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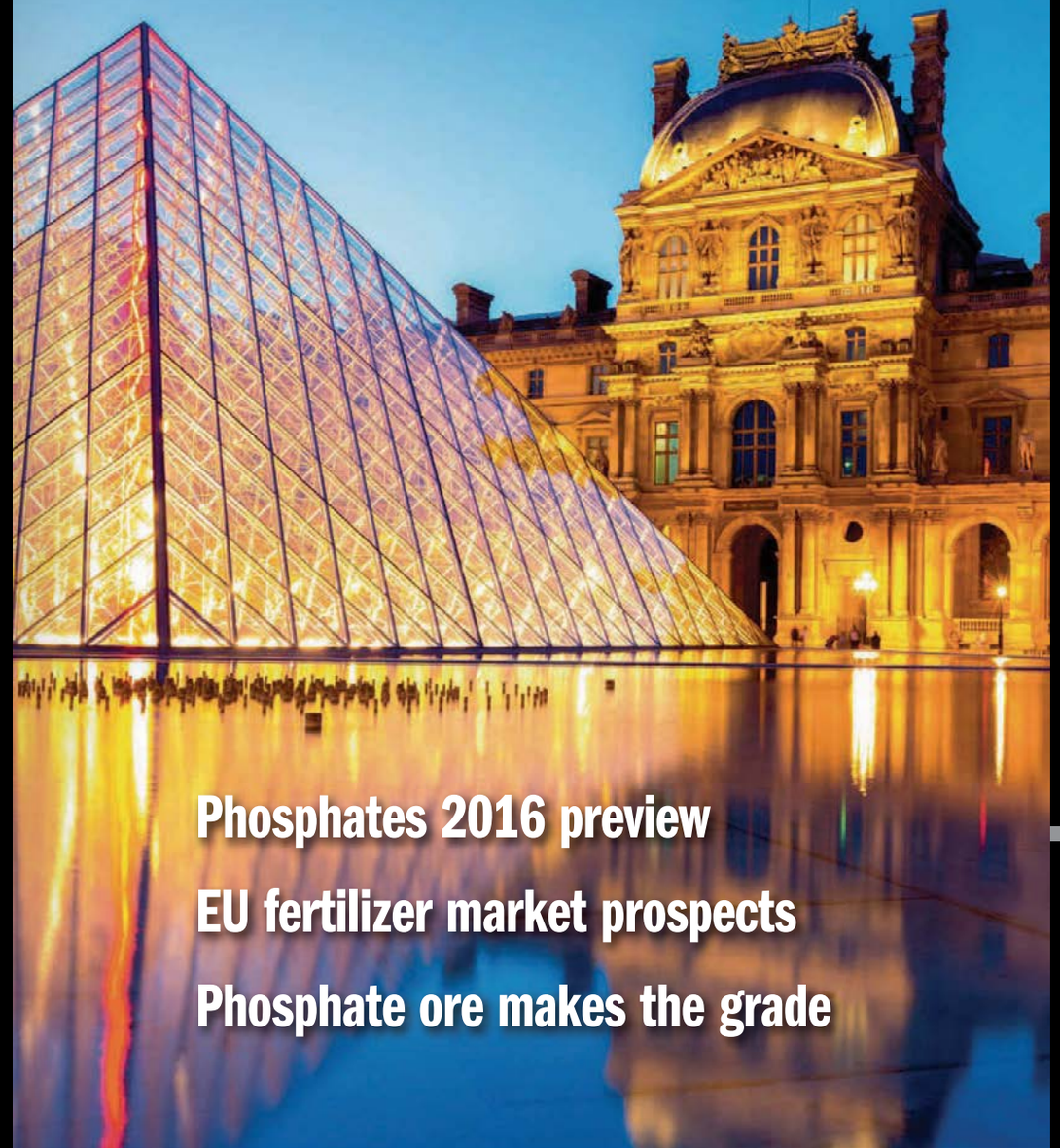

Phosphates 2016 preview

EU fertilizer market prospects

Phosphate ore makes the grade

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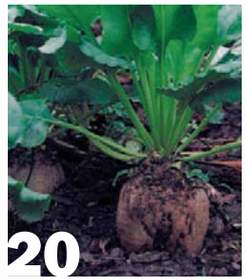
Cover: *The Louvre museum, Paris. vichie81 / Shutterstock.com*

NPK use in Vietnam



Chloride sensitivity

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Left Bank, right event

> The varied programme of presentations put together for Phosphates 2016 has all bases covered.

Having enjoyed last year's event in Tampa, I'm very much looking forward to attending CRU's 2016 Phosphates International Conference & Exhibition in Paris this March (p42).

The location seems fitting as Paris is the birthplace of a particularly distinguished French chemist, a man who did much to found both modern agricultural science and crop nutrition. Jean-Baptiste Boussingault (1801-1887) founded the world's first agricultural experimental station at Pechelbronn in Alsace, France, in 1836. (Rothamsted, the world's longest continuous experimental station, started some seven years later in 1843.) Importantly, Boussingault's pioneering scientific experiments helped establish nitrogen's role as a plant nutrient. He also conducted the first analysis of crops grown in rotation.

Because the Phosphates 2016 conference is convening in France, the largest consumer of fertilizers in the European Union (EU), we've taken the opportunity this issue to look at the current state of the European fertilizer market (p25). Strong growth in fertilizer sales is expected in parts of the EU over the next decade, as farm incomes rise and application rates increase in countries such as Poland, Hungary, the Czech Republic, Romania and Bulgaria.

The varied and stimulating programme of presentations put together by CRU for Phosphates 2016 has all bases covered. Elenilto Group, for example, is providing an update on its phosphate project in Togo, a West African country with strong historic ties to France.

The rise of West Africa as a phosphate producing region is, coincidentally, one of topics we cover this issue (p54). Promising projects in Togo, Senegal, Guinea-Bissau and the Republic of Congo should – if analysts are to be believed – add to the region's phosphate output this decade.

A session of Phosphates 2016 is being given over to phosphorus sustainability, whilst another is dedicated to technological innovation. The capture of struvite at wastewater treatment plants will be covered by one presentation. This is a hot topic at the moment, as P recovery using struvite crystallisation technology is becoming widely-adopted and increasingly viable, as we reported recently (*Fertilizer International*, 469 p43).

Extracting the maximum value from phosphate rock also makes environmental and economic sense. As CRU's principal consultant, Michael Mew, commented recently: "Today's tailings pile is tomorrow's reserve, given new technology."

Michael was specifically referring to JDCPhosphate, although he could equally have been talking about another 'disruptive innovator', Belgium's EcoPhos. Both firms will be presenting at Phosphates 2016 – and will no doubt garner a lot of interest in their highly original and distinctive phosphoric acid production technologies.

With sustainability very much in mind, this issue of *Fertilizer International* also examines country-to-country variations in the grade of phosphate ore, and weighs up the implications for production costs and prices (p42). Encouragingly, there is some evidence to suggest that the average costs of phosphate rock production have actually fallen in real terms over the last 30 years. More controversially – particularly for those of us who thought arguments about phosphorus scarcity ended in 2010 – the depletion risks facing China's phosphate mining sector are beginning to worry some observers.

