected **Chuck Magro**, who formerly headed Agrium, becomes Nutrien's president and CEO. **Jochen Tilk**, who previously led PotashCorp, will serve as the company's executive chair. Derek Pannell, who was the chair of Agrium, becomes independent lead director on Nutrien's Board. In other senior team appointments, **Wayne Brownlee** becomes executive vice president and chief financial officer, and **Steve Douglas** becomes executive vice president and chief integration officer. Filling other executive vice president roles at Nutrien are:

- **Harry Deans**, executive vice president and president, nitrogen
- **Michael Frank**, executive vice president and president, retail
- **Kevin Graham**, executive vice president and president, sales
- **Susan Jones**, executive vice president and president, phosphate
- **Lee Knafelc**, executive vice president & chief sustainability officer
- **Leslie O'Donoghue**, executive vice president & chief strategy & corporate development officer
- **Joe Podwika**, executive vice president & chief legal officer
- **Brent Poohkay**, executive vice president & chief information officer
- **Raef Sully**, executive vice president and president, potash
- **Mike Webb**, executive vice president & chief human resources officer

Germany's K+S is slimming-down its board of executive directors as part of its new 'Shaping 2030' strategy. Additionally, a newly-formed executive committee will advise the company's executive board and offer operational support. In future, the executive board team at K+S will comprise of **Dr Burkhard Lohr** (54) as chairman, with **Thorsten Boeckers** (42) as chief financial officer, and **Mark Roberts** (54) as chief operating officer. Board member **Dr Otto Lose** (46), who helped develop the new corporate strategy, is resigning by amicable, mutual agreement. Another board member, **Dr Thomas Nöcker** (59), will also retire in September, handing over responsibilities to his executive board colleagues.

Dr Andreas Kreimeyer, who chairs the supervisory board of K+S, said: "Under the leadership of Dr Burkhard Lohr, the implementation of 'Shaping 2030' and the integration of the Potash and Magnesium Products and Salt business units into 'One Company' is taking shape. The changes in the board of executive directors also follow the common goal of consistently developing the organization and business of K+S and realizing synergies."

Dr Burkhard Lohr, chair of K+S said: "Customer focus is core to our new group strategy. The new leadership structure follows the 'One company' logic and the alignment along our four product market segments – agriculture, industry, consumers and communities."

Danny Goeman is the new CEO of Danakali Limited, the Australian developer behind the Colluli potash project in Eritrea. He replaces **Paul Donaldson** who is remaining on the board as a non-executive director. Mr Goeman has been Danakali's head of marketing since 2016. In this previous role, he developed the company's offtake strategy and offtake contract frameworks, and also led on offtake negotiations. Before joining Danakali, Mr Goeman worked in leading roles at Rio Tinto, dealing with commodity price negotiations, market analysis, market segmentation, and price forecasting. He has worked across multiple commodities in multiple jurisdictions, and has significant customer engagement and international experience.

Danakali chairman Seamus Cornelius said: "This is another positive step forward for Danakali as we move into the development phase at Colluli with our JV partners ENAMCO. We believe we have the world's best SOP asset with Colluli, an outstanding team of people and fully aligned stakeholders working together to maximise value through constant improvement in every area. Paul's contribution to Danakali has been without equal, and the smooth transition from Paul to Danny as CEO is a testament to the extremely high calibre of both men."

Calendar 2018

FEBRUARY

13-15
24th AFA Annual Fertilizer Forum & Exhibition, CAIRO, Egypt
Contact: Arab Fertilizer Association
Tel: +20 2 23054464
Email: afa@arabfertilizer.org

26-MARCH 1
Nitrogen+Syngas 2018, GOTHENBURG, Sweden
Contact: CRU Events
Chancery House,
53-64 Chancery Lane,
London, WC2A 1QS, UK
Tel: +44 (0) 20 7903 2444
Email: conferences@crugroup.com

MARCH

6-9
IFA Production and International Trade Meeting, BUENOS ARIES, Argentina
Contact: IFA Conference Service,
28 rue Marbeuf,
75008 Paris, France
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

12-14
Phosphates 2018, MARRAKECH, Morocco
Contact: CRU Events
Tel: +44 (0) 20 7903 2444
Email: conferences@crugroup.com

APRIL

9-12
IFA Global Technical Symposium, MADRID, Spain
Contact: IFA Conference Service,
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

JUNE

8-9
42nd AIChE Annual Clearwater Conference 2017, CLEARWATER, Florida
Contact: Perry Alonso,
AIChE Central Florida Section
Email: vice-chair@aiche-cf.org.

18-20
86th IFA Annual Conference, BERLIN, Germany
Contact: IFA Conference Service,
Tel: +33 1 53 93 05 00
Email: ifa@fertilizer.org

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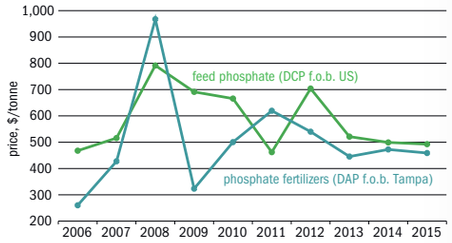
PICTURE THIS...

Feed phosphates market

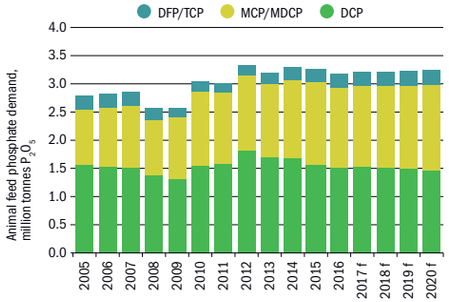
Phosphorus plays an important role in livestock nutrition, being an essential element for animal health and growth. Feed phosphates manufacture has been a niche but potentially lucrative business for producers targeting this market. Feed phosphates consume just five percent of global phosphoric acid production. Yet their premium pricing over phosphate fertilizers has offered producers attractive margins for much of the last decade. Despite supportive market fundamentals, demand for feed phosphates has remained largely static at around 3-3.5 million tonnes P_2O_5 since the start of the decade. The export market (one million tonnes P_2O_5) is also stable with only modest medium-term growth forecast. Branding and product development are essential to market success. Changes in feed formulation preferences have seen the production and consumption of monocalcium phosphate (MCP), monodicalcium phosphate (MDCP) and defluorinated feed phosphate (DFP) all grow, largely at the expense of dicalcium phosphate (DCP). China has led the way on feed phosphate production growth, while developed markets such as the United States have contracted. Consumption has typically levelled-off or declined in mature markets, due to stable demand for animal feed and substitution by alternatives such as phystase and distillers dried grains with solubles (DDGS). Oversupply is a notable feature of the feed phosphates industry with around 14 million tonnes of product capacity globally supplying a 8.2 million tonne market. Looking ahead, continuing oversupply and stagnating demand will put a cap on prices and further squeeze the price premium over fertilizers. The entry of new supply also looks set to be a disruptive influence as EcoPhos, OCP and others expand their market presence. Opportunities will continue to exist for producers supplying high-quality feed phosphates products – and for those positioned to meet growing demand in countries such as Russia and Brazil. ■

Data sources: Groupe Roullier/CRU

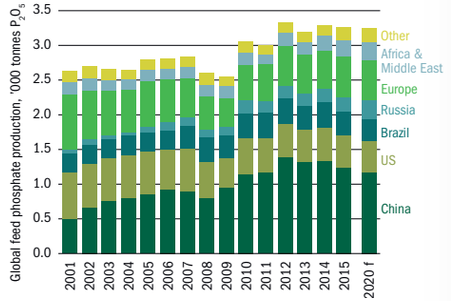
FEED PHOSPHATE PRICE PREMIUMS BEING SQUEEZED



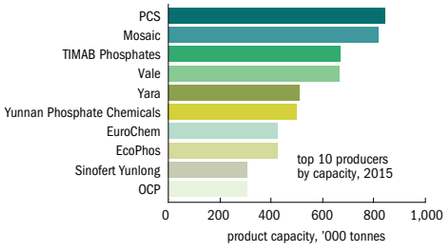
GROWING MARKET PREFERENCE FOR MCP/MDCP



CHINESE PHOSPHATE PRODUCTION GROWS, US WANES



OVERSUPPLY: 14 MT GLOBAL CAPACITY, 8.2 MT MARKET



FUTURE DEMAND: CHINA SLOWS AS RUSSIA GROWS

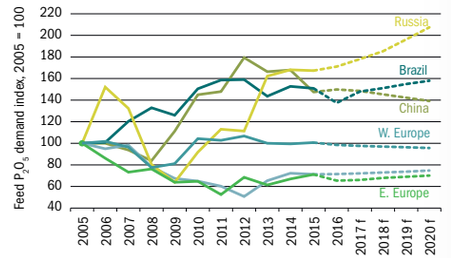


PHOTO: RAILELECTROPOWER /ISTOCKPHOTO.COM

The AFA welcomes you to Cairo

The theme of the 24th Arab Fertilizer Association Annual Fertilizer Forum & Exhibition is 'Miles of Pursuing Sustainable Agriculture and Environmental Protection'. This year's Forum will be held at the Ritz Carlton Hotel, Cairo, 13-15 February 2018. AFA Secretary General, **Mohamed Zain**, provides a preview of what is the Arab region's showcase annual fertilizer event.

The Arab Fertilizer Association (AFA) is made up of Arab companies and institutions involved in fertilizer production, trade and allied fields. Established in 1975, the AFA's aims include the development of the Arab fertilizer industry – and maximising its contribution to global food security.

Arabic countries are increasingly taking a lead when it comes to the world-wide supply and trade in fertilizers and associated raw materials. Globally, the Arab region possesses one-third of gas reserves and 70 percent of phosphate rock reserves, for example.

The AFA promotes the sustainable use of fertilizers and believes this involves taking a long-term approach and making balanced judgments based on social, environmental and economic considerations.

A warm and hospitable Egyptian welcome

Eng. Mohamed Zain, AFA Secretary General, is looking forward to welcoming delegates to Egypt in February:

"The Arab Fertilizer Association (AFA) would like to invite you to participate with more than 500 leaders in the 24th Annual Fertilizer Forum and Exhibition titled 'Miles of Pursuing Sustainable Agriculture and Environmental Protection'. It is an opportunity that should be seized. Accordingly, note it down and reserve your seat to meet with fertilizer sector decision makers from the Arab region and the rest of the world.

"The Forum is considered the pre-eminent fertilizer industry economic event in the Middle East and Arab region. Attendance this year is expected to reach 500 participants from more than 33 countries worldwide. These include the chairs of Arab and international fertilizer companies, heads of relevant international associations and organizations, experts, executives and general managers representing more than 133 companies and industry bodies.

"The Forum, since its launch in 1995, with the support of the Government of Egypt and Egyptian fertilizer production companies, has become an annual fixture and a must-attend fertilizer industry event.

"Behind the Arab fertilizer sector's growing status in international markets is the region's abundant and world-class natural gas, phosphate rock and potash resources. The remarkable returns generated by the fertilizer industry, through the production and export of fertilizers and associated raw materials, are also of great economic significance to Arab countries, and undoubtedly contribute to the region's economic and social development"

Forum programme

The AFA's Forum programme for 2018 includes three days of plenary sessions starting on Tuesday 13th February. This year, the Forum's main themes address:

- Arab region fertilizer policies
- Key factors shaping the fertilizer industry
- The supply and demand outlook
- Oil & gas markets and their impact on fertilizer production
- Fertilizer use efficiency
- The African fertilizer market
- Fertilizer industry sustainability
- Helping achieve world food security
- Environmental protection
- Fertilizer industry insurance
- Updates on the dry bulk freight market

Additionally, the wide-ranging commercial exhibition running alongside the Forum allows industry, trade and freight companies, from within and outside the Arab region, to showcase their products and services to a high-level national and international audience of professionals. ■

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Fertilizer INTERNATIONAL index 2017

A complete listing of all news items and articles featured in *Fertilizer International* during 2017.

INDEX 2017

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Bear statue at the Frankfurt Stock Exchange in Frankfurt, Germany.

PHOTO: TRAVELVIEW/SHUTTERSTOCK.COM

The year ahead: 2018 looking more bearish

We look ahead at fertilizer industry prospects for the next 12 months, including supply and demand growth, and explore the key agricultural, macroeconomic and geopolitical drivers likely to shape the market during 2018.

World fertilizer demand was rather subdued in 2017, while fertilizer production reached record levels. The industry faced both stiff competition and relatively weak market conditions during the first half of the year. Market demand did, however, eventually rebound in 2017's second half. Imports to the major fertilizer-consuming countries rose and prices firmed on the back of improving affordability and pent-up demand.

In this article, we look ahead at fertilizer industry prospects for 2018, and highlight some of the key demand and supply influences that will shape the market over the next year or so.

Complex demand drivers

Fertilizer demand is influenced by a range of factors, some of which are harder to predict than others. In the short-term, the main drivers of demand include:

- Farm economics and the macroeconomic outlook
- Crop prices and fertilizer-to-crop price ratios
- Crop mix, growing areas and crop yields
- Soil nutrient levels and nutrient replenishment
- Policy, regulation and fertilizer subsidies
- Sustainability, nutrient management and recycling

The importance of these factors varies from country-to-country and region-to-region. Adding to the complexity, these primary drivers are in turn shaped by a host of secondary influences.

Macroeconomic conditions, by triggering slowdowns or expansions in global, regional and national growth, control overall economic demand and affect the health of agricultural markets. **Farm economics** and attendant issues such as credit availability and barter ratios have a more direct impact on the ability of farmers to purchase fertilizers.

Crop prices and fertilizer-to-crop price ratios act as key controls on crop nutrient demand as they play a critical role in determining farm buying power and fertilizer affordability. Crop prices in turn are driven by **harvest sizes**, **stock levels** and **demand** for agricultural commodities. Fertilizer industry analysts pay particularly close attention to the prices of cereals, oilseeds, cotton, sugar and palm oil, the main fertilizer-consuming crop types globally.

The **biofuels market** is also an important driver of fertilizer demand due to large-scale cultivation of maize and sugarcane for ethanol and oilseed rape (canola) for biodiesel (*Fertilizer International* 474, p22). Crop failures due to extreme weather events such as the **El Niño** (*Fertilizer International* 475, p38) can also affect fertilizer demand in the short-term.

Global growth accelerates

World economic activity continues to strengthen. The International Monetary Fund (IMF) is currently forecasting global growth of 3.6 percent in 2017 and 3.7 percent in 2018, a marked improvement on the growth of 3.2 percent seen in 2016, economically the weakest year since the global financial crisis of a decade ago. The IMF has revised its 2017 and 2018 growth forecasts upwards since last spring, reflecting better-than-expected growth in Eurozone countries, Japan, Russia and emerging Asian and European nations. Upwards revisions for these countries more than offset downgrades to US and UK growth.

The recovery in the global economy remains incomplete, despite this welcome pickup in activity. Short-term risks are broadly balanced, in the IMF's view, although medium-term risks still tend to the downside.

"While the baseline outlook is strengthening, growth remains weak in many countries, and inflation is below target in most advanced economies," the IMF comments. "Commodity exporters, especially of fuel, are particularly hard hit as their adjustment to a sharp step-down in foreign earnings continues."

Oil prices are expected to average $50 a barrel in 2017, up from the $43 a barrel average in 2016, and stay at around that level in 2018. The IMF also expects prices of non-fuel commodities to generally strengthen in 2017–18. This is due to a combination of improving metals demand in China, tight food supply conditions, and an overall pickup in global demand.

Table 1: **Global fertilizer demand forecast, million tonnes nutrients***

Nutrient	2018/19f	2017/18f	2016/17e	2015/16	2014/15
N	107.3 (+0.5%)	106.8 (+0.5%)	106.2 (+2.3%)	103.8	102.2
P_2O_5	48.8 (+0.9%)	48.3 (+0.9%)	47.9 (+2.0%)	46.9	46.6
K_2O	36.4 (+2.3%)	35.6 (+1.8%)	35.0 (+3.0%)	33.9	33.9
Total	**192.5 (+1.0%)**	**190.7 (+0.9%)**	**189.1 (+2.4%)**	**184.7**	**183.1**

** Year-on-year percentage increase in parentheses e = estimate f = forecast Source: IFA (Nov 17)*

Ag commodity prices rally

As 2017 drew to a close, the FAO's food price index, at 175.8 points in November, was almost four points (2.3 percent) higher than a year previously. Sharp rises for sugar and vegetable oils were largely offset by a fall in dairy values.

Cereals rallied more strongly, with the FAO's November 2017 cereal price index improving almost 12 points (8.3 percent) year-on-year. "The index has remained largely steady since August, reflecting an overall balanced supply and demand situation – especially with regard to wheat and maize markets," the FAO commented. "In November, international rice prices rose by 1.1 percent, amid stronger buying interest and currency movements."

The FAO's vegetable oil price index also rose to a nine month high of 172.2 points in November 2017. The improvement mainly reflected price rises for three oils, soy, rapeseed and sunflower. The hike for soy oil reflected continuing weather uncertainties affecting crops in South America, as well as the below-average oil content of the recently-harvested US crop. Sunflower and rapeseed oil price hikes have been underpinned by subdued availability and firmer demand, respectively. Palm oil values, in contrast, have moved lower, linked to the rise in Indian import duties and higher-than-anticipated closing stocks in Malaysia.

High grain and oilseed stocks

Weather phenomena, trade headwinds and currency fluctuations could disrupt global food production and prices in 2018, according to agribusiness specialists Rabobank. The bank expects strong demand for coffee and cocoa this year – and is also forecasting a bullish 2018 outlook for wheat.

"Global stocks of grains and oilseeds are high, keeping the pricing environment relatively benign," commented Stefan Vogel, Rabobank's head of agricultural commodity markets. "In the case of coffee and cocoa, prices are supported by rising demand for these luxury commodities, particularly from emerging markets.

"Nevertheless, the picture is mixed. Demand for wheat is tempered by large supplies and record stocks, while palm oil producers… need to reclaim market share from other oils… [as] adverse weather has hit yields since 2015/16."

Vogel also warned of the 75 percent risk of La Niña conditions during the northern hemisphere's winter: "Supplies are not enough to sustain prices should a major event like La Niña disrupt major agricultural areas, such as the US and South America. This has the potential to cause a supply shock that would ripple through to food prices."

However, upside factors – such as the rising cost of global trade and potential currency fluctuations – should outweigh these downside risks in 2018, in Vogel's view.

Rabobank also raises the prospect of further appreciation of the dollar– linked to US interest rate rises– making American wheat and soybeans exports less competitive during 2018.

Fertilizer demand turns bearish?

The International Fertilizer Association (IFA) expects the world fertilizer market to turn "quite bearish" in 2017/18, particularly for nitrogen, in contrast to the firm rebound seen in 2016/17. IFA expects world nutrient demand to grow by just 0.9 percent to 190.7 million tonnes in 2017/18. This modest expansion is likely to be largely driven by increased consumption in India, Indonesia, the EU, the US and Russia.

The trend for slower–paced and below-average fertilizer market growth looks set to continue throughout the current year and into next. IFA expects world fertilizer demand to increase by one percent in 2018/19 to 192.5 million tonnes. This assumes that no major "weather-related, geopolitical or economic" shocks will significantly affect the outlook, cautions IFA.

Market stagnation in East Asia, particularly the anticipated demand contraction in China, are dampening the 2018/19 outlook. The other main factors behind the expected slowdown in demand growth over the next year or so include:

- Persistently low international crop prices
- Greater emphasis on reducing fertilizer losses and nutrient use-efficiency
- More recycling of organic nutrient sources
- China's domestic nitrogen and phosphate fertilizer consumption reaching a 'tipping point'

More positively, "This unfavourable market context is partly offset by improving world economic prospects and the need to feed the still fast-growing and wealthier world population," comments IFA. The outlook for individual nutrients going forwards is as follows:

- World potash demand is forecast to grow most strongly (+2.3%) pulled by China, India and Indonesia
- A more modest increase in global phosphate demand (+0.9%), with firm growth in India partly offset by a demand drop in China
- Nitrogen demand growth (+0.5%) to fall-back below the average medium-term trend, a reflection of improved nitrogen use efficiency in mature markets and China

Demand prospects in 2018/19 will be strongest in India, Indonesia, Ukraine, Pakistan/Bangladesh and Canada/EU, driven by the following:

- **India:** incentives for growing more food and the government's introduction of the direct benefit transfer (DBT) subsidy system
- **Indonesia:** potash applications to oil palm
- **Ukraine:** boost to grain exports from weak currency
- **Pakistan/Bangladesh:** need for greater food production
- **Canada/EU:** expected rebound in agricultural production

MARKET OUTLOOK

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Global supply and trade

Mirroring relatively flat world demand prospects, global fertilizer sales also look set to remain bearish with relatively sluggish growth in 2018. IFA expects global sales of primary fertilizer raw materials (ammonia, phosphate rock and primary potash products) to grow to 190 million tonnes *nutrients* in 2017 and to 192 million tonnes *nutrients* in 2018, a modest increase of 1.6 percent over two years.

Fertilizer production capacity, in contrast, continues to grow strongly. Major investment decisions made five to eight years ago under more bullish market conditions are now reaching fruition. Consequently, the massive incremental capacity increases seen in 2017 are set to be followed by further large expansions into 2018. IFA expects a total of 75 new ammonia, phosphoric acid and potash production units and expansion projects to come on-stream in 2017 and 2018, adding 20 million tonnes of additional nutrient capacity to world supply.

World urea capacity is projected to grow by six percent over the course of 2017 and 2018 to reach 221 million tonnes. A total of 22 new urea plants globally will provide an extra 13 million tonnes of incremental capacity over this period. Some nine million tonnes of this is due to be added in 2017, followed by a further four million tonnes in 2018. The US is expected to account for one-third of this expansion. New urea production plants are also due to be completed in India, Bolivia, Mexico, Russia, Azerbaijan, Malaysia and Indonesia.

Finished phosphates capacity is forecast to rise by seven percent during 2017 and 2018 to reach 104 million tonnes. This is divided between 3.7 million tonnes of additions in 2017 and 3.2 million tonnes of additions in 2018. Some 85 percent of this expected new capacity will come from just two countries, Morocco (3.3 million tonnes) and Saudi Arabia (2.6 million tonnes).

World potash capacity is set to rise by 14 percent (12.5 million tonnes) in 2017-2018 to reach 105 million tonnes MOP (muriate of potash) by the end of 2018. Around 80 percent of this global increase is expected to come from Canada (5.6 million tonnes) and Russia (4.4 million tonnes). Plant closures and mothballing in the US and Europe, in contrast, will remove 1.5 million tonnes of MOP capacity over the next few years.

The global trade in urea is projected to remain relatively flat at 49 million tonnes in 2018, equivalent to roughly one-quarter of world sales (183 million tonnes). Diammonium phosphate (DAP) production (+2-3% to 35-36 million tonnes) and trade (+3% to 17-18 million tonnes), in contrast, are set to rise significantly in 2018, thanks to larger shipments to Africa, South Asia and South-East Asia. Growth in monoammonium phosphate (MAP) trade is also likely in 2018 (+3-4% to 13 million tonnes) boosted by larger sales to Latin America and Africa. Moderate improvements in MOP trade are also expected in 2018 (+2% to 54 million tonnes), backed by firm demand in Southeast Asia and Africa.

Fig. 1: **Fertilizer crop-to-price rating 2010-2017**

Source: Mosaic

Synthesis

The world economy continues to strengthen, with global growth of 3.7 percent forecast for 2018. Importantly for fertilizer markets, economic activity has picked up in India, while China's economy slowed, and recessions in Russia and Brazil have both ended.

In agriculture, ample supplies are expected to weigh on agricultural commodity markets, keeping crop prices relatively stable and low in 2018. Fertilizers remain affordable, as nutrient prices have largely fallen in step with crop prices. The fertilizer-to-crop price ratio, a key measure of affordability, has risen since mid-2017 to end the year at 0.72, close to the 2010-16 average (Figure 1).

The fertilizer demand outlook for 2017/18 and 2018/19 looks generally bearish, particularly for the nitrogen and phosphate segments of the market, with annual growth retreating to below one percent. The prospects for potash growth this year and next are significantly better – with strong demand from China being a key stimulus.

Subdued demand growth is expected in Brazil this year. Despite the country's bumper harvests, farm profitability has declined due to currency appreciation and low international crop prices.

Whether China is on the brink of a long-term slide in domestic demand is a key question for the market. Although Chinese potash demand is still growing robustly, domestic nitrogen and phosphate consumption continues to decline – due to factors such as the country's zero growth in fertilizer use policy, cereal price falls and the expansion of soybean growing.

There is also speculation that the entire global fertilizer market could be about to enter a slower growth era. What is certainly clear is that, without China, the industry will become increasingly reliant on fast-growing but smaller and more fragmented markets – particularly in Latin America, Africa and Eastern Europe – as the main engines of future demand. Yet these regions account for less than one-fifth of the world market at present. Any waning in China's influence will also deepen the industry's dependency on India's heavily-subsidised fertilizer market – which at some future point will inevitably face deregulation and rebalancing.

On the supply-side, large additions of new, low-cost fertilizer production capacity will continue in 2018. The market looks set to remain in a supply-driven phase over the short-term with potentially growing nitrogen and phosphate surpluses. More encouragingly, fertilizer sales and trade are likely to expand year-on-year during 2018. ■

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Stamicarbon: champions of innovation

For Stamicarbon, license company of Maire Tecnimont Group, innovation is an essential lifeline for growth. The company reinvests 5-7 percent of its turnover annually in product development and innovation, substantially higher than the fertilizer industry average. **Harold van der Zande**, Stamicarbon's senior business development manager, explains the company's commitment to innovation, and highlights some notable recent innovation successes.

Technology is in our DNA

Italian engineering, procurement, and construction (EPC) contractor and technology provider Maire Tecnimont Group is deeply committed to innovation and technological development. Its purchase of Stamicarbon, the market leader in urea licensing technology, enhanced the Group's capabilities, by bringing together new competencies in innovation, intellectual property and licensing. Maire Tecnimont's current industrial strategy, with its strong focus on technology and high-level know-how, is specifically designed to meet future market challenges in the hydrocarbon processing value chain.

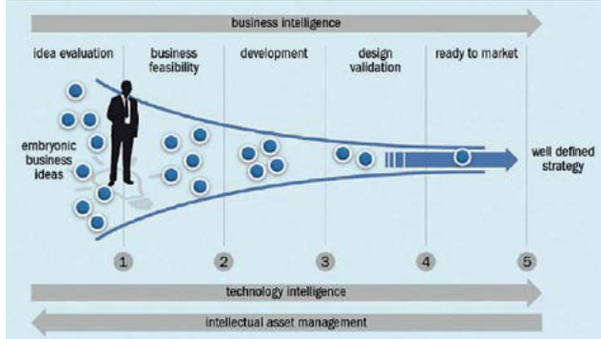
Intellectual property and innovation

Unlike many other companies in the fertilizer industry, Stamicarbon has always had an active innovation policy. The firm views innovation as an essential lifeline for growth, and reinvests 5-7 percent of its turnover annually in product development and innovation, substantially higher than the fertilizer industry average.

Stamicarbon tracks the progress on its investments in innovation using a so-called 'innovation funnel' (Figure 1). This monitors projects by benchmarking outcomes at each and every step, allowing the company to maintain a strong focus on the most promising projects.

That is not all: Stamicarbon has gone one step further by also linking the innovation process to intellectual property (IP). This means that, as well as measuring project progress and success based on commercial potential, Stamicarbon factors in the filing of patents too.

Fig. 1: **Stamicarbon Innovation Pipeline**



Source: Stamicarbon

Innovation incentives

The software used by Stamicarbon has been adapted to allow IP to be fully-integrated into the innovation monitoring process. Critically, this software provides inventors who contribute to the company's IP portfolio with financial incentives. Importantly, as well as being rewarded for the filing of patents, incentives and rewards are also linked to the commercial success of the invention.

In practice, this works as follows: two bonus payments are triggered, firstly, by the filing of the patent and, secondly, by the first commercialisation of a specific project innovation. This provides company employees with a clear message that their efforts on patenting do bring rewards and will pay-off. Crucially, establishing a link between Stamicarbon's commercial success and inventor rewards also strongly aligns the work of inventors with the company's business performance.

Embedding innovation

An evaluation of Stamicarbon's patent portfolio carried out some years ago revealed two interesting facts. Firstly, there was a clear bias towards patents in the field of process improvements. Secondly, most innovators tended to be seasoned, experienced employees, rather than staff who had joined the company more recently.

To reach younger innovators, Stamicarbon launched an extensive training programme to address this bias. This aim was to introduce relevant IP processes to

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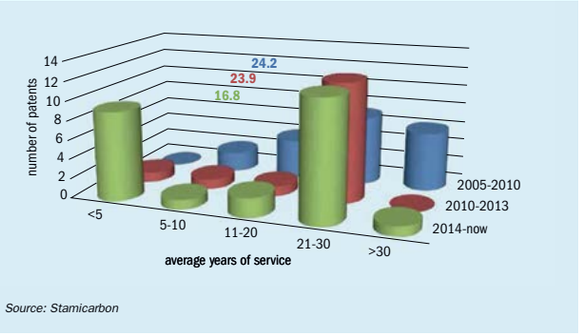
Fig. 2: **Reaching younger innovators by experience group**



Source: Stamicarbon

all new employees. The programmes has proved to be a great success.

Moving forward several years, IP has now become a core activity throughout the company, resulting in more patents filed, in a broader area than before, and by a far more diverse employee base, including younger employees. As a result of this programme, the average employment term of innovators has fallen from 24.2 to 16.8 years (Figure 2).

One positive outcome has been to establish a widespread and shared innovation philosophy throughout Stamicarbon. This philosophy, based on close cooperation between business development and IP, provides fast internal feedback on the latest innovation developments. Not only has this increased Stamicarbon's innovation outputs, it has also improved their quality and effectiveness. This is valuable as efforts should always focus on those innovation projects that have the potential to deliver the highest returns.

Internal versus open innovation

Over the years, a number of Stamicarbon innovation projects have been initiated and later successfully commercialised. Some of these can be regarded as internal innovations, while others have been realised in close cooperation with external partners. Stamicarbon has always promoted a culture of open innovation by establishing long-term, strategic partnerships with customers, suppliers, universities and research centres.

The company's approach to innovation has led to some key breakthroughs in urea technology, proprietary equipment and stainless steel materials, such as *Safurex*®. Some notable examples of recent innovation success stories are highlighted.

Fig. 3: **Bulk storage of urea**


PHOTO: STAMICARBON

Fig. 4: **Application of *ADVANCE COAT*™ on a conveyor**


PHOTO: STAMICARBON

Storage problems

Between the time fertilizers are produced and the time they are finally applied to the soil, they must be stored, either in bulk or in bags, for periods that can vary from less than a month to a year or more. Fertilizers also need to be handled, loaded, shipped and unloaded, sometimes under very humid conditions. Whatever the circumstance, it is vital that fertilizer quality is maintained throughout all these steps.

Urea prills readily absorb moisture from the atmosphere, leading to caking, a decrease in dynamic strength and an increase in dust formation. This problem is particularly notable when urea is stored for longer periods in bulk (Figure 3).