Throughout Phosphates 2016, myself and Marietta Beschorner, BCInsight's subscriptions manager, will be manning Stand 18 at the Marriott Rive Gauche conference venue. I very much hope those of you attending will be able to drop by and say hello. For those not attending, a full conference report will be appearing in *Fertilizer International* later this year. ■

S. Inglesfield

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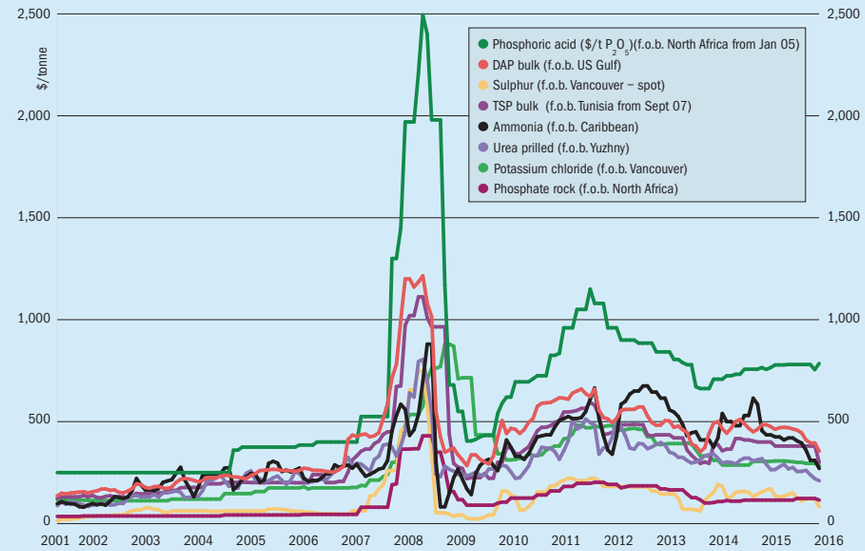
Market outlook

Historical price trends $/tonne



Source: BCInsight

Market insight courtesy of Integer Research

AMMONIA

Ammonia prices ended a six-month downward spiral in February. Market conditions are now beginning to firm up ahead of ammonia's peak spring application period. The benchmark Tampa ammonia contract price will roll over at $310/t cfr for March loadings, suggesting the market may have bottomed out. The Black Sea price has also moved up to around $260/t f.o.b. for late February/early March. Producers are continuing to restrict supply in a bid to halt prices from falling further. One of OPZ's ammonia lines is also down in Ukraine and Sofert is running only one of its two units in Algeria.

UREA

Urea prices stabilised or improved in some regions in February, after prices crashed to a ten-year low in January. The uptick came on the back of strong demand in the US and supply outages in North Africa. The US Gulf f.o.b. benchmark rose by $70/t between 21 January and 18 February to $267/t. The Yuzhny f.o.b. price stabilised at $255/t in late February as European demand has yet to emerge.

PHOSPHATES

Phosphate prices remained weak at the end of January with the Brazilian MAP price dipping to $335/t cfr, a significant decline from December's average of $385/t cfr. The price slide continued into February, with MAP prices bottoming at $327/t cfr Brazil, their lowest since November 2009. Increased demand in Brazil caused MAP prices to inch upwards to $340/t cfr in mid-February. The price decline in the DAP market has been less pronounced. Average US Gulf DAP prices dropped from $405/t f.o.b. in December 2015 to $387/t f.o.b. in January, with prices in the Chinese market following a similar path.

POTASH

The bearish sentiment in the potash industry has continued into the first quarter, with demand flagging in major import markets and prices weakening in most regions. Chinese and Indian contract negotiations have been pushed back further into 2016 on the back of high inventory levels. Chinese ports were reported to have as much as 3.1 million tonnes at the time of Chinese New Year. India's government announced that it will halt imports until the end of March and delay contract negotiations until June. Plantings in India have being severely impeded by drought and poor monsoon season rainfall. Indian demand has also been hit by weakness in the rupee.

The fall in potash prices seen in most regions is closely linked to the depreciation of key potash currencies witnessed over the last year. Granular MOP prices in Brazil have fallen to $230-240/t cfr, for example, a huge reduction on the $295-305/t cfr level we reported last November. Brazil's buyers are holding back on purchases in anticipation of lower prices, as the country grapples with credit availability and high inventory levels. In Southeast Asia, offers of MOP are currently around $250-260/t cfr, down from $295/t cfr at the end of December.

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SULPHUR

Sulphur prices have taken a tumble. Benchmarks have been lower than anticipated across key regions in February. Tasweeq acted to bring its sulphur pricing closer to deals being concluded in China by posting its February monthly price at $89/t f.o.b. Aramco Trading, meanwhile, posted at $90/t f.o.b. for its March exports. Buying in China continues to be hand-to-mouth only. Buyers there are sufficiently covered with no interest in further purchases emerging. There has been very little spot market activity, as the majority of players have looked to secure quarterly contracts instead. Supply has been stable out of Canada, the Middle East and Europe, with producers accepting reductions across their quarterly and half-year contracts for 2016. In Russia, Gazprom chose not to settle its usual contract with its supplier for shipment to OCP in Morocco. It was not prepared to reduce prices further and, instead, only agreed volumes to GCT, Tunisia, in the high $110s/t cfr. Similarly, although prices are still falling in Canada, some sellers out of Vancouver have suggested that pouring to block would be an option, rather than reducing price offers further.

Market price summary $/tonne – Late-February 2016

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phosphoric Acid
f.o.b. Caribbean	270	n.m.	f.o.b. E. Europe 100-105	f.o.b. US Gulf	360	n.m	n.m
f.o.b. Yuzhny	250-270	217-222	-	f.o.b. N. Africa	370	300	670-900
f.o.b. Middle East	275-305	215-265**	-	cfr India	360-370	-	715*
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**		**Sulphur**		
f.o.b. Vancouver	236-317	-	cfr US Gulf	40-50	f.o.b. Vancouver	75-85	
f.o.b. Middle East	233-322	-			f.o.b. Arab Gulf	85-90	
f.o.b. Western Europe	-	€490-520			cfr North Africa	92-117	
f.o.b. FSU	223-311				cfr India	100-105+	

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 outlook:** The improvement in ammonia prices is expected to continue in March, as US farmers should support healthy ammonia demand through the spring application season. Market sentiment is also improving with crop forecasts showing large US acreages dedicated to corn for the spring. In terms of supply, availability out of the Black Sea is expected to be limited if OPZ continues to run with one ammonia line. Several deals are expected in other regions, including Asia Pacific and Middle East, providing support to prices over the spring months.
- **Urea outlook:** Strong Northern Hemisphere demand is expected to support urea prices globally between March and April, as farmers there prepare for the spring application season. The impact of strong US demand on the international market is expected to last through March at least with European spring demand expected to kick in soon. Demand outside the US is expected to be quieter for the time being as buyers digest price increases and wait to step into the market. India is not expected to return to the market until late March at the earliest. Urea prices could, however, return to lower levels after spring demand subsides in May/June, as supply remains abundant.
- **Phosphates outlook:** Uncertainty remains the overriding factor in the phosphates market. Increased mid-February demand from Brazil did add support to MAP prices. But demand fundamentals are unlikely to support a sustained price increase, as Brazil's farmers continue to face problems obtaining credit. Chinese consumers should re-enter the market towards the end of February and help prop-up prices. The late February announcement of Indian fertilizer subsidies should also usher in Indian DAP demand. Major producing hubs in North America, China and the MENA region will turn their attention towards the target markets of Brazil and India during the second quarter.
- **Potash outlook:** US views are mixed on potash prospects in 2016, with crop economics pitched against weather forecasts. Sentiment for the spring planting season is fairly good and crop acreage for this year is expected to be high. Most major potash producers are predicting 58-60 million tonnes MOP demand in 2016. The current oversupply situation in the industry is the result of inventory build-up in 2014 and a lower-than-expected draw down in 2015. Producers have, however, responded with production curtailments which should ease the supply-demand balance slightly.
- **Sulphur outlook:** Lack of demand is the key issue for sulphur pricing. The weak phosphate market and the wider downturn in commodity pricing will continue to weigh on any upside in the short term. The Indian market has been quiet with demand not expected to emerge until fertilizer subsidies have been agreed. The Brazilian market is struggling to take off because buyers have been unable to access credit for purchases.

  The shift to a global sulphur surplus expected in 2016 is likely to mean that a lower range of prices will become the norm. A number of supply and demand developments are in the offing. Export availability from the Shah gas project in the UAE is increasing, for example, as it ramps up capacity. OCP in Morocco is also expected to import more from Ruwais as it expands its phosphates capacity. Mosaic's one million t/a melter will reduce railed imports of sulphur from Canada into the US market once it is up and running. Finally, the continuing Pars Oil & Gas Company (POGC) development in South Pars, Iran, will bring additional new supply to the market.