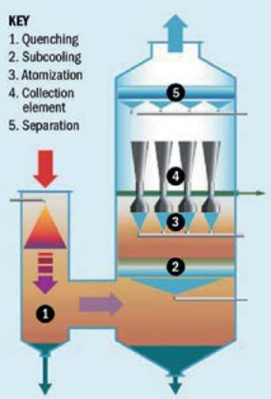
Conventional ways to reduce these problems include packaging urea in bags, rather than in bulk, or adding urea formaldehyde to improve prill strength. However, bagging-up urea adds complexity to loading and unloading, while formaldehyde imposes limits on the end-use of the product. For instance, formaldehyde makes urea unsuitable for technical applications such as *AdBlue*®, cosmetics and cattle feed.

ADVANCE COAT™

As a solution to the above storage and handling challenges, Stamicarbon has developed *ADVANCE COAT*™. This is a novel coating system for both prilled and granular urea that prevents caking and the loss of mechanical properties.

The coating can be applied, either by using a spraying system on the conveyor belt (Figure 4), or by adding to the product in a rotary drum. The effectiveness of this coating has been demonstrated under very different climate conditions, including both hot and cold temperatures, for example, and with high and low air humidity. The new coating results in less dust and less caking. It is also easier and cheaper to apply than formaldehyde. *ADVANCE COAT*™ has proven to be a cost-effective, safe and crop-friendly solution for the bulk storage and shipping of urea prills.

Fig. 5: **MMV Scrubber**



Source: Stamicarbon

MicroMist™ *Venturi Scrubber*

One recent example of a successful innovation partnership is the close cooperation between Stamicarbon and the external US-based partner EnviroCare International. This led to the development of an effective and efficient multi-stage scrubbing process for granulation plants. The new process was designed to meet more stringent emissions regulations by scrubbing urea particulate matter and ammonia.

Submicron dust generated during granulation can cause unacceptably high emission values. While older technology scrubbers easily scrub larger particles, a new approach was required to capture submicron dust, as well as efficiently remove ammonia via the injection of an acid solution.

The *EnviroCare MicroMist*™ *Venturi (MMV) Scrubber* contains five stages that progressively treat and clean the off-gas. With this technology, emissions of less than 10 mg/Nm^3 for dust and ammonia are achievable. Although this type of scrubber technology has been successfully proven in other industrial applications, its introduction in the urea industry was completely new (Figure 5).

Fig. 6: ***MicroMist*™ *Venturi***


PHOTO: STAMICARBON

During the first scrubbing stage, the exhaust gas is cooled down and saturated. This allows most of the coarse particulate urea dust to be collected from the gas stream. A secondary quench is then used downstream of this first quench zone. In the second quench, a dilute solution of urea further cools and humidifies the gas flow. This is a very important step as it ensures that the remaining submicron particules are exposed to saturated gas, allowing particles to grow substantially in size by condensation.

To further condition the gas stream, several Dual-Orifice Conditioning (DOI) trays can be fitted inside the scrubber vessel as an additional option. Multiple parallel venturi tubes are installed vertically on a diaphragm in the vessel. The diaphragm forces the gas flow to accelerate through these tubes (Figure 6). Each venturi tube has three main components: a converging conical section (the inlet), where the gas is accelerated to throat velocity, a cylindrical throat and a diffuser outlet. Gases and particulate droplets interact twice within the tubes, first during acceleration and again during deceleration. The venturi tubes are aerodynamically designed to reduce the overall pressure drop by slowing down the gas and recovering the energy.

Acidic scrubbing of ammonia takes place downstream of the MMV stage. The DOI tray is flooded from above with acidified water and the acid flow rate is controlled via pH measurement. Typically, sulphuric acid or nitric acid is used to react with NH_3 to form an ammonia salt. Any remaining suspended water droplets are then removed from the gas stream in the mist eliminator prior to the gases leave the scrubber. Clean, fresh water is continuously sprayed on the mist eliminator to catch and wash away dirt particles. An optional Wet ElectroStatic Precipitator (WESP) can be integrated on top of the MMV scrubber to further reduce overall emissions.

Dual pressure nitric acid technology

The recent introduction of Stamicarbon's dual-pressure nitric acid technology is a good example of an internal company innovation. Stamicarbon is now offering a best-in-class dual-pressure nitric acid technology design (Figure 7). This tech-

Fig. 7: **Nitric acid plant layout**


IMAGE: STAMICARBON

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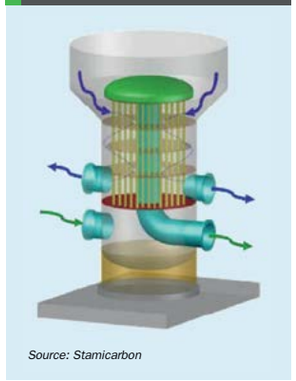
Fig. 8: **Ammonia burner design**



Source: Stamicarbon

nology was developed by applying and building on many decades of experience. Valuably, the new technology, by keeping and incorporating industrially proven elements, retains the reliability and operability appreciated by customers. Nitrates are valued as efficient fertilizers. They are of increasing importance in the northern hemisphere, where demand is healthy and growing, linked to the increasing need for food crops.

Stamicarbon's dual-pressure nitric acid process is designed to combine the highest possible energy recovery with low emissions. A dual-pressure configuration allows a lower oxidation pressure to be combined with higher absorption pressure, making nitric acid production more efficient as a result. The new technology meets growing customer demand for nitric acid plants with a low total cost of ownership.

The main feature of Stamicarbon's nitric acid process is the position of its third tail gas heater. This heat exchanger is located in the ammonia burner vessel (Figure 8), below the super heater and before the boiler, and permits tail gas temperatures of 480°C, some 50°C above conventional nitric acid processes. This configuration and design has several advantages:

- N_2O decomposition is favoured by the high temperature and takes place without the addition of an external agent such as natural gas, a common practice in the conventional nitric acid process
- Higher power generation in the expansion turbine
- An extra heat recovery step before releasing the tail gas to the atmosphere

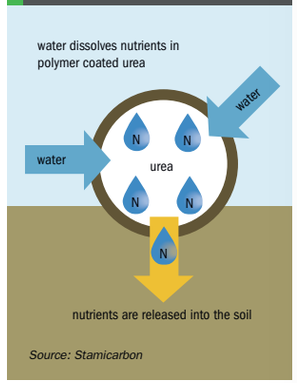
Collectively, all of these advantages lead to lower steam consumption by the compressor train and higher steam export from the plant.

NO_X and N_2O are environmentally-harmful products that contribute to acid rain, the greenhouse effect and ozone layer depletion. Stamicarbon's design provides the optimum tail gas temperature for the decomposition of N_2O in a tertiary N_2O/NO_X abatement system. This allows the catalytic reduction of NO_X and N_2O to concentrations below 20 ppm.

A commercially available iron zeolite-based catalyst is used in the first catalyst bed to decompose N_2O without the addition of an external reducing agent. This can only be accomplished if the tail gas temperature is above 430°C, as is the case with Stamicarbon's design. A similar catalyst is used in the second catalyst bed to reduce the NO_X gas to N_2 and H_2O, a step that requires the addition of NH_3 as a reducing agent.

Through strategic cooperation with a supplier of product finishing technology, Stamicarbon is able to provide a fully-integrated solution for the nitric acid and (calcium) ammonium nitrate process, including potential liquid fertilizer applications, to produce (C)AN and UAN. Stamicarbon's dual-pressure nitric acid technology package meets today's process challenges and, while highly innovative, has an excellent and well-proven platform as its starting point. The optimised heat exchanger layout also allows regular stainless steels to be used, making it a cost-effective as well as a highly energy-efficient solution.

Fig. 9: **Controlled release urea**



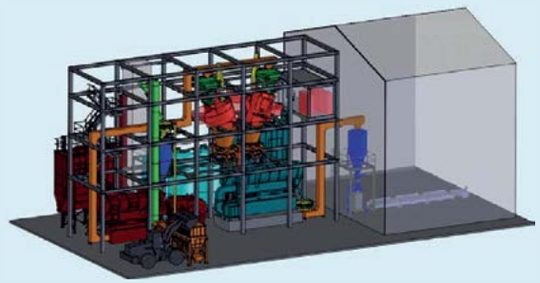
Source: Stamicarbon

Controlled-release fertilizers: Pursell Agri-Tech

Another notable example of open innovation is Stamicarbon's recent acquisition of a stake in Pursell Agri-Tech (PAT), a US-based start-up company developing controlled-release fertilizers. A thorough due-diligence process in advance of this investment provided the necessary financial reassurances, and also triggered other investors to join. The timing of Stamicarbon's investment was particularly critical, as it helped provide funding for PAT's first commercial demonstration plant.

PAT is developing a novel process to coat fertilizers with a polymer film that acts as barrier to moisture. The resulting

Fig. 10: **Modular coating plant design**



Source: Stamicarbon

controlled-release fertilizer slowly releases nutrients throughout the growing season. Water in the soil moves through the coating, a semi-permeable membrane, allowing the nutrients locked inside to dissolve. Depending on ambient temperature, dissolved nutrients then permeate outwards through the membrane back into the soil providing crops with a steady supply of nutrients (Figure 9).

Coating thickness regulates nutrient movement through the membrane and therefore the time period of controlled nutrient release. The duration of the controlled-release period can be adjusted from between two to six months, depending on the end application.

With environmental pressures mounting, notably for nitrogen and phosphorus, this technology should improve the sustainability of fertilization practices going forward, while at the same time still permitting crops to be grown in an intensive and highly effective manner.

The main aim of this novel technology is to position controlled-release urea as a suitable and practical product for application to broad acre crops. Under current fertilization practices, the application of standard urea fertilizers can result in high nitrogen losses, due to volatilization to air and leaching to surface and ground waters. As a result, global average nitrogen use efficiency is less than 50 percent, leading to unacceptable environmental pressures.

Substituting controlled-release urea for standard urea products can be an effective solution to the problem of nitrogen losses. By controlling the coating thickness, a single application at the start of the growing season can provide plants with the required nutrients throughout the whole of the season, without the need for a second or even third application. Ultimately, this type of coated urea product should allow crop yields to be improved, to keep pace with rising global food demand, while at the same time decreasing the environmental footprint of fertilizers.

Using a novel process technology, controlled-release coatings can be applied at a modular plant close to the end-user. This shortens the logistics chain with the farmer, reduces product handling and maintains product integrity. The modular coating plant's design allows semi-continuous operations, and has the capacity to produce more than 100,000 tonnes of controlled-release urea annually (Figure 10).

Stamicarbon has the licensing rights for this coating technology outside of North America.

Conclusion

Stamicarbon regards continuous innovation as crucial to maintaining its status as a leading license supplier in the fertilizer industry. Technological innovations can be accomplished and brought to market via many routes – including open innovation, as explained above. While innovative developments need to be commercially successful in the short-term, patent protection is necessary to secure and guarantee competitive advantage over the long-term.

Today, Stamicarbon owns more than 110 patent families, and a total of more than 1,100 individual patents, registered in many countries across the world. This is clear evidence that the company intends to remain an innovation champion for the industry, currently and into the future. ■

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A volatile, unsettling year for nitrogen

2017 was an unsettling 12 month period for the nitrogen market. The year was marred by continued oversupply and lacklustre demand. Market volatility, linked to the timing of international buying, also fuelled uncertainties over price direction, as **Laura Cross** of Integer Research explains.

The nitrogen market entered a turbulent period of uncertain prices in 2017. The year will certainly be remembered for its volatility. Decreased demand from India was also one of 2017's key signifiers. The country's disappointing urea imports were a reversal of fortune for the market and proved a bitter pill to swallow. Unsurprisingly, given the scale of its consumption, India's import downturn negatively affected sentiment and helped create an overall impression of a weaker-than-expected market. Significant stock carryover from 2016, and a new buying strategy by the Indian government's fertilizer department, were the main factors behind this.

The gap between nitrogen supply and demand also widened further with the commissioning of new nitrogen plants around the world. The current supply overhang will only get larger in the coming year. Fresh capacity additions will come from new plants scheduled for 2018, combining with projects whose start-up was delayed from 2017.

Despite the generally downbeat prognosis, there are still reasons to be positive, however. Meaningful supply rationalisation is taking place in China, for example – a significant development which we fully evaluate later in this article.

Fig. 1: **Chinese urea utilisation rate, 2015-2017**

Source: Baiinfo, Integer

Indian demand below expectations

Falling domestic urea sales in India over the last 18 months reduced Indian urea imports from 10.0 million tonnes in 2015 to just under 7.0 million tonnes in 2016. This figure looks set to fall further in 2017 – signalling a stunning reversal of India's role as the world's largest urea import market.

The Indian government has proclaimed loudly that the switch to 100 percent production of neem-coated urea in 2015, is driving this sales reduction by encouraging greater use efficiency. However, we believe that record imports in 2015, in combination with lower farm-level consumption linked to poor monsoons, are the most likely explanations for the subsequent falls in urea sales and imports. These factors have allowed significant inventories to build up throughout the supply chain. India's carried inventory continues to overhang real consumption, limiting sales activity among co-ops and wholesalers.

Furthermore, the Indian government is rolling-out policy initiatives designed to reduce both the over-application of urea and combat 'informal' market sales. In late-November it was announced that urea will be sold to India's farmers in 45 kg bags from 2018, instead of the 50 kg bags sold currently. The Indian government believes this will reduce urea consumption by 10 percent, as farmers usually buy and apply fertilizer on a bag-per-acre basis.

Currently, the price of 50 kg bag of urea is Rs 268 ($4.16) plus taxes, based on a maximum retail cost of Rs 5,360 ($83.13) per tonne. In 2018, this per-bag price will fall to Rs 245 ($3.80) plus taxes for the new 45 kg size bags.

The Indian government is also in the process of modernising how fertilizers are sold to the country's farmers. The new 'direct benefit transfer scheme' will introduce new electronic point-of-sale devices. In future, under the new scheme, urea producers will have to provide an itemised proof of sale with the national ID numbers of individual farmers.

This new transaction system should allow the government to track and cap urea sales and, in particular, curb sales to customers falling outside of the country's subsidy scheme. The government claims that informal (black market) reselling of subsidised urea at a profit – to industrial consumers and those outside the country– is a chronic problem currently.

The new scheme is due to roll-out nationwide in the first quarter of 2018. However, we remain cautious about how much of an impact it will have on India's urea consumption, as it is unclear just how large the country's informal market is. Potentially, the introduction of the new system could also fail and be withdrawn, if it causes widespread disruption to fertilizer purchasing.

China successfully implements environmental policies

Chinese urea production in the first eight months of 2017 decreased 15 percent year-on-year to total 37 million tonnes, according to figures from the China Nitrogen Fertilizer Association (CNFA). The Chinese urea utilisation rate fell over the summer to around 55 percent in the third quarter of 2017 (Figure 1), driven by environmental and economic changes. Some urea plants remain in temporary shutdown due to emissions levels, while other plants have cutback on urea output in response to low prices and increasing costs.

Since 2016, China has unveiled a series of polices aimed at reducing the environmental impact of heavy industry, including fertilizers, with varying degrees of success. A parallel objective is to speed-up industry consolidation and increase market competition, which for urea means tightening the domestic supply-demand balance.

The impacts of various Chinese environmental protection measures have been mixed (see box). Beyond short-term urea production stoppages, the effects of China's formal environmental inspection programme seem to have been minimal to date. Much more effective, instead, has been day-to-day pollution management in urban areas. This development appears to have had the most profound impact on China's urea operating rates in 2017.

It is clear that widespread environmental protection policies are being implemented by the Chinese government. Despite this, Integer believes that weaker production economics have been the main catalyst for lower production during 2017, although there is no denying that increasing environmental regulation has pressured domestic urea production.

Shift to methanol and urea

The recent CNFA conference in Shanghai confirmed that those Chinese urea plants with flexible capacity are moving away from urea into methanol and ammonia production, as both these markets provide stronger financial returns. Changes to product pricing have led to the complete closure of urea lines at some plants.

The price incentives for this have been obvious. In early November 2017, ammonia ex-factory prices reached RMB 3,000/t ($448/t) in some provinces, up by 50 percent year-on-year. By comparison, ex-work urea prices increased by 30 percent over the same period to RMB 1,750/t ($260/t). Some ammonia producers have been encouraged to switch downstream production from urea to more profitable methanol. Methanol prices increased by 35 percent year-on-year to RMB 2,700-2,800/t ($403-418/t) in November 2017.

Chinese urea costs forced upwards

The Chinese coal market has tightened since the start of 2017, due to supply restrictions and healthy downstream demand. While coal prices have increased across the board, the effect on the anthracite-coal market has been most notable (Figure 2). This is highly significant for the

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CHINA'S ENVIRONMENTAL POLICIES

Environmental audits/inspections

China's central government implemented four rounds of environmental inspections between January 2016 and September 2017. To date, some production disruption has occurred at inspected plants, albeit only temporary shutdowns in the majority of cases. Most producers have quickly resumed production after inspection. In cases where emissions were found to be above desired limits, however, plant adjustments were necessary before production could resume.

The '2+26 Cities Air Control Plan'

Designed to tackle Beijing's chronic pollution, the central government published its '2+26 Cities Air Control Plan' in early 2017. The plan covers cities in Beijing, Tianjin, Hebei, Shanxi, Henan and Shandong provinces. The plan requires industries such as steel and chemicals to reduce operating rates by 30-50 percent during winter heating periods – mainly between 15th November and 15th March. Urea capacity in the '2+26 cities' area totalled around 35 million t/a in 2017, some 44 percent of total Chinese capacity. The plan is expected to reduce urea production in these regions by more than 30 percent compared to 2016. This policy is a key factor behind the seven million tonne (11 percent) year-on-year decrease in urea production to around 55 million tonnes in 2017, as estimated by the Chinese Nitrogen Fertilizer Association (CNFA).

The Yangtze River Economic Belt relocation plan

A further policy measure will see the relocation of some fertilizer plants located near to the Yangtze River. The Chinese government requires chemical plants within 10 km of the river to relocate over the next three years. Rather than relocate, operators usually instigate a complete plant closure and then construct a new, identical capacity plant elsewhere, typically at a designated industrial park. The first round of 47 chemical relocation projects, spread across 11 provinces in the Yangtze Economic Belt, have been announced – and include seven nitrogen projects (see Table 1 below). All these projects will need to successfully relocate by 2020.

Heavy industry on the Yangtze River.

PHOTO: MANX_IN_THE_WORLD/ISTOCKPHOTO.COM

Table 1: **Fertilizer relocation projects along Yangtze River Economic Belt**

Province	Company	Capacity
Anhui	Yinshang Xintai Chemical	150,000 t/a of ammonia
Anhui	Sinosalt	One million t/a of NPK 300,000 t/a of ammonia 300,000 t/a of urea
Anhui	Haoyuan Chemical	One million t/a of NPK
Hunan	Jinmei Jinniu	200,000 t/a of ammonia 160,000 t/a of ammonium bicarbonate
Chongqing	Jiangbei Chemical	600,000 t/a of NPK
Chongqing	Sanling Chemical	200,000 t/a of ammonia 250,000 t/a of nitric acid 50,000 t/a of nitrate potassium
Sichuan	Guangyu Chemical	150,000 t/a of ammonia

Source: Integer

urea market as anthracite happens to be the feedstock used by China's price-setting urea producers operating at marginal cost.

Anthracite coal prices increased markedly during 2017, being 80 percent higher year-on-year by September time. The recent rally in prices has been partly driven by local government-instigated capacity closures. Environmental protection measures have also kept a cap on production volumes and tightened logistics.

As well as supply rationalisation, stoppages at a number of anthracite mines in Jincheng and Shanxi provinces, linked to security issues, caused further supply restrictions. Jinmei Group also permanently shut down several anthracite mines due to long-term resource depletion. Adding to market tightening on the supply-side, anthracite demand has also been particularly healthy, driven by higher prices for downstream products in China, particularly methanol and ammonia (see above).

Coal closures and falling inventories

China's central government has plans to reduce coal capacity by 800 million t/a by the end of 2020. Around 150 million t/a of capacity was closed in 2017, adding to 290 million t/a of closures in 2016. Actual closed capacity in 2016 and 2017 could, however, be as high as 620 million tonnes, according to some Chinese estimates. There are suggestions that local administrators, who view coal capacity closures as a performance indicator, are swiftly closing coal mines beyond the central government's initial targets.

Chinese coal supply has remained tight over the last 12 months, despite the removal of the coal market's 276 working day limit in late 2016. Some coal producers have struggled to return their production volumes to previous levels. Strict environmental measures, coupled with security inspections, have reduced coal industry operating rates. Because of this, the industry has needed to draw on inventories as a result of robust coal demand in the year-to-date. As a consequence, Chinese coal inventories decreased by 37 percent year-on-year by September 2017, based on a sample of major producers.

Decline in gas-based urea production

Much of the commentary surrounding the cutback in Chinese urea production has focused on coal-based capacity. But increased competition for natural gas supplies also began affecting urea plants in late-2017.

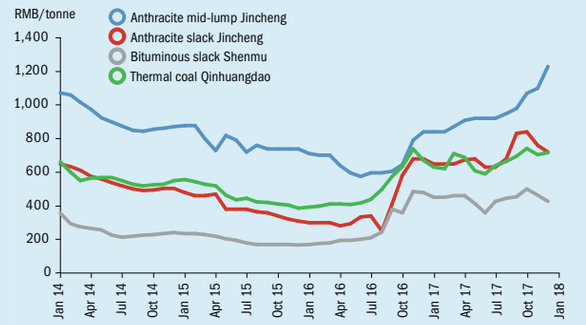
China's gas demand is set to hit record highs this winter. This is being driven by a major changeover from coal to gas for heating in North China, part of the government's drive to reduce pollution. China's total gas demand this year will reach 230 bcm in 2017, according to PetroChina, up 17 percent or 33 bcm year-on-year. The policy-driven switch from coal to gas is expected to generate some 20 bcm of this additional demand.

PetroChina and Sinopec are said to have suspended supplies to fertilizer and chemical plants in Sichuan and Chongqing in order to guarantee gas supply in North China. Elsewhere, almost all gas-based urea producers in Southwest China stopped production from 8-10 December. Meanwhile, a majority of gas-based urea producers in Gansu, Xinjiang and Inner Mongolia reduced their operating rates or shut down temporarily because of gas shortages across the country.

Although gas-based urea production will decline over the next 2-3 months, Integer does not expect local market supply to be significantly affected. This is because it is already usual for gas-based urea plants to stop or reduce production in winter when gas demand is at its seasonal peak. The overall impact on production volumes is also likely to be relatively small.

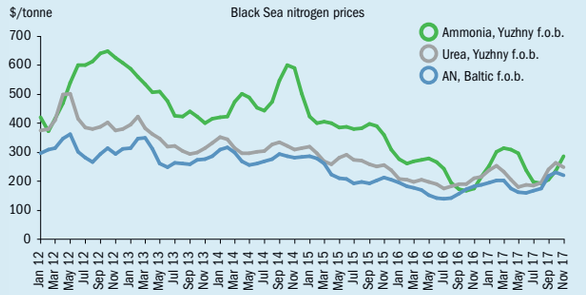
The average operating rate of gas-based urea plants was 19 percent in December 2017, down from 27 percent in December 2016, according to our calculations. This is equivalent to a monthly reduction in urea output of about 135,000 tonnes between December 2017 and February 2018, compared to the same period 12 months ago. This amount represents just three percent of average Chinese monthly production.

Fig. 2: **Average Chinese coal prices, 2014-2017**



Source: SX Coal, Integer

Fig. 3: **Nitrogen price developments, 2012-2017**



Source: Baiinfo, Integer

NITROGEN MARKET REVIEW

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2017: A MOST VOLATILE YEAR

JANUARY

- The urea market was temporarily tight amid short-term supply shortages
- Price increases were driven by the absence of Chinese producers in the international market
- The OPZ and Cherkassy plants in Ukraine were down and Dnipro was the only plant running in the country
- The expectation of seasonal demand from the US and Europe, and speculation over a March Indian import tender, supported price ideas

FEBRUARY

- The hope that the US market would act as a key importer in February failed to materialise leading to weakening urea prices going into March
- Import demand from Brazil and Europe remained sluggish, and India delayed its first import tender of the year, leading producers to drop their price ideas for March

MARCH

- The first Indian import tender of the year was met by 2.5 million tonnes of offers despite only 265,000 tonnes being purchased by Indian Potash Limited (IPL)
- The tender attracted fierce competition from Iranian and Arab Gulf producers
- Chinese producers remained out of the international market

APRIL

- The start of the second quarter was characterised by far lower demand levels than had been expected, although buying did emerge in the US
- Black Sea producers were relatively quiet in April and most price ideas (around $210/t f.o.b.) came from Chinese producers
- India's urea imports were down 35 percent in the April 2016 to March 2017 fiscal year

MAY

- Urea prices lifted ahead of the IPL Indian market tender for 500,000 tonnes, supporting some upward movement in price ideas
- Arab Gulf producers were largely committed under Indian tenders, keeping spot availability out of the region tight
- Chinese export price ideas ($240/t f.o.b.) were significantly above market prices

JUNE

- While market sentiment was positive compared to previous months, the general opinion was that any bounce in price ideas was likely to be short-lived
- The greatest uncertainty was the risk of a resurgence in Chinese exports following the end of the country's domestic season
- A sustained resurgence was unlikely in Integer's view, given the capacity rationalisation in China and the seven million tonnes of urea capacity closures in 2016

JULY

- Price ideas weakened as the urea market entered the year's quietest period and remained in a state of slow demand
- Indian buying had mostly come to an end, with the prospect of only one or two tenders to come

AUGUST

- Price ideas were mixed and new business stalled in late-August in anticipation of the next Indian tender
- This tender was, however, delayed due to notional increases in urea prices and sufficient domestic inventories
- As a result, price ideas softened going into September, after a slightly firmer August

SEPTEMBER

- India's announcement of two import tenders coincided with temporarily tight supply, sending global urea prices upwards
- The first tender was concluded on 8 September for 325,000 tonnes
- The second was concluded on 25 September with prices $39-44/t higher; some 591,000 tonnes being purchased at $285/t cfr
- China entered the urea export market again, selling over 100,000 tonnes under the second Indian tender, but offering the highest prices
- Egyptian sales were concluded as high as $300/t f.o.b.

OCTOBER

- Price sentiment was softer until prices received another upward boost when India's RCF issued its 14 October import tender
- Prices climbed by an extra $6/t from the previous tender, with China supplying 246,000 tonnes
- Suppliers were reluctant to reduce prices leading Sorfert in Algeria to top price ideas with a 20,000 tonne sale for $308/t f.o.b.
- Prices were forecast to remain firm heading into 2017's final months

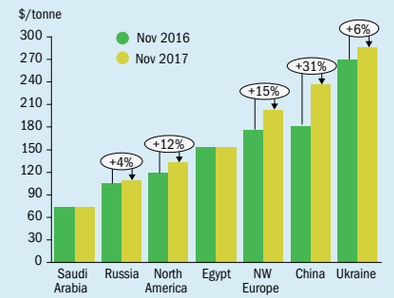
NOVEMBER

- India's NFL initially agreed to purchase 779,000 tonnes under its 25 October import tender
- NFL subsequently scrapped this tender on 7 November on the anticipation that the market would soften
- Price sentiment was severely affected, as suppliers who had made offers under the tender battled to find alternative destinations for 800,000 tonnes of urea
- Oman set the tone in late November, selling a cargo of granular urea in the $230s/t f.o.b. price range
- Indian port stocks of 1.4 million tonnes at the end of October 2017 were expected to be depleted quickly assuming good rainfall

DECEMBER

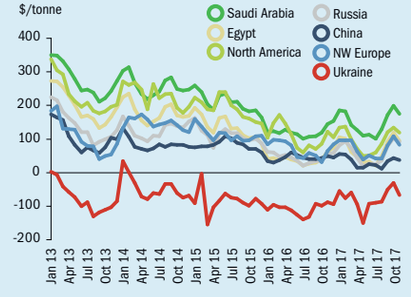
- Finally, after weeks of speculation, India's NFL issued an import tender for an unspecified quantity of granular or prilled urea closing on 22 December
- The tender is expected to dictate 2017's closing urea price level

Fig. 4: **Urea production costs (ex-works), by region**



Source: Integer

Fig. 5: **Typical urea gross margins, by country**



Source: Integer

Although the impact on the whole market will be limited, and is unlikely to lead to marked changes in China f.o.b. prices, local effects could be significant. Urea supply is likely to be tighter in China's southwestern region, for example, once the demand for spring planting arrives, as this is where most of the closed gas-based urea plants are located.

Nitrogen industry financial performance

The market remains dominated by oversupply, putting pressure on the financial performance of nitrogen producers, despite the increase in nitrogen prices through most of 2017's second half (Figure 3).

A regional breakdown of urea production costs and gross margins is provided in Figures 4 and 5. Urea ex-works production costs have generally increased during 2017, especially in China where the cost of anthracite coal has steadily increased since May 2016, peaking at $165/t in November 2017.

There are notable regional differences in the increases to urea production costs seen during the year. Chinese urea production and exports reduced dramatically over the course of 2017, due to various environmental and economic factors, as described above. Chinese urea plants using anthracite coal as feedstock typically experienced a 31 percent year-on-year increase in production costs between in the year, these rising to $237/tonne by November 2017.

In Northwest Europe, the average production cost increased by 15% year-on-year to around $203/t in November 2017. This was primarily driven by increased gas prices. The Zeebrugge hub reference price increased by 20 percent year-on-year to $6.70/MMBtu in November 2017. The Dutch TTF gas price also moved upwards for six months in succession, reaching its highest level in over two years by November.

Ukraine remains one of the highest-cost nitrogen producers globally, despite the country's continued diversification away from Russian gas. Natural gas supplied by state-owned Naftogaz increased month-on-month during the latter part of 2017. By November, Ukraine's average natural gas price was $9.4/MMBtu, up seven percent year-on-year

Finally, although the gas price to Russian nitrogen producers remained fixed in rouble terms, currency appreciation against the US dollar led to a four percent increase in urea production costs during 2017, rising from around $105/t in November 2016 to $109/t in November 2017. ■

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Hard fruit nutrient needs

More than 100 million tonnes of hard fruits are produced worldwide each year from orchards spread across nearly seven million hectares of land. Hard fruit cultivation is also on the rise globally, with world apple and pear production increasing by 15 percent over the last decade. Fertigation is a common growing-practice in orchards, and adopting the right fertilizer strategy can boost both hard fruit yield and produce quality.

Apples and pears are classed as pome (Rosaceae family, Maloideae sub-family), a group of fruit-bearing deciduous trees that originated in the temperate regions of the northern hemisphere. These two widely cultivated hard fruits, and other pomes such as nashi and quince, grow from spring blossom and are harvested from late summer through to late autumn. They require a period of low winter temperature to enable bud break and sprouting to occur in the spring.

The two main temperate zones for cultivation are found either side of the equator between the latitudes of 35° and 60° north and 30° and 50° south. Pome fruits are also grown in mountainous tropical and subtropical areas such as the Andean Cordilleras of South America and the Himalayan foothills of India.

PHOTO: FOTOKOSTIC/SHUTTERSTOCK.COM

Production and trade

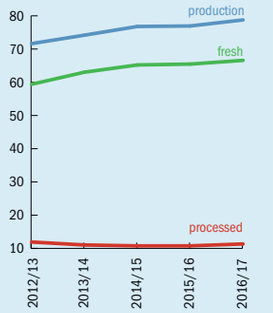
More than 111 million tonnes of pome fruit were produced globally in 2014, according to the FAO, from a total growing area of 6.7 million hectares. Apple and pear growing predominates, accounting for 76 percent and 23 percent of pome production, respectively, in 2014. Other pomes such as quince have a production share of less than one percent.