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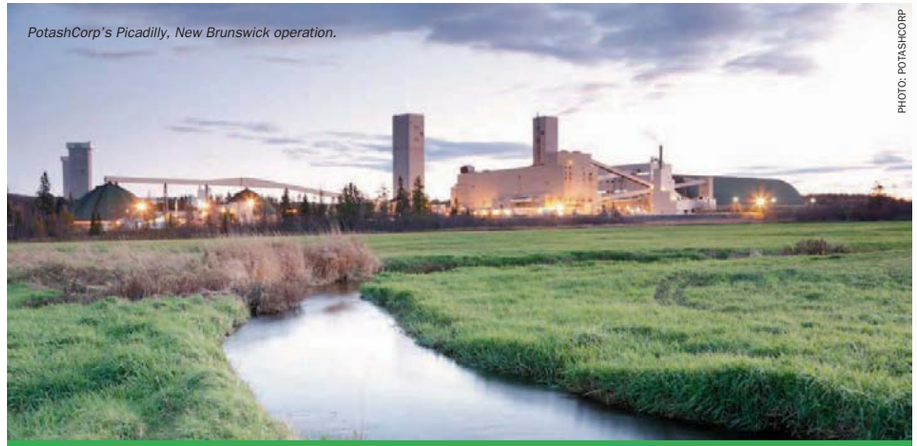

PotashCorp's Picadilly, New Brunswick operation.

PHOTO: POTASHCORP

CANADA

PotashCorp suspends New Brunswick production

Canada's PotashCorp indefinitely suspended production at its Picadilly, New Brunswick potash plant on 19 January. The decision was made against a "challenging macroeconomic backdrop" with the company describing it as a "difficult but necessary step".

A determination to make "meaningful capital savings" and shift potash production to lower-cost operations was behind the move. Maintaining operational flexibility and protecting jobs throughout the business over the longer term were also part of the rationale.

Suspension of production at Picadilly should help improve PotashCorp's competitiveness by reducing the cost of goods sold by $40-$50 million in 2016. These saving exclude severance and transition costs which are expected to run to around $35 million. Maintaining Picadilly will also cost PotashCorp some $20 million in 2016 and $15 million in subsequent years. The suspension will, however, cut PotashCorp's capital expenditure by around $50 million in 2016 and $135 million in 2017/18.

Between 420 and 430 New Brunswick employees are set to lose their jobs as a result of the decision, although more than 100 of those affected will be offered positions at the firm's Saskatchewan operations. PotashCorp is also setting up a community investment fund to lessen the impact of the job losses locally. Around 35 surviving staff will be kept on at Picadilly to keep the site in a 'care-and-maintenance' condition.

"This is a very difficult day for our employees and our company," said PotashCorp president and chief executive officer Jochen Tilk. "While these are important steps in running a sustainable business and positioning the company to best meet the needs of its many stakeholders over the long term, such decisions are never easy."

The suspension will also have knock-on effects for Canpotex, the Canadian export partnership between PotashCorp, Mosaic and Agrium. International customers previously served by New Brunswick will now be supplied from Saskatchewan through Canpotex. Beginning in 2016, PotashCorp's volume entitlement within Canpotex will also change, increasing by 750,000 tonnes, an allotment of around 52%. Canpotex will also have access to 2.5 million t/a of PotashCorp capacity at the port of Saint John.

New Brunswick operations have been on inventory shut down since the end of November. Three other PotashCorp mines in Saskatchewan were also placed on similar shutdowns in December (*Fertilizer International*, 469 p8).

UNITED STATES

Mosaic curtails phosphate production

The Mosaic Company is reducing phosphates production in response to current market conditions. Rotating plant shutdowns will reduce phosphates production by up to 400,000 tonnes in the first quarter of 2016, Mosaic announced in a brief statement on 3 February. Mosaic expects the demand lull to be short lived, and believes that long-term fundamentals remain positive.

"With the recent price volatility and decline in raw material costs, buyers appear to be delaying purchases. This is lengthening the seasonal period of weak demand," said Rick McLellan, Mosaic's senior vice president, commercial. "Today's crop nutrient prices, including phosphates, are attractive to farmers globally and we expect a strong demand response after this seasonally slow period."

Joc O'Rourke, Mosaic's president and chief executive officer, added: "The long-term positive outlook for phosphates has not changed, but we are adjusting our production levels to match immediate demand and manage our margins."

Mosaic's latest decision follows action to limit potash production in the final quarter of last year (*Fertilizer International*, 469 p8).

thyssenkrupp to build $2bn Indiana nitrogen plant

Midwest Fertilizer Company (MFC) has awarded the $2 billion contract to build its state-of-the-art nitrogen fertilizer complex at Posey County, Indiana, to thyssenkrupp Industrial Solutions. MFC announced the award of the engineering, procurement, construction (EPC) contract to thyssenkrupp at a ceremony in New York on 25 January.

The project, which is backed by Pakistan's Fatima Fertilizer Company, hopes to reach financial close later this year and start construction immediately after. The world-scale complex will produce ammonia, urea, urea ammonium nitrate (UAN) and diesel exhaust fluid, once completed, and is scheduled to enter production in 2020. It will target fertilizer production at domestic US farmers in the Eastern Corn Belt.

"thyssenkrupp is a world leader in fertilizer plant technology," said Mike Chorlton, MFC's president and chief executive officer. "This partnership allows us to move forward with the next phases of this world-class project in southwest Indiana. We are on the path to provide farmers in Indiana and the Midwest a reliable local source of high-quality nitrogen fertilizer."

MFC intends to part-finance the project with $1.3 billion worth of tax-exempt debt secured under the 2008 Heartland Disaster Tax Relief Act. The EPC agreement with thyssenkrupp supersedes a previous 2014 memorandum of understanding between MFC and Maire Tecnimont.

KBR buys three Chematur subsidiaries

Houston-based KBR, Inc has bought Weatherly Inc, Plinke GmbH, and Chematur Ecoplanning Oy from Chematur Technologies and its owners Connell Chemical.

The purchase of Weatherly is particularly significant as KBR will gain from its extensive track record of providing nitric acid and ammonium nitrate proprietary technologies and services. Weatherly, which is based in North America, has designed, engineered and constructed fertilizer complexes worldwide for more than five decades. This includes the installation of 80 nitric acid plants worldwide, an approximate market share of 30%.

German-based Plinke specialises in proprietary technology and specialist equipment to purify and concentrate inorganic acids during hydrocarbon processing. Ecoplanning, which is based in Finland, offers proprietary evaporation and crystallisation technologies and specialist equipment.

KBR announced the purchases in a 12 January statement. All three acquisitions have growth potential in its view.

"KBR's ammonia and Weatherly's fertilizer capabilities result in a powerful combination of industry-leading technologies, and Plinke and Ecoplanning enhance the scope of KBR's technology solutions across expanded platforms," said Stuart Bradie, KBR's president and chief executive officer. "KBR sees great opportunity to extend these technologies outside North America to new customers and in revamping units of the existing customer base globally."

He added: "We chose these companies, all with over 50 years of experience and hundreds of plants worldwide, based on their track record of superior performance, market reputation, unique technologies, and proven delivery capability… We are pleased to add these technologies and capabilities – as well as the talented staff who will manage them for us within our global portfolio."

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Rentech confirms Pasadena plant sell off

Rentech Nitrogen Partners has lodged documents with the US Securities and Exchange Commission (SEC) relating to the proposed sale of its ammonium sulphate plant at Pasadena, Texas.

The disposal of the 600,000 t/a capacity plant is a condition of the merger between Rentech Nitrogen and CVR Partners announced last year (*Fertilizer International*, 468 p9).

The registration statement filed with the SEC prepares "for a potential spin-out of the Pasadena facility in the event it is unable to close on a sale of the facility on acceptable terms in a timely manner", Rentech Nitrogen said in a statement on 26 January.

Such a spin-out is an attractive and potentially quick option – as it would satisfy the conditions of the pending merger and allow it to go ahead as planned.

Cargill pulls out of Black Sea fertilizers

Cargill Inc will stop selling inputs to farmers in the Black Sea region, including fertilizers, seeds, and crop chemicals, from this summer.

In a highly symbolic move, the 150-year old global trading firm will start winding down its crop inputs business in Russia, Ukraine, Romania and Hungary immediately, and completely exit the region by the end of May.

Cargill confirmed the cut back in Black Sea operations in a 17 February statement. The announced changes are part of a restructuring of Cargill's business in response to falling commodity prices. The firm said it had been "unable to realise many of the expected synergies" between selling crop inputs and buying grain.

Cargill says it will now concentrate on grain and oilseeds trading in the Black Sea region instead. Such a move makes sense as the region remains a major producer and exporter of corn and wheat.

The end of seed and fertilizer selling in the Black Sea region is likely to affect about 180 employees, according to Cargill. This is relatively minor, given that the company employs around 25,000 workers in Europe, the Middle East and Africa out of 150,000 employees worldwide.