Latest figures from USDA show that nearly 79 million tonnes of apples and nearly 25 million tonnes of pears were harvested worldwide in 2016/17. Some 83 percent of apple production and 88 percent of pear production globally is sold as fresh market produce, the remainder being processed for food production (Figures 1 and 2).

China is the dominant global grower with a production share of almost two-thirds for apples and three-quarters for pears. Europe – EU member state Italy in particular – and the Americas are also major growing regions (Figures 3 and 4). Around eight percent of apple production and seven percent of pear production is traded internationally. World apple production is projected to fall back to 76 million tonnes in 2017/18. Unseasonable freezes affected EU orchards, dampening trade and offsetting production gains in China.

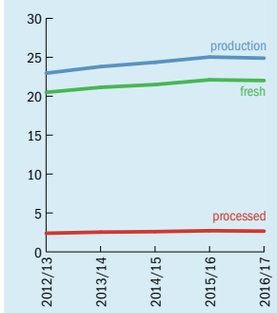
Countries such as Chile, South Africa, New Zealand, Argentina and Iran are important exporters (Figures 3 and 4). Russia, the EU and Belarus are all large apple importers and, together with Brazil and Indonesia, are also major export destinations for pears.

Fig. 1: **World apple production, 2013/14 to 2016/17**



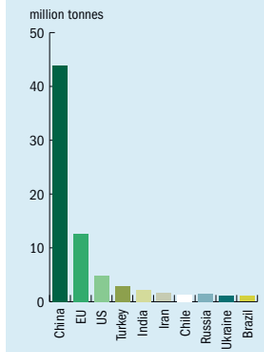
Source: USDA

Fig. 2: **World pear production, 2013/14 to 2016/17**



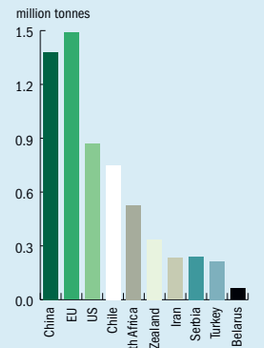
Source: USDA

Fig. 3a: **World apple production, by country, 2016/17**



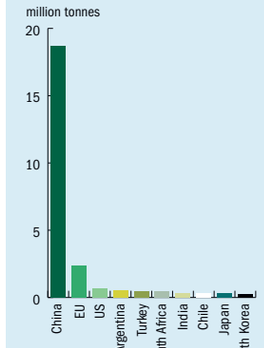
Source: USDA

Fig. 3b: **World apple exports, by country 2016/17**



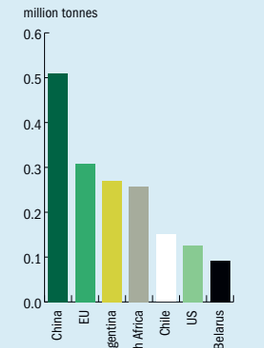
Source: USDA

Fig. 4a: **World pear production, by country, 2016/17**



Source: USDA

Fig. 4b: **World pear exports, by country 2016/17**



Source: USDA

Nutrient needs

Fruit trees have the capacity to store reserves of nutrients during winter in their buds, bark and roots. These are then remobilised in the spring allowing trees to grow leaves, bring flowers into bloom and help fruit to form and grow. The recycling of nutrients in orchards – their return to the soil by pruning, fruit thinning and leaf fall each year – reduces net nutrient removal.

The total export of nutrients in fruit orchards is much lower than the amounts removed from the field by broad-acre crops, mainly because the nutrient concentration in harvested fruit is less. On a per hectare basis, apples remove 20 kilos of nitrogen, for example, compared to the 100 kilos removed by wheat, assuming a 10 t/ha yield in both cases[1].

Calcium, potassium and nitrogen are the most important macronutrients for productive fruit orchards[1]. Potassium plays a key role in fruit yield and quality, and is exported in large amounts in harvested fruit (Figure 5). Nitrogen influences both fruit size and flavour, while the presence of calcium helps prevent pre- and post-harvest deterioration[2].

Nitrogen for size and flavour

Nitrogen influences the size and flavour of hard fruit and is involved in the development of skin colour[2]. It is essential for flower bud formation, fruit set and fruit development. Nitrogen-deficient trees produce low numbers of small, poorly-developed fruit. Excess nitrogen is also undesirable as it can delay fruit ripening and reduce fruit firmness and shelf life[2].

Removal rates for apple trees are between 60-75 kg/ha[2]. The fruit itself removes nitrogen in the range 12-48 kg/ha, depending on yield[1] (Figure 6). Soft apple varieties and those grown for the fresh market (eating apples) have a lower nitrogen requirement than harder varieties sent for processing.

It is common practice to apply nitrogen twice annually. An initial post-harvest application in the autumn boosts tree reserves, which are later remobilised to support flowering, fruit set and leaf development in early spring. A second spring application at flowering helps ensure further fruit and leaf development during late spring and the summer.

Nitrogen availability early in the season promotes good leaf growth, bloom and fruit set. Excess application later in season should, however, be avoided due to adverse effects on fruit quality.

For nitrogen supplied to pears harvested in the Italy's Po valley in Italy[2]:

CROP NUTRITION

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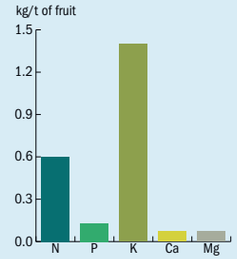
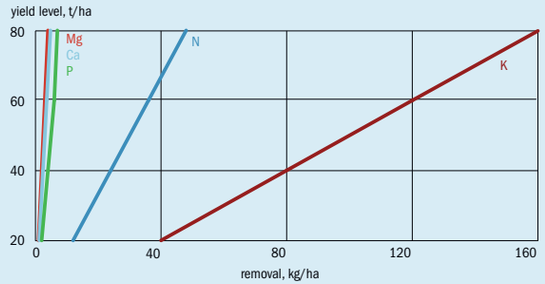
Fig. 5: **Typical apple macronutrient removal**



Source: Yara

Fig. 6: **Macronutrient removal by apple trees at different yield levels**



Source: Ebert (2009)

- Around two-fifths comes from stores accumulated the previous year
- Half is taken up from soil between March and May, the first two months after bloom
- Only one-tenth is taken up from soil from end of June to harvest, the last two months of fruit growth

When growth begins in springtime, apple trees initially rely on internal stores of nitrogen until two weeks prior to full bloom, before switching to nitrogen uptake from the soil thereafter. The rate of uptake peaks from 37 to 81 days after full bloom and then declines. Foliar applications to trees are generally a highly efficient and effective way of supplementing soil nitrogen supply, especially post-harvest when there is an increased risk of soil leaching[2].

Nitrogen deficiency early in the season may reduce leaf area and negatively affect fruit yield and quality later on. Small size fruits lacking in flavour can result if deficiency persists throughout season. Good availability at the end of winter dormancy prompts leaf development and shoot growth[1].

In apples, oversupply of nitrogen results in 'luxury' consumption. This prevents colour developing in red varieties due to shading from excessive leaf growth. Too much nitrogen also makes trees more susceptible to winter frost damage as it stops the hardening of shoots. In pears, excess nitrogen may delay fruit maturation during summer, lowers total soluble solids (TSS), and decreases resistance to pests and diseases such as psylla, fire blight and post-harvest blue mould[2].

Potassium for firmness and sweetness

Potassium is the most abundant nutrient in hard fruit. It has a positive impact on fruit size, firmness, skin colour, flavour, juiciness, acidity and TSS[2]. Potassium also reduces winter injury, limits spring frost damage to buds and flowers, and generally protects against disease.

Potassium content of fruit does, however, need balancing with levels of other nutrients, particularly calcium. The K/Ca ratio of apples, for example, has to be kept below 30 at harvest to prevent fruit disorders from developing during storage[1].

Mature, productive apple orchards remove more potassium than any other nutrient. Potassium has a key influence on yield and fruit sweetness, and a good soil supply helps optimise both fruit size and sugar-to-acid ratio[2]. Potassium removal is strongly yield dependent and can range from 80-120 kg/ha for fruit yields of 40-60 t/ha (Figure 6).

Apple fruit acts as a strong sink for potassium, the nutrient normally being present at a concentration of 0.6-0.8 kilos per tonne of fruit. Trees become potassium-deficient and produce fruit with less sugar when leaf concentration falls below one percent in summer.

Calcium and magnesium uptake can decrease as soil potassium levels rise, however, due to their antagonistic relationship. Excess potassium supply can subsequently affect fruit quality during storage by triggering calcium disorders, such as 'cork spot' in pear which is linked to high fruit K/Ca ratio[2].

Phosphorus for flowering and fruiting

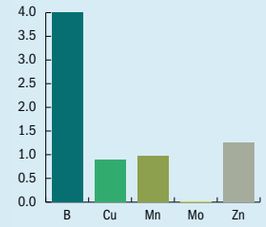
Although relatively low levels of phosphorus are required, availability is important during early growth stages such as flowering and fruiting, when new roots and flowers are formed and fruitlets develop by cell division[1]. The nutrient also has an impact on quality factors such fruit firmness and skin colour. Fruits high in phosphorus are also more resistant to pre- and post-harvest disorders[1].

Magnesium plays a critical role in leaf growth and flowering, and also helps minimise fruit drop – although, again, relatively little uptake is required. Deficiencies are common in acid soils, particularly those with high levels of plant-available potassium[2]. Magnesium improves fruit size and colour, increases sugar content and helps aroma and acidity develop[1].

Calcium for improved storage

Calcium is crucial for fruit firmness. Its presence in hard fruit also reduces disorders during storage[2]. Calcium helps maintain structural integrity and a low content in fruit is associated with internal breakdown and disorders such as bitter pit and fungal fruit rot. These can be prevented by maintaining a low K/Ca ratio and high fruit calcium concentrations, above 50 ppm for apples and above 100 ppm for pears[1]. Calcium deficiency disorders in apple and pear fruit, such as bitter pit, can be a serious problem. This is generally prevented by pre- and post-harvest spraying with calcium chloride or calcium nitrate (0.3-0.6%)[2].

Fig. 7: **Apple micronutrient removal**



Source: Yara

Calcium uptake by apple trees can be relatively high. Uptake by Gala varieties, for example, is around 74 kg/ha, although this is mainly stored in in leaves (60%) and pruned wood (25%), rather than in the fruit (4%) and the framework of the tree (11%)[2].

Calcium uptake in pear trees is associated with the first stage of fruit growth some 40-50 days after blooming. Some apple varieties such as 'Cox's Orange Pippin' accumulate calcium 30-40 days after full bloom, whereas other varieties such as 'Golden Delicious', 'Breaburn' and 'Fuji' will take up calcium at lower rates over a longer period (120-140 days)[2].

Foliar applications of calcium have been reported to be effective for certain soil types, such as silt loams and low organic matter sandy soils[2].

Boron for fruit set

A range of micronutrients such as boron, copper, manganese and zinc are taken up by hard fruit (Figure 7). Deficiencies are often associated with high pH soils and are indicated by characteristic leaf symptoms (Table 1). Leaf analysis is therefore a good indicator of micronutrient status[1].

Boron promotes fruit set and yield and inhibits post-harvest disorders. It also has a beneficial effect on storage behaviour by making calcium more mobile. Deficiency is associated with cracking and russetting, internal corking and increased fruit drop. Deficiency in pear trees results in malformed fruits containing lots of stone cells[1].

Impaired iron uptake may compromise fruit crop yield and quality, and can be particularly yield-limiting for trees grafted on 'quince' rootstock. Zinc- and copper-based foliar sprays are often applied to fruit trees to control disease. Pear is particularly zinc-sensitive but will respond promptly to pre- or post-bloom foliar applications. Soil accumulation of copper can be a problem if it leads to toxicity symptoms.

Table 1: **Nutrient deficiency symptoms in fruit trees**

N	Leaves are light green to yellow (chlorosis), sometimes with red margins. Early leaf drop, retarded growth of the tree. Small and firm fruits.
P	Small, but dark green leaves, sometimes with red margins, growth of the tree is retarded, resembling a 'shadeplant'. Delayed bud burst. Poor flowering and fruiting.
K	Older leaves with chlorotic margins, later turning necrotic, beginning from the leaf tip. Leaves sometimes curled. Weak branches, poor quality of fruits, shorter post-harvest life.
Ca	Leaf symptoms are very rare in most orchards. Young leaves turn chlorotic, midrips lighter in colour, leaf drop, dieback of branches. Physiological disorders of fruits (bitter pit).
Mg	Mature leaves become chlorotic, starting from areas in the region of the midrib (interveinal chlorosis), then progressing later from the centre to the leaf margins. Leaves are sometimes curled.
S	Similar to N-deficiency, chlorotic, pale green leaves. In contrast to N-deficiency young leaves are more affected.
Fe	Young leaves become yellow, but their veins remain green. Leaves may lose all pigments and turn white, later necrotic.
Mn	Similar to Fe-deficiency, but veins have a green seam, chlorotic interveinal areas turn pale green to yellow, sometimes necrotic spots.
Cu	Young leaves turn yellow or pale, necrotic leaf tips and margins. Dieback of young shoots, small sized fruits. Often associated with Zn deficiency.
Zn	Similar to Fe-deficiency, leaves are small; twigs are stunted and rosette-like. Poor flowering and fruiting.
B	Leaf chlorosis or yellow spots, smaller leaves with a hard leaf texture. Stems and leaves distorted. Malformed fruits with stone cells (often in pear fruits).

Source: Ebert (2009)

Fertilizer recommendations

Applying the right amounts of nutrients at the right time is fundamental for yielding large quantities of high quality fruit from modern orchards.

Fertilizer recommendations are usually based on annual leaf analysis and periodic soil testing. Growers generally monitor for tree growth, leaf nutrient levels, fruit yield and fruit quality, and adjust their annual fertilizer programme accordingly[3].

It is very important for growers to correct pre-existing soil nutrient deficiencies when an orchard is first established – as this may be the only practical opportunity to improve soil fertility at depth.

Fertilizer recommendations are influenced by:

- Cultivar, e.g. apples divide into low and high nitrogen requirement varieties
- Soil conditions
- Leaf nutrient status
- Expected yield
- Planting system, tree density and pruning severity
- Soil management
- Climate

Low yielding 'Cox's Orange' apple trees, for example, require less nitrogen than heavy-bearing 'Gloster' trees. The trees in high-density orchards are typically more prone to nutrient deficiency because of their small, shallow root systems[1]. Young, non-bearing trees also benefit from higher nitrogen applications than older fruit-bearing trees. This is because woody and vegetative growth is encouraged in young trees, while older, fruit bearing trees are grown for high fruit yield and quality[3].

A relatively high nitrogen status early in the season encourages rapid leaf development, fruit set and flower bud formation. Allowing nitrogen status to decline gradually as the season progresses tends to enhance flavour and fruit colour[3].

US plant and soil testing company **Spectrum Analytic** offers the following general nitrogen recommendations for apples:

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Table 2: **Example phosphorus and potassium recommendations for apple trees, based on soil status***

	Soil status			
	Low	**Medium**	**Good**	**High**
New planting				
P_2O_5 (kg/ha)	224	112	67	0
K_2O (kg/ha)	336	224	101	0
Established trees				
P_2O_5 (kg/ha)	101	67	34	0
K_2O (kg/ha)	168	135	101	0

**See text for example nitrogen recommendations* *Source: Spectrum Analytic*

Table 3: **Nutrient application rates for mature apple trees via fertigation***

Nutrient	Rate (g tree^{-1} yr^{-1})
N	20-40
P	10-20
K	30-50
Mg	10-20
S	10-20

Usually sufficient amounts of Ca dissolved in the irrigation water.

Source: Ebert (2009)

- **Pre-planting:** apply 45 kg/ha (40 lb/ac) worked into the soil prior to planting. Apply an additional 45 kg/ha top dressing if the soil under trees is laid permanently to grass.
- **Young, non-bearing trees:** typical recommendations are 0.05-0.11 kg per tree (0.1-0.25 lb/tree), adjusted according to leaf analysis and for tree growth. Optimum growth is normally obtained at leaf nitrogen levels of 2.4-2.6 percent. Foliar applications or fertigation can be used to adjust leaf nutrient status. Growers may need to increase the nitrogen rate to 0.09-0.18 kg/tree (0.2-0.4 lb/tree) where weeds or grass are present under trees.
- **Fruit-bearing trees:** apply 45 kg/ha (40 lb/acre) annually in the absence of leaf analysis. Mature, standard trees may require as much as 0.23-0.45 kg per tree (0.5-1.0 lb/tree), whereas dwarf trees typically require half this amount. Nitrogen is adjusted to obtain: an annual terminal growth of 20-30 centimetres (8- 12 inches), good fruit colour and quality, and optimum leaf nitrogen. Leaf nitrogen levels should be in the range 1.8-2.2 percent for soft fruit varieties and fresh market produce, and around 2.2-2.4 percent for hard fruit varieties and fruit for processing.

Spectrum Analytic advises adjusting potassium and phosphorus applications according to soil status, depending on whether this is low, medium, good or high (Table 2). Application rates are generally higher for new plantings versus established trees.

Phosphorus recommendations are designed to build-up and maintain good soil levels. Apples are very responsive to potassium, making adequate fertilization vital for maximising yield. Potassium's beneficial effects can be lost, however, if the leaf ratio of nitrogen to potassium is too high. Low nitrogen trees such as McIntosh do better with an N:K ratio of around 1:1 to 1.25:1, while high nitrogen trees such as Red Delicious should have a ratio of between1.25:1 and 1.5:1. Annual potassium applications should therefore be adjusted to correct leaf imbalances.

Table 4: **Fertigation recommendations for apples**

	Nutrient requirement (Kg/ha)			Fertilizer recommendations (kg/ha)		
	N	**P_2O_5**	**K_2O**	**Multi-K, KNO_3 (13-0-46)**	**MAP***	**AN** (34-0-0)**
Spring to early summer	60-90	50-100	120-170	260-370	80-160	50-70
Post-harvest	20-35	-	60-70	130-160	-	10-40
Total	**80-125**	**50-100**	**180-240**	**390-530**	**80-160**	**60-110**

**Monoammonium phosphate **Ammonium nitrate* *Source: Haifa Group*

Nutrition starts at planting

Hard fruit nutrition needs to start at planting, advises **Tessenderlo Group**. The company recommends supplying nitrogen fertilizer at the end of winter or the beginning of spring for orchards in production. It suggests applying phosphorus close to the roots because of its limited mobility.

Tessenderlo also recommends combining potassium from two separate supply sources, an initial base fertilizer together with an annual supply, suggesting that this holds the key to successful potassium fertilization:

"Fertilization prior to planting is aimed at promoting good rooting and rapid plant development, whereas the annual fertilization programme targets balanced nutrition in order to optimise crop yield and quality, notably… the juice and sugar content of the fruit. Choices are largely guided by soil analysis, subsequently complemented by foliar diagnosis."

Tessenderlo cites a long-term study on apples carried out at the Pôle d'Aspach research centre in France in support of this approach. This demonstrated the benefits of two sources of potassium over a decade-long period. "The two supplies are necessary even after 10 years – the annual supply will not compensate for the absence of a base fertilizer and vice-versa," comments Tessenderlo.

Sulphate of potash (SOP) is ideal for cultivation of chloride-sensitive fruit trees, including apples and pears, according to Tessenderlo. SOP has a positive effect on sugar levels and regulates the sugar/acidity balance, a key influence on fruit taste. SOP also improves frost resistance and enhances dry matter production, the latter resulting in firmer fruit that are easier to transport and have better storage properties.

One advantage of foliar treatments is the ability to correct deficiencies more quickly than soil application. In trials, foliar application of *K-Leaf* (3 kg/ha), for example, the fast-dissolving SOP product from Tessenderlo, improved apple and pear yields by 20 percent and 12 percent respectively, when used to supplement soil application of potassium (160 kg/ha).

Fertigation and non-fertigation

General fertigation application rates are shown in Table 3. Haifa Group also provides a set of recommendations for fertigation and foliar feeding of apple orchards as part of its online nutrient advice for fruit trees (Table 4). These recommendations are for light-to-medium soils and a planting density of 600-700 trees/ha. Haifa advises that fertigation:

- Ends 50 days before harvest
- Applications are divided into weekly amounts and applied with at least three hours of irrigation
- Recommendations are adjusted according to leaf analysis

Yara International offers comprehensive crop nutrition advice for pome fruit, including both non-fertigation and fertigation programmes. The following Yara products are suitable for apple and pear tree application:

- *YaraLiva Tropicote* (15.5% N + 18.8% Ca) is a high-quality calcium nitrate product for soil application
- *YaraMila Complex* (12-5-15) is a high-quality, prilled NPK fertiliser which also contains magnesium, sulphur and micronutrients
- *YaraVita Bortrac* is a concentrated liquid boron foliar formulation
- *YaraVita Frutrel* is a high-concentration foliar product developed for fruit crops containing Ca, P, Mg, B and Zn
- *YaraVita Bud Builder* is a high-concentration foliar product for improving the flowering of top and soft fruit
- *YaraVita Stopit* is a food-grade calcium chloride foliar product
- *Unika Kali* is a high-quality, prilled, field-grade potassium nitrate fertilizer for application to horticultural crops

Yara's non-fertigation programme recommends foliar and soil applications of these products at the following stages during the growing season:

- **Bud Burst:** soil application (150 kg/ha) of *YaraLiva Tropicote*
- **Start of flowering:** soil application of *YaraMila Complex* (200 kg/ha) and foliar application of *YaraVita Bortrac* (1-2 l/ha)
- **Fruit set & development:** soil application of *Unika Kali* (125 kg/ha) supplemented by 3-4 foliar applications of *YaraVita Fruitrel* (10 l/ha) or 5-6 foliar applications of *YaraVita Stopit* (10 l/ha)
- **Post-harvest:** soil application of *YaraMila Complex* (150 kg/ha) together with foliar application of *YaraVita Bud Builder* (10 l/ha)

Foliar trial results

SQM has obtained highly positive trial results on Fuji apple orchards in Shandong province, China, using one its speciality foliar products, *Speedfol Colour SP*. This micronutrient-enriched PK product (0-48-32 + 0.2 B + 0.03 Mo) was found to have a positive impact on fruit yield, maturity, colouring and the quality of Fuji apples. These results are significant as the Fuji variety accounts for more than 70 percent of China's apple production.

After three applications with *Speedfol Colour SP*, growers obtained larger and heavier fruits with higher sugar content. Treated fruits also matured and coloured 3-7 days earlier, were more uniform in colour and higher in density. This enabled the apples to be brought to the market at an earlier stage, where they were sold at a higher price, so raising the net income of growers.

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Young professionals

The International Fertilizer Association (IFA) is helping to fully develop the career potential of younger employees through the recently-launched 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, Mohammed Razem, the Arab Potash Company's Chief Financial Officer (CFO) in Jordan, talks to us about his career.

PHOTO: IFA

Mohammed Razem, 38 Chief Financial Officer

How did your career in the industry start?
It was completely unplanned! I originally studied accounting at the University of Jordan, and later qualified as a Certified Public Accountant (CPA). I eventually joined the Arab Potash Company (APC) as a financial controller in 2011, after four years in public accounting and three years in real estate. I thought the fertilizer industry looked dynamic and interesting – and my guess was right.

What achievements are you most proud of?
Having the trust of the chairman, the CEO and the APC board in my ability to lead the finance department and promote me to CFO. I'm one of the youngest executive managers in the company – and the first Jordanian to be appointed to a PotashCorp-approved senior management position. I also led the technical team that fast-tracked the installation of efficient temporary electricity generators, an energy-cutting initiative that has saved APC tens of millions of dollars.

What do you find most rewarding about your job?
My team and I like new challenges and doing things differently. We enjoy working together as a group, coming up with and introducing new business ideas across the company. Some of the new ideas we've championed include the outsourcing of catering and transportation, and securing much better value through open, competitive procurement.

What hurdles have you had to overcome?
As a young newcomer with fresh ideas, overcoming resistance to change was an issue. But with patience and persuasion, I have helped make changes to the way APC operates and conducts business. We've moved to a paperless environment, cloud computing and quarterly results announcements, for example, and introduced a media plan and changed our logo. Internationally, I think more needs to be done to empower and involve the younger generation at a much higher-level within the industry.

How do you get the best from yourself and colleagues?
My approach can be summed-up in two words: ownership and engagement. Allowing the team to shine and be able to present and defend their ideas is important. Part of inspiring colleagues is saying: "This is your baby. You manage the meeting, make the presentation, talk to the board." People in teams also need to be appreciated and kept up-to-date on the progress of their initiatives.

Has mentoring been important to you?
Mentoring is a very important. That is something I learnt recently, having heard industry CEOs talk about their own careers at recent IFA events. That inspired me to find my own mentor last year. We now talk regularly – and I find that has real advantages and has been really beneficial for me.

Will your job and the industry change in future?
For sure, our industry needs to get ready for the pace of change that will transform the whole world over the next five to ten years. We need to prepare for and adapt to what's coming in the future. The next industrial revolution will be internet-based and involve green technology. For APC, the development of electric ocean vessels is one innovation that could change how we ship our products.

Would you recommend a career in the sector to others?
Yes, the international experience you'll gain is unique. It's a dynamic, fast-paced industry that requires prompt action and will always keep you mentally engaged. It's an industry that teaches you to dig deeper and be analytical, so you will learn a lot about how a worldwide business is run.

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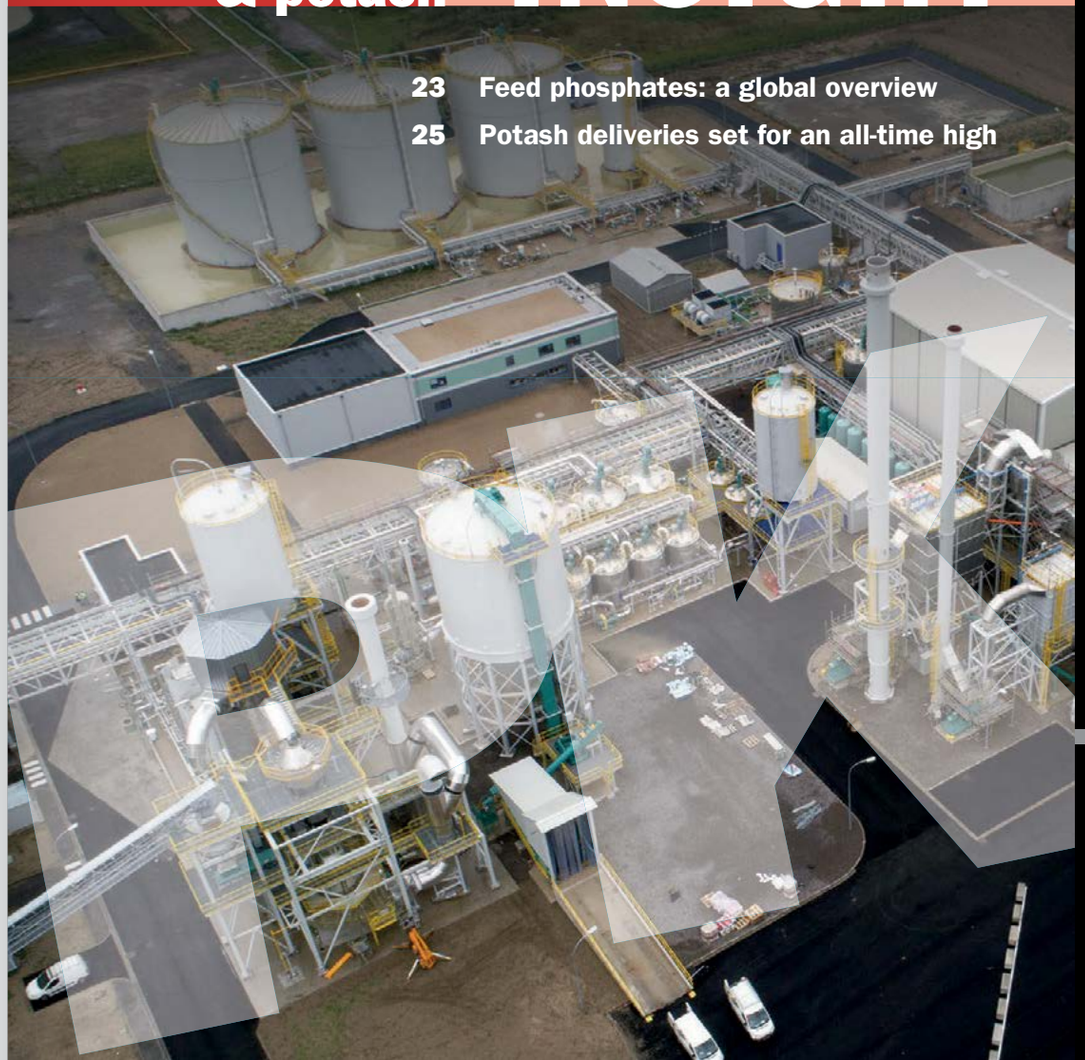
phosphates & potash INSIGHT



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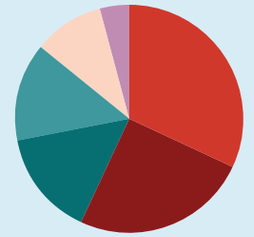
Feed phosphates: a global overview

Global feed phosphates production capacity has increased substantially in the past decade, reports **Janos Gal**, senior analyst at Feedinfo, especially in China. Incumbent producers and new entrants are attempting to capitalise on the growing and potentially lucrative market for feed phosphate products in regions such as Europe, Asia and Latin America.

PHOTO: ALIPHOS

The newly-constructed Aliphos feed phosphate plant in Dunkirk, France.

Fig. 1: **2017 global inorganic feed phosphate nameplate capacity: regional share**



World total: 11 million tonnes approx.

Source: Feedinfo

It is estimated that about five percent of global phosphoric acid production is used to manufacture inorganic feed phosphates. Major integrated producers are widely distributed across the globe. The United States, North Africa, Europe and China are all major centres of feed phosphates production.

Europe, in particular, plays host to a number of non-integrated producers. Such producers – because they depend on externally-sourced phosphoric acid and hydrochloric acid feedstocks – are more exposed to market volatility and pressures on their margins.

Europe relies on imported phosphoric acid from various sources, with Moroccan phosphates giant OCP being a major supplier. Unsurprisingly, a hike in the price of phosphoric acid, because it is an essential feedstock, generally leads to higher feed phosphate prices.

The price of the other main feedstock for feed phosphates, hydrochloric acid is largely determined by its origin as a by-product of chlor-alkali production. As a by-product, the cost of hydrochloric acid tends to be lower than phosphoric acid, although its availability is controlled by the demand for primary chlor-alkali products.

Change and consolidation in Europe

Europe is a major producer and consumer of monocalcium phosphate (MCP) and dicalcium phosphate (DCP). Feed phosphates production in the region has gone through major changes and consolidation in the past decade. Tessenderlo's exit from the market, following the closure of its Belgian and Italian operations, has been particularly significant. The company subsequently sold its remaining feed phosphate production plants to Aliphos, part of EcoPhos, in 2014.