Cargill will continue to sell crop inputs in the United States, Canada and other countries.

PHOTO: K+S GROUP

K+S Kali's Wintershall plant.

BRAZIL

X2 Resources weighs-up Anglo American bid

Interest in acquiring Anglo American's phosphate assets appears to be increasing.

The London-based private mining venture X2 Resources is said to be weighing-up a bid for Anglo American's $1 billion Brazilian niobium and phosphates business. South32, a BHP Billiton spin-off, is also considering making an offer for the same assets, according to reports earlier this year. There is additional speculation that a sizeable North American fertilizer company may yet enter the bidding as well.

Anglo American confirmed plans to sell its phosphates and niobium business at the end of last year as part of a massive restructuring exercise (*Fertilizer International*, 470 p10). Goldman Sachs and Morgan Stanley are believed to be handling the Brazilian sell-off on Anglo American's behalf.

SWITZERLAND

ChemChina to buy Syngenta

The China National Chemical Equipment Corporation (ChemChina) has agreed to buy Swiss-based agrochemicals giant Syngenta in a deal worth $43 billion. This will be the largest acquisition of an overseas company by a Chinese buyer, and second only to the Dow-DuPont merger in terms of deals in the chemical sector.

Syngenta's board backed the deal unanimously and have recommended it to shareholders. The buy-out would see the creation of a new 10-strong board of directors, including four of the current board, overseen by ChemChina chairman Ren Jianxin. Syngenta will, however, keep its existing management structure and headquarters in Basel, Switzerland.

The prime motivation for the acquisition is thought to be China's desire to ensure food security, amid concerns that agricultural productivity is not keeping pace with population growth. Its purchase of Syngenta – a producer of genetically modified (GM) seeds – also suggests China may be more willing to adopt GM technology in future. The country has yet to grow GM food crops because of public opposition, although GM plants are used for animal feed.

GERMANY

K+S cuts saline wastewater by half

Germany's K+S Kali GmbH has cut the volume of saline wastewater it produces to seven million cubic meters, a fall of 50% since 2006, following the successful implementation of a €400 million package of water protection measures.

The savings have been achieved on schedule thanks to the successful start-up of the kieserite flotation facility at the

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firm's Wintershall site and recent investments at other German sites. These include the ESTA plant at its Philippsthal site, the evaporation plant in Heringen as well as the cold preliminary decomposition and thick matter plant in Unterbreizbach.

"We have completed the implementation of the package of measures launched in 2013 and achieved a further greater step toward reducing the burden on the environment," said Rainer Gerling, managing director of K+S. "Water protection is an integral part of our sustainable potash production and an important condition for the preservation of almost 4,500 jobs in the Werra-Fulda potash district."

The new flotation facility has enabled K+S to reduce wastewater generation by half a million cubic meters a year. The innovative plant was specifically designed to separate out the mineral kieserite from a salt mixture produced upstream, using much less water than was possible previously.

Working with the Hessen state government, K+S is now planning to cut wastewater by a further 1.5 million cubic meters annually by constructing another new processing plant by the end of next year. Other measures are planned to help cut saline wastewater by even more over the longer-term. These include the construction of a long-distance pipeline to the Upper Weser and restoration of the Werra and Weser rivers by reclaiming mine tailings piles.

MOROCCO

Jorf Lasfar $537m fertilizer unit officially opens

OCP's new one million t/a capacity phosphate fertilizer unit at Jorf Lasfar has entered production, Morocco's state new agency confirmed on 1 February.

The new unit, opened by Morocco's King Mohammed VI, has been dubbed the 'Africa Fertilizer Complex', as it will supply DAP fertilizer to the African market. The complex also includes a 1.4 million t/a sulphuric acid plant, a 450,000 t/a capacity phosphoric acid plant, a 62-megawatt solar power plant as well as 200,000 tonnes of fertilizer storage capacity.

OCP has invested 5.3 billion dirhams ($537 million) developing the production unit, part of the Jorf Lasfar hub that is currently under construction on Morocco's Atlantic coast in the northwest of the country. OCP is constructing three other identical phosphate fertilizer units as part of the same hub.

The first stage of Jorf Lasfar's seawater desalination plant has also been completed. The plant will eventually produce 75 million cubic meters of freshwater each year when all three stages are completed.

King Mohammed VI also visited OCP's Phosboucraa complex in the southern region of Laayoune on 5 February, and marked the start of construction at the site by laying the foundation stone. The $2bn project will have the capacity to produce 500,000 t/a of phosphoric acid and one million t/a of fertilisers once completed.

The complex will process phosphate rock from the Boucraâ area and also includes a washing and floatation plant, a phosphate drying plant and a 500,000 tonne capacity storage area. Around $430m has also been earmarked for the construction of an adjacent port facility on the coast.

The major investments taking place at both Jorf Lasfar and Phosboucraa are part of OCP's strategy to secure its position as a leading global producer

JORDAN

Aqaba fertilizer complex planned

Plans to build a $1.4 billion fertilizer complex in Aqaba, Jordan, have emerged.

The Jordan Phosphate Mines Company (JPMC) has signed a memorandum of understanding over the complex with China's Chongqing Minmetal and Machinery Import and Export Company (CQMM). JPMC and the Arab Potash Company will both supply the complex with raw materials.

"Procedures are going ahead for the implementation of this new significant investment in Aqaba," Khalil Farrayeh of the state-owned Aqaba Development Corporation told the *Jordan Times* on 23 February. "We are currently in the process of determining the amount of land that we will lease to the two sides for the industrial complex."

The fertilizer complex will process and add value to 1.5-2 million t/a of phosphate rock supplied by JPMC, and includes a 500,000 t/a capacity phosphoric acid plant. The first phase of the project will cost around $350 million, according to Farrayeh, who said that fertilisers from the complex will be exported to several markets globally.

CQMM previously helped construct the JAFFCO plant in Jordan. Precisely when the Aqaba complex will be completed remains unclear.

UGANDA

Sukulu project finance agreed

Previously-announced funding of $240 million for the Sukulu phosphate project in Uganda is now in place, the country's *New Vision* newspaper reported in February.

The finance deal for the project was formally agreed by the project's backer, the Industrial and Commercial Bank of China, and its Chinese developer, Guangzhou Dongsong Energy Group, during a recent meeting in South Africa, according to the newspaper.

A series of payments from the bank will fund the development of a two million t/a capacity mine extracting phosphate from deposits In Uganda's Tororo region. The finance will also go towards developing 300,000 t/a of fertilizer production capacity, 200,000 t/a of sulphuric acid capacity and a 300,000 t/a capacity steel mill.

"The project will boost agriculture production through the provision of fertilizers… offer jobs to the region, support other industries and boost our export earnings," said Fred Kabagambe Kaliisa, permanent secretary at Uganda's ministry of energy and mineral development.

RUSSIA

Indian investors pull out of Talitsky project

Indian investors have shelved plans to take a 30% stake in Acron's Talitsky potash project in Perm Krai, Russia, the *Press Trust of India* reported in January.

In 2014, a five-member consortium led by India's state-owned National Mineral Development Corporation (NMDC) signed an agreement in principal to invest in Talitsky with Verkhnakamsk Potash Company, an Acron subsidiary.

However, the group of Indian investors have reportedly now exited this agreement following the conclusion of a feasibility study re-evaluating the cost of the proposed investment. The original agreement signed in 2014 was based on an investment of around $2 billion.

Acron announced last November that it was also seeking around $1 billion of funding for the Talitsky project from investors in China, India and Arabia. However, falling project costs, due to the devaluation of the rouble, means Acron has not ruled out financing the greenfield potash project itself.

Neither Acron or the NMDC consortium have officially confirmed the press reports.

PhosAgro signs $38 million loan agreement

PhosAgro has signed a three billion rouble ($37.7 million) 18-month loan agreement with Russia's state-owned Eximbank. The loan was agreed in January and forms part of a programme of Russian government support for high-technology exports.

"This loan agreement will enable us to strengthen the flexibility of our sales and improve PhosAgro's competitive advantages in the global fertilizer market," said Andrey Guryev, PhosAgro's chief executive officer. "We have reached an agreement on exceptionally attractive terms."

EGYPT

Intecsa wins Ain Sokhna contract

Intecsa Industrial has secured a €315 million ($347 million) contract to build the Ain Sokhna fertilizer complex in Egypt.

The firm, part of Spain's ACS Group, signed the contract with El Nasr Co for Intermediate Chemicals (NCIC) in February. It will go ahead and build a sulphuric acid plant, DAP plant and TSP plant at Ain Sokhna under the terms of the deal.

"This contract represents half of the total fertilizers complex to be built at Ain Sokhna, which will be the biggest complex ever built in Egypt in the fertilizers sector," said Intecsa.

Egypt's president, Abdel Fattah El-Sisi, personally approved the construction of the complex in November (*Fertilizer International*, 469 p11). The complex, which will produce fertilizers for the domestic market and for export, should take 30 months to complete, according to the NCIC.

Misr Phosphate's El Sibiya mine opens

The first phosphate shipment from Misr Phosphate's El Sibiya mine near the Red Sea are ready to leave the port of Safaga, according to latest reports.

Mining at El Sibiya began two months ago, the state-owned company confirmed in February, and produces either 24-25% P_2O_5 or 27-30% P_2O_5 grade rock. Production from the new mine will supplement existing Misr Phosphate production of two million t/a from Abu-Tartour.

Misr Phosphate says production at Egypt's Red Sea Mine has also resumed. This site is said to be producing between 15,000-40,000 tonnes of higher-grade (30-32% P_2O_5) rock each month.

Combined phosphate rock production from all three sites should reach around three million t/a, estimates Misr Phosphate.

EQUATORIAL GUINEA

Urea complex construction contract awarded

A Chinese consortium led by East China Engineering Science and Technology Co Ltd (ECEC) has won an EPC contract to build a new petrochemicals complex for Riaba Fertilizers Ltd.

The 1.5 million t/a ammonia-urea complex, at Riaba on Bioko Island, will use offshore gas reserves supplied by Noble Energy and its partners Gunvor, Atlas Petroleum International and Glencore.

WorleyParsons has completed front end engineering design (FEED) for the project. Construction should begin at the end of March and is scheduled to be finished 32 months later. ■

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Dr Andreas Radmacher leaves K+S

Andreas Radmacher, the head of the potash and magnesium business unit at K+S Kali GmbH, left the company on 29 February.

K+S announced that Dr Radmacher was standing down from the board and leaving the company by mutual agreement in a brief statement on 26 February. It decided not to renew his current mandate which was due to expire on 31 August.

Dr Radmacher was appointed to the board of K+S in 2013 and has headed-up its potash and magnesium products business since October 2014. He was also responsible for disposal and recycling and inactive plants at K+S. Norbert Steiner, chairman of K+S, is to temporarily take over these responsibilities.

The composition of the K+S board remains otherwise unchanged with Dr Lohr (CFO), Dr Nöcker (labour director) and Mark Roberts (salt business unit) keeping their current executive responsibilities.

The board expressed its gratitude to Dr Radmacher for the work he had performed and wished him all the best for his future.

PHOTO: K+S

Dr Andreas Radmacher stepped down from his position at K+S Kali on 29 February.

Major senior level shake-up at Yara

Yara International has announced a major senior level re-organisation following the outcome of a strategic review.

"After spending recent months visiting numerous Yara sites, meeting employees and conducting business and organisational reviews, I have concluded on the key organizational changes needed to strengthen operational focus and improve alignment behind our strategic direction," said Svein Tore Holsether Yara's president and chief executive officer. "I am confident that the changes announced today will sharpen our strategic focus on profitable growth and reinforcing our integrated business model."

In a major change, Yara's upstream business and mining activities are to be combined into a single new 'production segment'. This will be headed by Petter Østbø, formerly head of gas and industrial applications at Yara. Gerd Löbbert Yara's head of upstream is to step down and leave the company.

A new 'supply chain segment' is also being set up to combine Yara's supply & trade activities with its IT function. This will be headed by Tove Andersen, formerly head of Yara's European supply chain unit.

In a related move, Alvin Rosvoll, the former head of Yara supply & trade, will take up the newly-established post of senior vice president, partner operations. Yara downstream is also being re-named 'crop nutrition' but will continue to be headed by Terje Knutsen.

Lair Hanzen, former head of Yara downstream in Brazil, will take up the newly-established position of senior vice president for Yara Brazil. Hanzen will be responsible for Yara's entire portfolio in Brazil, including the Galvani joint venture.

Kristine Ryssdal is leaving Statoil to become Yara's chief legal officer at the end of May. Trygve Faksvaag, the current chief legal officer, will step down once Ryssdal joins, but will continue to work in Yara's Legal department.

Bente Slaatten, chief communication and branding officer, and Kaija Korolainen, chief HR officer, have both decided to step down and leave the company. Yara's communication and HR staff will report to chief financial officer Torgeir Kvidal until further notice.

"I am convinced that these changes will strengthen Yara going forward," said Svein Tore Holsether. "I want to thank my colleagues who are leaving the executive management group for their hard work and dedication to Yara."

Hart to lead Trammo's commodities division

Brent Hart has been appointed chief executive officer of Trammo's commodities division, taking over in this role from Christian Wendel. He has also joined the company's board of directors.

Hart previously served as president of Trammo's North American commodities division. He has held several senior positions in Trammo since joining the company in 1995.

"We are pleased that Brent will take the helm of our commodities division," said Trammo chief executive Henk van Dalfsen. "Brent is a highly experienced trader, an outstanding manager and a team builder. His leadership will ensure Trammo's further growth and continued success."

van Dalfsen also paid tribute to Christian Wendel's contribution to the company over a 17-year period: "Chris has brought new products, new ideas and much energy to Trammo."

Jeffrey Minnis will succeed Hart as president, commodities division, North America. Minnis is currently senior vice president and head of ammonia trading for North America.

Trammo also announced the election of Dave Smothermon, chief executive officer of Trammo's gas division, to its board of directors. "With the addition of Hart and Smothermon, all three Trammo divisions will be represented at board level," van Dalfsen said.

New phosphates and potash leadership at Mosaic

Walter Precourt is to become senior vice president, phosphates operations at the Mosaic Company from 1 June.

He is currently senior vice president, potash operations, and will move from Saskatchewan to Central Florida to take up his new role. Precourt joined Mosaic in 2009 as vice president for environment, health and safety (EHS) before becoming a senior vice president in 2012.

"Walt has provided remarkable leadership for EHS and Potash," said Joc O'Rourke, president and chief executive officer of Mosaic. "With more than two decades of operational and functional leadership roles at The Dow Chemical Company and Holcim, Walt is uniquely qualified to lead the next phase of our company's phosphates journey."

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In a co-ordinated change, Bruce Bodine, who currently leads Mosaic's supply chain, will become vice president for potash on 1 April. Bodine will move to Regina, Saskatchewan, in June to head-up Mosaic's potash business. He has held senior positions in potash, phosphates and supply chain during his 15 years at Mosaic.

"Bruce is an insightful and engaging leader of both people and process, and he is driven to help Mosaic compete in the potash market," O'Rourke said.

Gary 'Bo' Davis, after six years as Mosaic's senior vice president of phosphate operations, will take on a senior advisor role, prior to his planned retirement in January next year. Davis has worked at Mosaic since the company's formation in 2004 and has 41 years experience in the industry. He has been Mosaic's senior vice president, phosphate operations since 2009. He also served on the board of the Wa'ad Al Shamal Phosphate Company, the joint venture between Mosaic and Ma'aden.

"Bo led the transformation of our phosphates business unit and achieved levels of operational excellence not previously reached in the phosphates industry," O'Rourke said. "His strategic contributions have led Mosaic's phosphate business to be the largest and strongest in the world, and we thank him for his years of dedicated service."

Three new board appointments at Agrium

Agrium Inc has announced three new board-level appointments.

Maura J. Clark, Miranda C. Hubbs, and William (Bill) S. Simon joined the firm's board of directors on 24 February. The appointments expand Agrium's board to 12 directors, 11 of whom are independent.

Maura Clark was president of direct energy business at US firm Direct Energy from 2007 to 2014. She is a chartered professional accountant and currently serves on the boards of both Elizabeth Arden and Fortis.

Miranda Hubbs was executive vice president and managing director of McLean Budden Limited from 2002 to 2011. She is a chartered financial analyst and currently serves on the board of Spectra Energy Corp.