In a separate development, Phosphea, formerly Timab, bought two Spanish feed

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Table 1: **Phosphoric acid imports of selected EU member states and country of origin, January-September 2017 (tonnes)**

Supplier/Importer	Belgium	Bulgaria	Finland	France	Italy	Netherlands	Spain	Total
Morocco	186,486	6,291	0	105,317	12,283	0	128,813	439,189
Israel	0	143	155	16,925	11,395	173,101	70,111	271,831
Tunisia	0	0	0	0	36,404	0	9,153	45,557
Lebanon	0	0	0	0	11,998	0	14,675	26,672
South Africa	19,640	0	0	0	3	0	0	19,644
China	0	759	437	50	727	439	2,177	4,588
US	894	0	1	50	41	296	57	1,338
Turkey	1	0	0	0	0	0	0	1
Others	2,111	310	1	500	2,839	165	97	6,022
Total	**209,133**	**7,502**	**593**	**122,842**	**75,690**	**174,001**	**225,082**	**814,843**

Source: Eurostat

phosphate production plants previously-owned by Ercros. Phosphea is a Europe-wide producer and currently operates plants in France (St Malo), Tunisia (Gabes I and II) and Spain (Flix and Cartagena).

Europe's total nameplate feed phosphates capacity is around 2.7 million tonnes currently, including plants in Serbia and Russia.

Although older, mainly DCP, plant capacity has contracted in recent years due to closure, MCP capacity in Europe is on the increase. Phosagro and EuroChem have both upped the capacity of their operations in Russia and Lithuania. Elixir in Serbia has also started production at a new plant, while Aliphos has expanded its *Dical+* output in both the Netherlands and France.

European consumption trends are changing as consumers switch from DCP to MCP in increasing numbers. Feed-grade MCP benefits from higher water solubility and higher absorption rates in comparison to DCP, and many feed companies prefer DCP over MCP because of these qualities.

New European capacity

The main addition to European feed phosphates capacity over the past decade has occurred in Lithuania, with EuroChem increasing its MCP capacity to just under 200,000 t/a. In Russia, Phosagro and EuroChem have also increased feed phosphates output to 360,000 t/a and 220,000 t/a, respectively. EuroChem's Phosphorit plant in Russia produces defluorinated phosphates (DFP), while PhosAgro produces MCP.

Phosphea bought Elixir's modern 100,000 t/a Serbian MCP plant in 2017. The plant, which first entered production in 2015, will enable Phospea to market its own product in the region. Supply from the Serbian plant has allowed local end-users to switch from traditional suppliers in western and northern Europe during the past two years.

The only company to bring extra western European capacity online in recent years has been Aliphos. The Vlaardingen expansion, which started-up in March 2017, provided the company with an extra 80,000 t/a of *Dical+* production capacity. Its new 220,000 t/a nameplate capacity plant in Dunkerque, France, also entered production in the fourth quarter of 2017. With these two new additions, Aliphos now has a combined European production capacity of 620,000 t/a, making it Europe's biggest feed phosphates manufacturer and supplier.

European feedstock supply

Europe's only integrated plant operators are Yara, EuroChem and Phosagro. The Phosphea (formerly Elixir) plant in Serbia sources its phosphoric acid by pipeline from the nearby Elixir phos acid plant.

The phosphoric acid manufacturing plants operated by Yara, EuroChem and Phosagro consume sulphuric acid made from purchased sulphur. Almost half of European feed phosphates supply is sourced from these plants. Europe's other feed phosphate producers buy-in phosphoric acid and hydrochloric acid from European and non-European suppliers.

The phosphoric acid imports of selected EU member states are shown in Table 1. Morocco is by far the largest phosphoric acid supplier to the EU. Spain, Belgium, the Netherlands and France were the top four phos acid importing countries during the first nine months of 2017.

The Americas: a north/south split

Combined North American and South American feed phosphates production capacity of 3.2 million tonnes is about one-third of the global total, and divided almost equally between the north and south of the region. The US dominates North American production whereas Brazil has the largest industry in South America.

The US feed phosphates market has undergone consolidation in recent years similar to that seen in Europe. As in Europe, DCP production in the US has contracted, due to the combined effects of deep phytase penetration into the market and increased usage of distillers dried grains with solubles (DDGS).

The market impact of phytase and DDGS substitution over the past decade has been more pronounced in the US, due to their displacement of DCP in the region. End-users are also increasingly switching to MCP as a way of improving their efficiency and margins, continuing a trend that began in the early 2000s.

MCP consumption in the US and other parts of the world is on the rise because its digestibility is higher than DCP, about 75-80 percent versus 50-55 percent. Due to changing preferences, annual DCP production capacity in the US has dropped from close to 600,000 tonnes in 1990 to just tens of thousands of tonnes by 2016.

PotashCorp is the largest inorganic feed phosphates producer in the US, with some 800,000 t/a of combined capacity – although actual output, 310,000 tonnes in 2016, is much lower than nameplate capacity. The company also cut back production recently, announcing the closure of its 85,000 tonne capacity Aurora DFP plant.

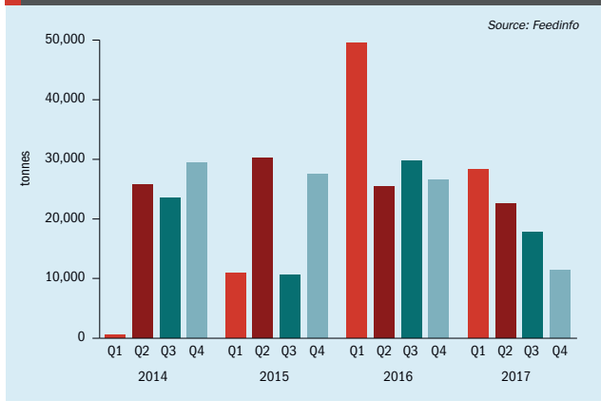
PotashCorp is a vertically-integrated producer, mining its own phosphate rock, while buying sulphur and sulphuric acid to make phosphoric acid. Its phosphoric acid production fell in 2016, according to the company's most recent annual report, partly in response to decreased demand for feed phosphates.

In marked contrast to the US, the Latin American feed phosphates market has grown in the past decade with the emergence of both new and rebranded producers. Notably, Quimpac in Peru and Monómeros Colombo Venezolanos (MCV) in Colombia have both built new plants. Vale Fertilizantes has also revamped one of its feed phosphates plants and relocated another.

Vale, with a total capacity of 755,000 t/a, supplies about half of Brazilian feed phosphates market and is the largest producer of DCP in Latin America. The company also exports to neighbouring countries, with about six percent of its production going to Argentina, Paraguay, Bolivia and Uruguay. The sale of Vale's fertilizer assets to The Mosaic Company, announced in December 2016, also includes its considerable feed phosphate assets.

The domestic market for Peruvian DCP, where Quimpac is the only producer, is very small, meaning that most of the company's feed phosphates output is destined for export. Brazil and Chile, followed by Ecuador and Venezuela, are the largest consumers of Peruvian feed phosphate. Colombia was also an important market for Peru, prior to the start-up of a 12,000 t/a capacity domestic TCP plant by MCV in the country in 2014.

Fig. 2: **Brazil quarterly dicalcium phosphate imports, 2014-17**



The Middle East and Africa

The African and the Middle Eastern feed phosphates market, although not as mature as those of Europe or North America, is home to a number of modern production plants. Most of the region's production capacity is located in Turkey, Saudi Arabia, Morocco and Tunisia, as well as South Africa.

South African supply is dominated by Yara in Durban and, to a lesser extent, by Biominerale in Wonderfontein. The North African market has also gone through a substantial growth cycle in the past decade with Phosphea in Tunisia and OCP in Morocco building three new MCP/DCP units. Egypt also looks set to enter the feed phosphates market. Evergrow is building two new DCP plants in the country using EcoPhos technology. The company has plans to construct two *Dical+* production lines in phases.

Production plans shelved

The Middle East is dominated by feed phosphates production in Turkey, which has three plants, two in Bandirma and one near Adana. Production facilities are also located in Iran. Saudi Arabia possesses one small plant with a second due to start-up in late 2017.

The Middle East's feed phosphates industry has remained comparatively small

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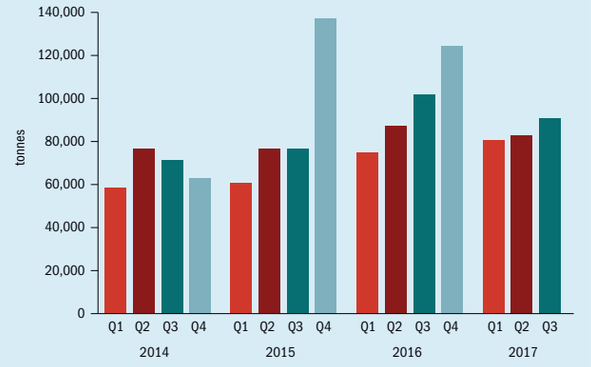
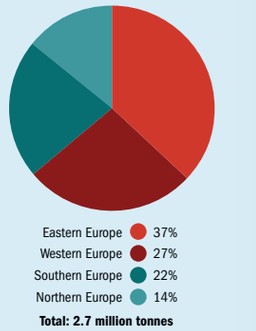
Fig. 3: **China: quarterly dicalcium phosphate exports, 2014-17**



Source: Feedinfo

Fig. 4: **2017 European feed phosphate nameplate capacity: sub-regional share**



Source: Feedinfo

by global standards. Although a sizeable increase in supply was forecast in 2017, linked to Ma'aden massive phosphates expansion programme in Saudi Arabia, these plans have now been shelved, at least for the time being. In Syria, UCCI completed a 60,000 t/a DCP plant in 2011 using technology supplied by EcoPhos. This plant is not currently operational, however, due to the country's civil war.

The expanding Asian market

The Asian market for feed phosphates has grown into one of the largest in the world, with enough capacity to produce 3.5 million tonnes of products. Most of the region's production plants have been built since 2000. China is by far the world's largest feed phosphates consumer. The expansion of its feed phosphates industry, similar to the rise in industrial output in other parts of the economy, has largely been driven by government incentives.

Although China has historically used DCP, the use of MCP/MDCP has increased sharply since 2008, with both products expected to gain an even larger market share over the medium-term. The bulk of growth in feed phosphates consumption in China is linked to increased poultry and swine production, together with rising use in aquaculture. The increased feeding of freshwater fish and shrimp, although a relatively new trend, now generates significant demand, mostly for MCP.

Most of Asia's production capabilities are located in China, combined with some operations in India and a few other economies. China's feed phosphates industry has grown explosively in the last decade, with new plants entering production almost every year. The new MCP and DCP lines introduced by Wengfu and Yunnan Yuntianhua have been the most recent additions.

Wengfu is believed to operate the country's only tricalcium phosphate (TCP) plant. The company and its Japanese partner completed the construction of a 50,000 t/a capacity TCP plant in early 2013. The plant was designed to export product to Japan, as TCP does not currently have a market in China. Wengfu plans to expand TCP output to 200,000 t/a, depending on demand.

China mainly exports feed phosphates to its regional neighbours Japan, Thailand, Vietnam and Taiwan, as well as South Korea. However, total Chinese DCP exports have declined from 388,000 tonnes in 2004 to 319,000 tonnes in 2016, with Thailand, Indonesia and Taiwan seeing the largest decreases in sales.

Outside of China, the most recent new capacity development has been the joint venture (JV) between EcoPhos and Gujarat Narmada Valley Fertilizers & Chemicals Limited (GNFC) in India. The JV agreement calls for the construction of a 220,000 t/a *Dical+* plant due to start-up in 2019. Indian feed phosphates production, estimated to total 100,000 t/a, is currently small-scale and scattered across the country. Most plants have a capacity of 15-20 t/d.

Market price trends

In Europe, MCP and DCP prices declined during 2017 from the first quarter onwards. Price falls during the past year – with the exception of a hiatus during the second quarter – were driven by ample availability and increased competition between suppliers. Looking ahead, it is highly likely that the declining price trend seen in the feed phosphate market in 2017 will be reversed during the first quarter of 2018, given that phosphoric acid prices across the world are now on the increase.

Similar price declines were witnessed in North America in 2017. Feed phosphates prices fell year-on-year linked to improved supply from Europe. The US feed phosphate sector continues to struggle financially, according to recent quarterly earnings. More positively, US market participants do not expect any major price changes before the end of 2017. Imports have also slowed, as domestic prices have now fallen below landed prices in the US Gulf.

2017 Brazilian prices, in contrast, edged up on a decline in US imports as well as production issues within Brazil, both planned and unplanned. It appears likely that prices in this market will further increase early in 2018 driven by rising feedstock costs. ■

Potash deliveries set for an all-time high

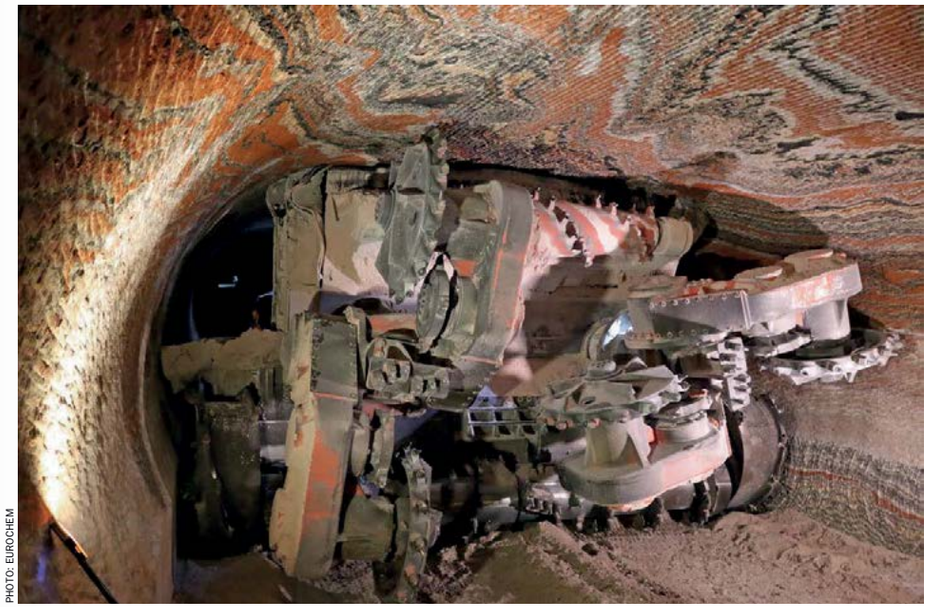


PHOTO: EUROCHEM

The potash market performed robustly in 2017. Strong demand growth in China, Brazil, Southeast Asia and India could see global potash deliveries reach a new high point of 62-65 million tonnes. Potash prices also strengthened in most regions during 2017, on the back of improved demand.

Above: Potash ore mining at EuroChem's new Usolskiy mine in Russia.

As 2017 drew to a close, potash prices continued to firm in countries such as Indonesia, Malaysia and Brazil, reflecting the high levels of demand and positive agricultural fundamentals in the main potash export markets and consuming regions.

In further evidence of strong and sustained potash demand, Canpotex, Canada's potash export consortium, was sold out for most of 2017, announcing it was fully committed on five separate occasions during the year. Currently, the consortium's export volumes remain sold out until the end of February 2018.

PotashCorp, in a decidedly upbeat market overview timed to coincide with TFI's 2017 World Fertilizer Conference in September, reported[1]:

"Potash deliveries were strong during the first half of 2017 and global supply and demand fundamentals continued to tighten. Potash prices have further strengthened in most geographies since the beginning of 2017 on improved demand.

"We expect strong potash demand through the remainder of 2017 and estimate global potash shipments between 62-65 million tonnes, potentially setting an all-time high."

Strong demand growth supports deliveries

Estimated 2017 global potash deliveries of between 62-65 million tonnes are well above the 60 million tonne level of the previous year. The momentum from strong deliveries in the latter part of 2016 continued into 2017, with PotashCorp expecting year-on-year growth in many of

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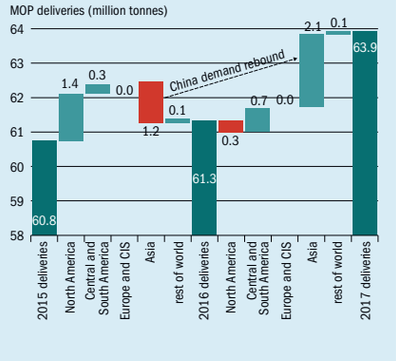
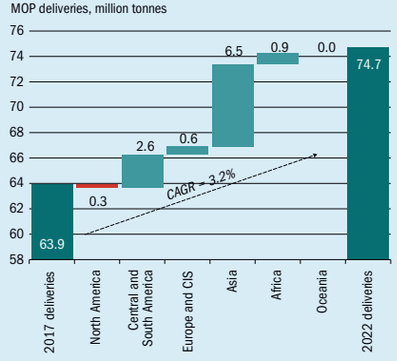
Fig. 1: **Estimated 2017 potash deliveries, versus 2016 and 2015**



Source: CRU

Fig. 2: **Forecast medium-term growth in potash deliveries, 2017-2022**



Source: CRU

the key potash consuming regions and countries. Significant volumes were eventually booked for 2017's second half, once Chinese and Indian contracts were in place, sustaining demand as the year progressed. PotashCorp linked demand growth to fertilizer affordability and supportive crop economics[1].

Russian potash giant Uralkali also reported strong potash demand, rising prices and robust buying activity in 2017. In August, the company raised its full year global potash demand estimate to 63-64 million tonnes on the back of an improving outlook. In a highly favourable mid-year market review, the company reported an expansion in potash demand in all regions[2]:

"In Brazil, potash imports continued to grow at record pace in the first half of 2017, with demand supported by increased soybean acreage and improved farmer economics. Spring season demand was strong in North America and Europe, supported by favourable weather conditions and restocking needs. In China and India, first half potash imports have been more robust than previously anticipated. Import volumes were higher year-on-year in Southeast Asia, driven by profitable palm oil economics and more favourable planting conditions."

Analysts CRU also expect global 2017 potash deliveries to move up 4.2 percent year-on-year from 61.3 million in 2016 to 63.9 million tonnes. Its 2017 global growth forecast was boosted by a 2.1 million tonne rebound in Chinese demand, a turnaround on the year-on-year fall of 1.2 million tonnes in 2016 [Figure 1]. Improved affordability and good cropping conditions also supported record potash shipments to Brazil in the first half of 2017[3].

Prices move upwards on robust demand

Potash prices in most regions strengthened during 2017. Indeed, by September, PotashCorp was able to report five consecutive quarterly increases in global potash prices. Year-on-year, the Brazil cfr price and US Midwest f.o.b. price had improved by 13 percent and 10 percent, respectively. Brazil's MOP price, for example, appreciated by around $30/t during the year to September, a reflection of sustained, robust demand[1].

The successful completion of buying contracts mid-year benefited both pricing and buying activity in 2017, according to Uralkali[2]: "The conclusion of contracts with China and India was a very positive sign for global potash market in terms of pricing. Clarity regarding China and India contracts established a price benchmark for the global market at the start of the third quarter and encouraged customers to step into the market more actively."

The strongly affordability of fertilizers currently, relative to crop price levels, also appears to be acting as a spur to demand. Affordability, says PotashCorp, is providing farmers with a strong incentive to apply crop nutrients and improve yields. CRU agrees. Its mid-2017 fertilizer affordability index was at its best position since 2004.

Market tight and balanced

Potash demand in 2017 has been largely driven by growing requirements in several key markets, according to PotashCorp's president and CEO, Jochen Tilk. Speaking at the Citi Basic Materials Conference on 29 November, he said:

"The demand story for potash is really driven by China, India and Asia and South America. Not so much by North America [where] we have a very consistent demand going forward. The [2017] increase in [world] potash fertilizer consumption has been four percent. Those are CRU's numbers… our projection is about 2.5 to three percent."

The market remains tight and in broad balance currently, said Tilk, with demand and supply closely matching one another.

"Our view is that operational capability and demand are relatively close together, as they have [been] in the past. We saw that particularly in 2017. So there is not really a big change.

"Demand has been the real story for us. Canpotex has been sold out most of the year. Our competitors were committed most of the year [too]. And we anticipate a similar picture in 2018, a very tight narrow balance consistent with the past."

Arrival of greenfield capacity

2017 saw the arrival of millions of tonnes of new greenfield potash capacity. K+S Canada's 2.8 million tonne capacity Bethune solution mine started-up in June 2017, placing around 600,000-700,000 tonnes of product on the market by the year's end. Turkmenhimiya's 1.4 million tonne capacity Garlyk potash mine also entered production in March 2017.

Further substantial capacity from new greenfield mines is expected by the end of 2017 and into 2018. EuroChem's 2.3 million tonne capacity Usolskiy mine, south of Berezniki in Russia's Perm region, Russia, remains on track to start production before the end of 2017. Commissioning of EuroChem's sister VolgaKaliy mine could also begin as early as February 2018, with the first production tonnages from this project expected mid-2018. EuroChem has made a combined investment of around $7 billion in both projects to date.

Additionally, a number of under-construction projects are at various stages of completion currently, including:

- Mosaic's Esterhazy K3 mine expansion
- Urakali's new Solikamsk-2 mine, Solikamsk-3 expansion and Ust-Yayva project
- Acron's Talitsky mine
- Belaruskali's Petrikov mine
- Slavkali's Lyuban project

These greenfield projects and brownfield expansions are expected to add significant additional potash capacity over the medium-term.

"[There's] always been… more potash operational capability than there was actual demand. This has been historically... part of how the potash market has worked," commented PotashCorp's Jochen Tilk, adding that this would that remain the case going forward with new additions to existing capacity: "That will level out eventually… somewhere around 70 million tonnes by 2020."

Production cutbacks

The arrival of new potash capacity will be largely offset by both demand growth and production cutbacks elsewhere, in Tilk's view.

"First of all, we have seen some reduction in potash production. For example, SQM… is producing less generic potash. K+S has announced that it will reduce some of its high-cost production in Germany. And second… the market has been growing… four percent in the last five years on average… eight percent in China, six percent in India. We expect the trend to continue.

"K+S [Bethune] production capability is two million tonnes… with the two EuroChem mines at four million tonnes. There is room for the market to absorb that… six million tonnes… [in] approximately four years [at current demand trends].

"These mines don't come up that fast. Will they be absorbed in five years? We think absolutely yes. That's why we believe that [the] supply and demand balance is relatively tight."

Mosaic calculates that North American closures in recent years have removed around 3.65 million tonnes of potash capacity since 2014. Additionally, ICL's Boulby mine in the UK is in the process of switching its production from potash to polyhalite. K+S Group has also decided to end potash production at the Sigmundshall mine in Germany's Hanover region at the end of 2018, blaming mine depletion.

Market moves to oversupply?

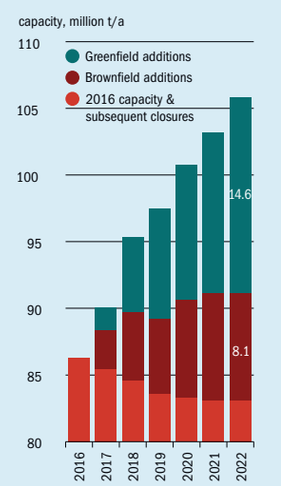
While both PotashCorp and Mosaic foresee a reasonably balanced outlook for the potash market, analysts CRU think demand growth will struggle to keep pace with scheduled capacity additions over the medium-term.

In its demand forecast, CRU expects global potash deliveries to increase from an estimated 63.9 million tonnes in 2017 to 74.7 million tonnes by 2022, an annual growth rate of 3.2 percent (Figure 2). Latin American (+2.6 million tonnes) and Asian (+6.5 million tonnes) markets will lead the way on demand growth, particularly China and Brazil. Smaller markets are also expected to grow, rising NPK demand in Morocco being one example.

Growing demand is, however, outstripped by CRU's capacity forecast out to 2022. It expects 22.7 million tonnes of extra potash capacity to come on-stream over the next five years, split between 14.6 million tonnes of greenfield additions and 8.1 million tonnes of brownfield expansions (Figure 3). Much of this extra capacity will come from either Russia and Belarus (12. 5 million tonnes) or Canada (5.9 million tonnes).

Although projected increases in nameplate capacity look likely to exceed demand growth by a substantial margin over the medium-term, several million tonnes of this extra capacity will simply replace production lost from the closure of high-cost operations.

Fig. 3: **Capacity forecast, 2017-2022**



Source: CRU

Effective capacity and real production growth are also likely to be much lower than nameplate increases would suggest. Indeed, actual potash production in 2022 could be below 80 million tonnes, depending on the average industry operating rate (Figure 4).

The extent to which the market moves from current tightness into oversupply will be critical for prices. Although potash prices firmed in 2017, underpinned by high demand, CRU expects slight oversupply to exert a downwards pressure on potash prices over the next five years with a gradual decline to below $200/t by 2022 (Figure 5).

Regional trends

PotashCorp is expecting 2017 deliveries to **China** of 15.5-16.5 million tonnes, potentially surpassing the previous record of 15.8 million tonnes in 2015. Similarly, Uralkali is also anticipating China deliveries in the range of 15.5-15.7 million tonnes in 2017.

China has increased domestic potash production in recent years to meet growing demand. Yet the country still relies on imports for around half of its potash needs (Figure 6), with seaborne shipments fulfilling four-fifths of the nation's total import requirements.

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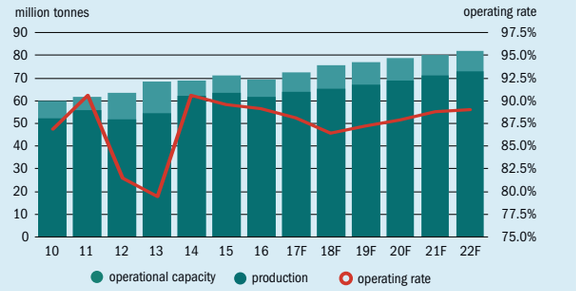
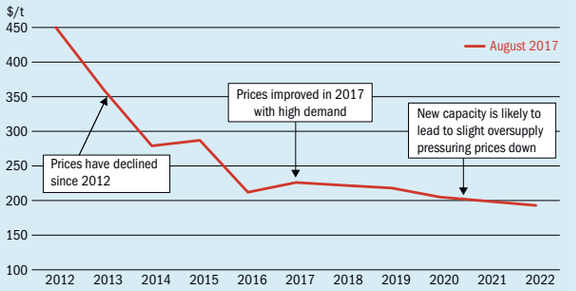
Fig. 4: **Global potash operational capacity, production and operating rates, 2010-22**



Source: Company reports, CRU and Mosaic

Fig. 5: **Potash price developments and outlook, 2012-2022**



Source: CRU

China has been the fastest growing global market for potash over the last decade, mainly due to the expansion of corn, fruit and vegetable growing. Higher Chinese crop production levels are expected to continue to drive-up consumption of potash, which has been under-applied historically relative to nitrogen and phosphate, despite the country's zero growth in fertilizer use policy. Looking ahead, the area planted to fruits and vegetables in China is forecast to rise further, sustaining potash demand, although the country's corn acreage is expected to decline as a result of government subsidy changes.

PotashCorp expects total 2017 deliveries to **India** of 4.0-4.5 million tonnes. Uralkali is forecasting calendar year imports in a similar range (4.0-4.1 million tonnes), supported by contract settlements, a good monsoon season and the strengthening of the rupee against the US dollar.

Potash application rates in India are well below average global levels. Deliveries to the country peaked at 6.3 million tonnes in 2010. Since then, fertilizer subsidy policy changes and currency volatility have acted to depress potash imports.

Despite this, Indian fertilizer demand in 2017 was aided by positive growth in crop production. The boost in farmer confidence from good monsoon rains was behind much of the rise in market demand for potash and compound fertilizers during the year. Looking further ahead, potash affordability, and the need to return to more balanced fertilizer applications, will remain vital if potash demand in India is to continue to recover, according to PotashCorp.

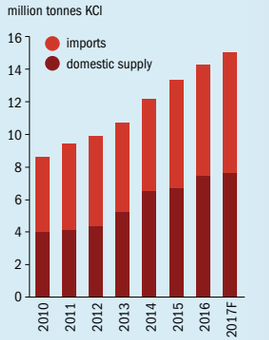
In **Southeast Asia**, 2017 potash demand has been supported by improving growing conditions at palm oil plantations, reports Uralkali, and the appreciation of local currencies against US dollar. The Russian producer expects full-year potash imports for the region of 9.5-9.6 million tonnes. This is slightly above PotashCorp's 9.0-9.5 million tonnes regional forecast for 2017. Both estimates are close to the previous demand record for Southeast Asia of 9.5 million tonnes set in 2014.

Large-scale demand from palm oil plantations is what drives potash imports in Southeast Asia. Palm oil output in Southeast Asia is projected to recover in 2017, reports PotashCorp, "as the impact of El Niño dryness wanes and [the region] returns to normal rainfall". Malaysia has already reported a 15 percent year-on-year increase in palm oil output for the first half of 2017.

Improving weather, together with supportive palm oil prices, have led to rising potash demand in the region. Indonesia's potash imports set a January-July record of 2.1 million tonnes in 2017, up almost a third on the previous year. Shipments by Canpotex to the country were up by one quarter to 310,000 tonnes over this period.

PotashCorp is forecasting record potash deliveries to **Latin America** in 2017, in the region of 12.0-12.5 million tonnes versus the previous 11.7 million tonne high set in 2014. Uralkali also expects the region to post record potash demand levels in 2017:

Fig. 6: **China: potash imports and domestic supply, 2010-2017**



Source: PotashCorp

"We expect favourable farm economics to continue supporting demand in Latin America. Potash imports to Brazil might surpass the previous record year of 2014 (9.1 million tonnes). Full-year potash demand in Latin America is expected to reach 12.4-12.6 million tonnes."

Brazil's fertilizer demand, in particular, set the pace regionally in 2017. Fertilizer deliveries and imports into the country in the first six months of 2017 are on-track to exceed the record levels seen in 2016. Brazil's potash consumption has grown by nearly 50 percent since 2010, driven by an expanding crop area and increased fertilizer application rates.

Brazil recently planted what is thought to be the country's largest soybean crop on record, according to PotashCorp. The area planted to soybean for the 2017/18 growing season (86 million acres) is nearly two million acres above what Brazil planted the previous season, and only slightly below the 2017 growing area of the US. Brazil's total corn planting is also expected to be the second largest on record.

Healthy and stable potash demand is the norm in the mature **North American** market, albeit with scope for higher application rates. PotashCorp expects 2017 potash deliveries, currently estimated at 9.3-9.8 million tonnes, to exceed historical averages. Many distributors are reporting higher potash sales compared to the previous year.

Strong first half demand in 2017 saw North American potash imports from countries such as Russia, Belarus, Israel and Chile rise to record levels. Uralkali reported strong demand for summer fill product in North America, while projecting relatively flat potash deliveries for 2017 as a whole:

"Potash deliveries to the North American market are expected to remain stable. Full-year demand is expected to be flat or slightly lower compared to the previous year level (9.5 million tonnes) given reduction in corn acreage this year."

PotashCorp expects North America to finish relatively well in 2017 due to high affordability and the expectation of a strong fall application season.

Potash factors to watch

Looking ahead at the performance of the global potash market in 2018, The Mosaic Company suggests keeping a watch on the following five factors:

- **Industry restructuring, cost-optimisation and idling**, especially in Canada, and closures due to resource depletion
- **Start-up of new greenfield capacity** in Canada and Russia
- **Exchange rates of the key potash exporter currencies**, the Canadian dollar, Russian rouble and the euro
- **Prospects for broad-based demand growth**, including increases in potash demand in China and Brazil, sustained Indian demand levels, and contributions from Africa, the FSU and other regions
- **Demand drivers**, such as agricultural commodity prices, and policy changes influencing nutrient use ■

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