Bill Simon was the former president and chief executive officer of Walmart US from 2010 to 2014, a subsidiary of Wal-Mart Stores. He currently serves on the board of Darden Restaurants.

"These individuals are an excellent complement to our existing board skill set, bringing demonstrated and relevant industry experience and strategic acumen to the table. We believe their combined experience will further support our strategy to deliver value to our stakeholders through good governance, operational excellence, and continued growth," commented Agrium's board chair, Victor Zaleschuk.

FLSmidth appoints new VP for process technology

Tony Troutman has joined FLSmidth as vice president for process technology in the company's minerals division. His responsibilities include oversight of process engineering and process optimisation opportunities. He will also be tasked with leveraging the capabilities of FLSmidth's Minerals Testing Center in Salt Lake City, Utah.

Troutman has almost 30 years of experience in the mining industry in a career encompassing engineering, process operations and research and development.

Most recently, he was manager of engineering at Jacobs and also held the position of director of process technology at the firm. Previous roles include working for Fort Knox Mining Company (Kinross), Newmont, and Hazen Research. Troutman's first degree is in chemical and petroleum refining engineering. He also holds a masters degree in metallurgical and materials science engineering from the Colorado School of Mines.

Calendar 2016

MARCH

13-15

Phosphates 2016,
PARIS, France
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53-64 Chancery Lane,
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Web: www.crugroup.com

14-17

IFA Global Technical Symposium,
NEW DELHI, India
Contact: IFA Conference Service
28, rue Marbeuf,
75008 Paris, France
Tel: +33 1 53 93 05 25
Email: conference@fertilizer.org
Web: www.fertilizer.org

APRIL

11-13

TSI Sulphur World Symposium 2016,
VANCOUVER, Canada
Contact: Joshua Maak
Tel: +1 202 296 2316
Email: JMaak@sulphurinstitute.org
Web: www.sulphurinstitute.org

MAY

30 – 1 June

84th IFA Annual Conference 2016,
MOSCOW, Russia
Contact: IFA Conference Service
28, rue Marbeuf,
75008 Paris,
France
Tel: +33 1 53 93 05 25
Email: conference@fertilizer.org
Web: www.fertilizer.org

JUNE

10-11

40th AIChE Annual Clearwater Conference 2016,
CLEARWATER, Florida, USA
Email: chair@aiche-cf.org
Web: www.aiche-cf.org

23-24

International Fertilizer Society Meeting,
BUDAPEST, Hungary
Contact: International Fertiliser Society,
PO Box 12220, Colchester, CO1 9PR, UK
Tel: +44 1206 851819
Email: secretary@fertiliser-society.org

NOVEMBER

7-10

Sulphur 2016, LONDON, UK
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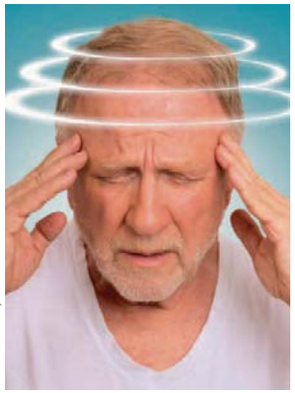


PHOTO: PATHDOC/SHUTTERSTOCK.COM

Living with the overinvestment hangover

Investment in new urea capacity looks set to dwindle year-on-year up to 2020. We examine urea project prospects over the next five years – and also look further ahead beyond the current cyclical downturn.

More than 25 new urea plants are expected to be commissioned over the next three years (Table 1). These additions mark the final phase of a massive expansion in global urea capacity that was kick-started by the 'commodity supercycle' of the early 2000s. For much of the preceding decade, high nitrogen prices together with the availability of cheap capital – and what analysts CRU describe as "a wide global cost arbitrage" – combined to create an almost perfect environment for urea plant investment.

High prices cause big capacity boom

From 2005 onwards, the Black Sea urea price benchmark doubled in real terms, compared to the long run average ($165-175/t), driven upwards by energy market conditions and a tightening supply/demand balance, as Alistair Wallace, senior consultant at analysts CRU, recently explained[1].

"When you run up to the commodity supercycle, we had a massive creation of demand for most global commodities… that really drove up the price of urea," says Wallace. "Over the last 10 years, we've seen prices averaging $355/t – double the long run average – and that's what's really stimulated this huge boom in capacity investment."

Dramatic oversupply depresses prices

The ideal investment climate over this period also coincided with a concerted drive by China for self sufficiency in urea supply. The resulting growth in Chinese urea capacity has been impressive. In less than 10 years, China has transformed itself from a country which needed to import several millions of tonnes of urea each year into a nation now able to export 14 million tonnes of urea annually.

China's emergence has had a marked effect on the global nitrogen market, particularly on prices.

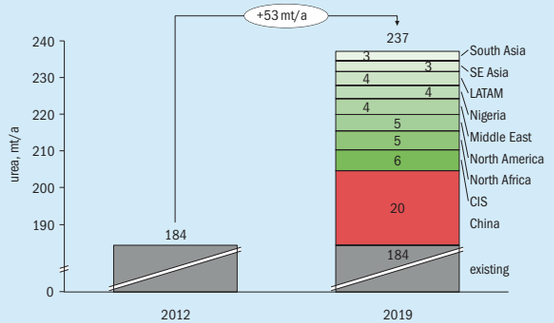
"The Chinese government really wanted to create this self sufficiency in urea," comments Wallace. "In doing so, they dramatically over-stimulated investment in China and created a huge exportable surplus – that, of course, has had a dramatic impact on the market."

He continues: "The combination of investment driven by economic returns outside of China, along with China's state-sponsored expansion of urea capacity, has created a dramatic nitrogen oversupply that has depressed prices across the board."

Between 2012 and 2019, CRU is forecasting around 53 million t/a of urea capacity additions, boosting global capacity from 184 million t/a to 237 million t/a, an increase of nearly 30% in seven years (Figure 1). China has played a leading role in urea's global expansion over this period, contributing 20 million t/a of extra capacity.

The number of newly-commissioned plants and expansion projects does, however, look set to tail-off during the second half of this decade. CRU expects plant start-ups to decrease year-on-year, declining from 22 in 2015 to 17 this year and then dropping to six in 2017. Urea project completions are likely to fall even further in subsequent years, from four in 2018 to just one in 2019 – before finally dwindling to zero in 2020 (Table 1).

Fig 1: **Urea capacity additions by country, 2012 to 2019**



Source: CRU

"This is the first time that CRU's five-year forecast has had no committed plants coming online in the last year," comments Wallace "That really shows you the extent to which market oversupply and the deflationary impact on prices has deterred investment."

The fact that capacity growth (3.4% p.a.) will continue to outstrip urea demand (2.2% p.a.) over the next four years will add to downward price pressures. "Capacity will continue weighing on prices throughout the rest of the decade, and it won't be until 2020 that we start to see incremental demand catch up with supply growth," predicts Wallace. "It's unlikely we will see much market scarcity – and scarcity-driven pricing – until the beginning of the next decade."

Low-cost US production to displace Atlantic trade

In the US, major investment in urea capacity will boost domestic production and drastically reduce import dependency over the next three years, with large repercussions for international trade. In 2014, the US relied on around 8 million tonnes of urea imports to supplement its domestic production of 3.2 million tonnes.

Table 1: **Urea capacity additions, 2015-2020**

China	Urea capacity ('000 t/a)	Rest of the world	Plant	Urea capacity ('000 t/a)
2015: 6.7 million tonnes China, 10.5 million tonnes ex-China				
12 plants	**6,740**	United States	PCS Lima Debottleneck, OH	73
		United States	CF Donaldsonville, LA	1,200
		Mexico	Coatzacoalcos restart	990
		Algeria	AOA, Azrew	2,310
		Egypt	MOPCO, Damietta	1,165
		Russia	Ammonii Mendeleevsk	677
		Saudi Arabia	SAFCO V, Dammam	1,073
		India	Matix Panagarh, West Bengal	1,300
		Bangladesh	Shahjalal, Fenchugonj	581
		Indonesia	Pupuk Kaltim V	1,155
		Total		**10,524**
2016: 6.6 million tonnes China, 6.9 million tonnes ex-China				
10 plants	**6,580**	United States	CF Port Neal II, IA	1,350
		United States	OCI Wever, IA	730
		United States	Koch Enid, OK	816
		United States	Agrium Borger, TX	610
		Nigeria	Indorama Eleme, Port Harcourt	1,320
		Indonesia	PT Pupuk	908
		Malaysia	Petronas, Sipitang, Sabah	1,200
		Total		**6,934**
2017: 3.2 million tonnes China, 4.0 million tonnes ex-China				
ChinaCoal Erdos II, Inner Mongolia	1,600	Canada	CF Courtright, Ontario	130
Manshi Energy, Inner Mongolia	1,600	Bolivia	YPFB Bulo Bulo	650
		Nigeria	Dangote	2,540
		Azerbaijan	Socar Sumgait	700
Total	**3,200**	**Total**		**4,020**
2018: 4.2 million tonnes ex-China				
		Petrobras	Tres Lagoas	1,188
		Egypt	Kima Aswan II	
		Russia	EuroChem Nevinnomysskiy	1,225
		Turkmenistan	Garabogaz	1,225
		Total		**4,173**
2019: 0.3 million tonnes ex-China				
		Russia	Uralchem Perm	250

Source CRU

END OF THE NITROGEN BOOM

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"Four million tonnes of that came from the Arab Gulf, with around a million tonnes from Europe/Russia, half a million tonnes from Trinidad/Venezuela and 1.5 million tonnes from Asia, mostly from China – with another million tonnes coming over the border from Canada by rail," explains Wallace.

However, by 2019, CRU expects US domestic production to surge to around 7.5 million tonnes with a corresponding curtailment of imports to around three million tonnes – half of which will be serviced from the Arabian Gulf.

"Looking at new domestic capacity, the US is now obviously a low-cost producer that has access to the highest value fertilizer market in the world in the US corn belt," says Wallace. "Investments made over the past three years are now starting to come to market and are going to displace Atlantic trade."

An end to growth?

Although bituminous coal feedstock is cheap and construction costs low, heavy oversupply looks set to limit growth in China's domestic urea market over the medium term. "Other feedstock sources, natural gas and anthracite, are increasingly expensive," notes Wallace. "The government is also undertaking reforms that are removing generous fertilizer subsidies – and there are obviously going to be environmental challenges facing urea producers consuming environmentally-polluting coal."

For a variety of reasons, significant urea supply growth is also unlikely in several other regions over the next 5-10 years, as Wallace explains. "It seems unlikely that China will add to its own supply, gas prices in Southeast Asia are also rising, there's not much appetite in the Middle East and North Africa (MENA) region for capacity investment, and Latin America remains a structural mess."

He adds: "In Southeast Asia, markets are growing and [urea] demand is on the increase. However, the region is facing some gas scarcity and we're seeing rising prices in Malaysia/Indonesia – and with Chinese [urea] exports pressurising local markets we think that's going to deter future investment."

Whilst the MENA region does have access to low cost gas, other obstacles to investment remain. "There appears to be limited incremental gas availability for urea producers – and they will obviously face competition for that from energy producers," says Wallace. "North Africa also faces considerable challenges from political instability."

Growing urea demand and logistical advantages for the Brazilian market should make South America an attractive investment proposition. However, such obvious advantages are largely outweighed by a host of downside factors, in Wallace's view. "There are huge structural problems, corruption and government protectionism. Energy costs are high and rising and without infrastructure investment it will remain a logistical problem to move urea around. There is also limited access to capital, given eroding government finances."

Large-scale urea projects

2015: Investment at full throttle

Globally, more than 17 million t/a of new urea capacity was scheduled to come on-stream during 2015, split between 10.5 million t/a outside of China and 6.7 million t/a from 12 new plants inside China. In the Americas, CF's new Donaldsonville plant in the US and the restart of the Coatzacoalcos plant in Mexico added over two million t/a of extra urea capacity. A further 3.5 million t/a of additional urea capacity was also expected in the Middle East and North Africa (MENA) region last year, with the commissioning of AOA's 2.3 million t/a urea plant in Algeria and MOPCO's new 1.2 million t/a plant in Egypt. In Asia, Matix's 1.3 million t/a Panagarh plant in India and Pupuk's 1.2 million t/a Kaltim V plant in Indonesia also added significant new urea supply.

2016: US expansions gather pace

A further 13.5 million t/a expansion in global urea capacity is expected this year, with a further 10 plants in China contributing 6.6 million t/a towards this total. But it is the expansion in US capacity which will really gather pace in 2016. The opening of four plants there, CF Port Neal II, OCI Wever, Agrium Borger and Koch Enid, will increase North American urea capacity by 3.5 million t/a. Indorama's 1.3 million t/a Eleme plant in Nigeria will be another notable development this year. Additionally, Pupuk and Petronas will together bring on around two million t/a of new capacity in Southeast Asia during 2016.

2017: Investment starts to slow

Looking further ahead, 2017 should be the year when investment starts to slow. Dangote's world-scale Nigerian urea plant is, however, likely to become operative next year, adding 2.5 million t/a of capacity. In the Americas, only two projects, YPFB Bulo Bulo in Bolivia and CF Courtright, a brownfield expansion in Canada, are due to come online in 2017. The pace of Chinese capacity investment will also begin to slow next year, although two new bituminous coal plants from China Coal Erdos and Manshi Energy will add 3.2 million t/a to Inner Mongolia urea capacity.

Both Inner Mongolian plants should be extremely cost-effective, according to CRU's Alistair Wallace: "We will be looking at an ex-works cash cost of $160/t [for urea production] as these plants are sited almost on top of the coalfield. It's a bit expensive to get out to the north-eastern sea ports, but we still think they can get there for around $200/t."

2018 and after: No new Chinese plants

At present, no new urea plants are expected to come online in China after 2017, although capacity outside of China should expand by 4.5 million t/a during 2018 and 2019. EuroChem's Nevinnomysskiy plant in Russia, the Garabogaz plant in Turkmenistan and Petrobras' Tres Lagoas plant in Brazil will each add 1.2 million t/a of urea capacity, supplemented by another 0.5 million t/a of capacity from Kima's Aswan II plant. By 2019, investment will have dwindled to just one modest brownfield project: Uralchem's 250,000 t/a revamp of its Perm urea plant. ■

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Opportunities in North America, the CIS and Africa

Bright spots for investment still exist, however, and CRU believes that North America, Mexico, Nigeria and the CIS countries will continue to offer sound market opportunities for greenfield and brownfield urea projects.

Wallace reels off many of North America's strong fundamentals: "A high-value agricultural market, a high-value fertilizer market, a large import requirement and low gas prices. Negatives are a high tax liability, of course, and capital building costs have also increased dramatically."

The CIS also looks an attractive region for urea investment, despite large overland distances to major f.o.b. ports and the risk of political instability. "In the CIS, state-regulated production costs and low gas prices mean great returns," comments Wallace. "The rouble's devaluation helps this even further, and Central Asian governments are often involved in leading projects and funding investment."

Sub-Saharan Africa also has the necessary credentials to make it a future growth region for urea supply. This part of the continent benefits from "great logistical advantage into the Americas, a low gas price and long-term growth potential", explains Wallace, although political instability, logistical problems and limited access to capital will continue to present risks in his view.

Coal provides some price protection

It is not only the supply overhang that is weighing on nitrogen market prices currently. Deflationary factors, such as the commodities market collapse, and strong macroeconomic headwinds have also exerted downward pressure and 'tanked' the market.

"This is feeding into nitrogen markets. Oil has collapsed the price of European gas – and weighed even more on Henry Hub and AECO [gas prices] in North America," comments Wallace. "That's lowered the industry's costs and generally puts a downward pressure on prices."

He adds: "In Europe, we can see how closely-linked to oil the European gas contract price and the Ukrainian gas price are– and we expect those to remain low for the remainder of the decade, pricing between $6-8 MMBtu."

In contrast to oil, anthracite coal, a key feedstock for China's urea industry, has managed to keep much of its value – a fact that has helped urea prices stay relatively stable over the last 18 months. To some extent, the previous coal price fall in 2012 has helped shield urea's value.

"Oil collapsed in September 2014 and coal hasn't followed it down because we think it was effectively a stalking horse that had already lost much of its value due to oversupply two years earlier," suggests Wallace. "We think that should provide a stable foundation, providing us with price protection going forward."

'Devastating' Indian subsidy reform risk

India consumes about 30 million tonnes of urea each year but only has the capacity to produce about 22 million tonnes, the difference being imported and sold at a huge loss due to government price controls. India's control of the urea price distorts the fertilizer market, encourages consumption and, as Alistair Wallace points out, "presents the Indian government and Indian taxpayers with a large fiscal liability".

CRU has flagged-up reform of India's fertilizer subsidy regime as a major demand-side risk for the urea market. Indian demand for urea could fall by as much as a half if it was sold at the market price, according to some calculations. Although subsidy reform is on the Indian government's agenda, moving the Indian urea price to parity with the market price in one go would be "a terrible idea" according to CRU.

"An increase in the urea price to market prices would cut demand in India by 50%," comments Wallace. "That would be fairly devastating for Indian agriculture and it would be fairly devastating to the global urea market."

Adding to the risks, any changes to the urea subsidy would probably damage phosphate and potash demand too. "This isn't pain that would just be felt by the urea market," suggests Wallace. "Any move towards reforming the Indian subsidy would also hurt DAP and MOP consumption."

However, one upside of selling urea at the market price, according to CRU, would be a shift in India's N:P:K consumption ratio from 10:2:1 down to 4:2.5:1. This more balanced application rate "would promote a much healthier agricultural system in India", argues Wallace.

Investing in Iran makes sense

The slow progress on Indian subsidy reform to date could be interpreted as fortunate, given the potentially damaging consequences for the wider urea market. "The Modi government hasn't impressed us so far with reform. So we think the probability [of reform] is low, considering how painful the damage to urea demand will be from even small increases to the urea price in India," comments Wallace.

India still has the option of investing heavily in new domestic urea capacity to offset its import demand. Unfortunately, the economics for doing so fail to add up. "We think it will be unlikely that the Indian government will be able to build plants within India in combination with the private sector," confirms Wallace. "Whichever way we calculate it, those plants make huge economic losses."

India does have another option though. The subcontinent could act to improve its urea supply by investing in Iran's industry, following the lifting of sanctions (*Fertilizer International*, 470 p22), an option CRU believes would be "a more interesting approach" for the country. India is a long-standing, major market for Iranian urea and the two countries have maintained ties in recent years.

The current Oman India Fertiliser Company (OMIFCO) joint venture is one successful collaboration which future urea capacity investment in Iran could follow.

The urea boom is over

It is likely to take the nitrogen market at least several years to emerge from the enormous investment in capacity of the last decade. "The boom in the urea market, indeed the nitrogen market, is over and we're going to live with the hangover of this investment boom for the next 3-4 years," sums up Alistair Wallace. "Overcapacity is not the only negative pressure as strong macroeconomic headwinds are also pushing down costs and prices at the nitrogen market's margin in China."

The deflationary pressures currently acting on the market should, however, have positive as well as negative consequences. One significant silver lining, for example, will be better margins for urea producers in Russia, Europe and the US over the next few years as they reap the benefits of cheaper inputs. ■

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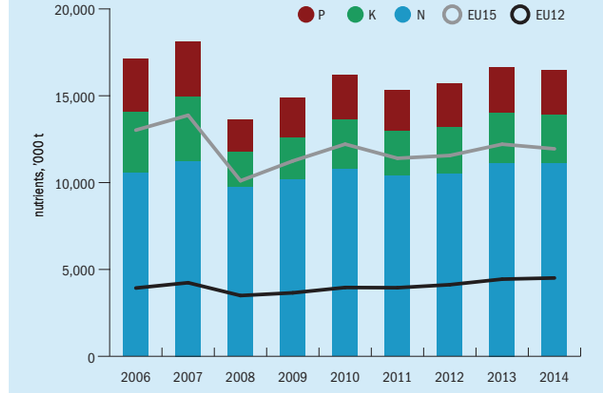
EU fertilizer market continues to recover

After a period of decline, the European Union (EU) is emerging as a sizable, mature and relatively stable market for fertilizers. Europe's farmers currently apply 16-17 million tonnes of nutrients each year to around 130 million hectares of arable land. Encouragingly, rising application rates in the countries of Central and Eastern Europe should drive modest growth in the EU fertilizer market over the next 10 years.

Nitrogen production, consumption and trade is a central and integral feature of the European fertilizers market. Nitrogen products – nitrates and urea in particular – account for two-thirds of total EU fertiliser use, with remaining consumption divided fairly evenly between phosphate and potash fertilizers. Nitrogen products also account for the majority of European fertilizer production and a sizeable segment of its fertilizer trade, although the continent also produces and exports potash in large volumes.

Fig 1: **European fertilizer consumption, 2006-2014**



Source: Fertilizers Europe/Eurostat

Demand falls, rebounds and stabilises

In recent decades, Europe's global importance as a fertilizer market has waned and been eclipsed by other regions such as East Asia. Consumption of nitrogen, phosphate and potash in Western and Central Europe peaked in the 1970s and 1980s at around 30 million t/a, but fell back significantly subsequently, particularly during the early 1990s and again during the last recession. Europe's decline has been all the more stark because it coincided with sustained growth in fertilizer demand elsewhere. As a consequence, Europe's share of the world fertilizer market has slid inexorably from more than 40% in 1961 to below 10% currently.

In recent years, however, the EU's consumption of primary nutrients has stabilised at around 16-17 million tonnes (Figure 1). Consumption rebounded particularly strongly in 2012/13 and 2013/14 in response to favourable weather and attractive market conditions, notes the International Fertilizer Industry Association (IFA), although subsequent falls in agricultural commodity prices are expected to put a lid on current demand.

Looking ahead, Europe's status as a major key regional market for nitrogen seems reasonably secure. Current consumption levels for N are similar to those of the United States (Figure 2), for example, and the size of the European nitrogen market should stay ahead of Latin America over the medium-term, despite rapid demand growth in that region.

A stable picture

Fertilizers containing 11 million tonnes of nitrogen, 2.6 million tonnes of phosphate and 2.8 million tonnes of potash were applied annually to 133.6 million hectares of EU farmland, based on average applications over the last three growing seasons, 2012/13 to 2014/15.

These figures were revealed in the latest annual forecast for European fertilizer consumption published by trade body Fertilizers Europe[1]. The consumption data in this yearly report is recognised by Eurostat, the statistical office of the European Union, lending them weight and authority.

Fertilizers Europe expects EU nutrient consumption to remain relatively stable over the next decade. It is currently forecasting annual fertilizer consumption to

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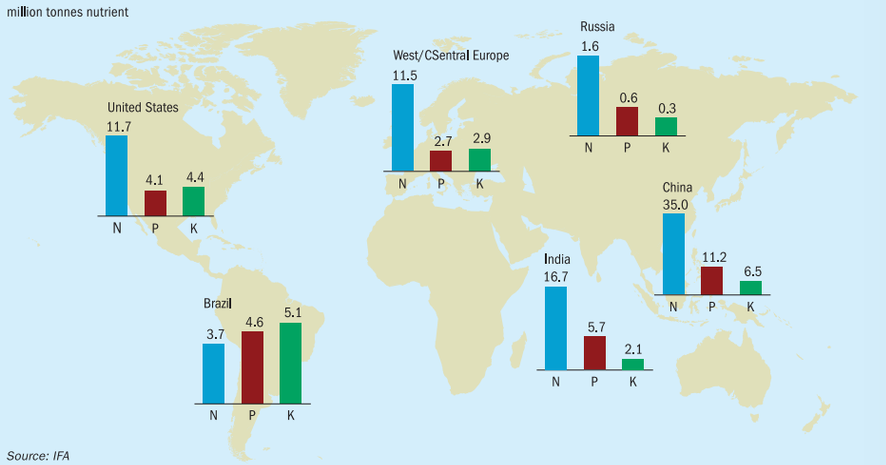
Fig 2: **Fertilizer consumption in key regions, 2013**



Source: IFA

reach 11 million tonnes of nitrogen (-0.3% growth), 2.6 million tonnes of phosphate (+3.3% growth) and 2.8 million tonnes of potash (+7.3% growth) by 2025.

However, the region's long-term growth prospects have been downgraded in the last 12 months. Much more favourable growth expectations – of 1.3% for nitrogen, 8% for phosphate and 13% for potash – were forecast by Fertilizers Europe only a year ago. Unfortunately, this forecast now looks overly optimistic and fertilizer consumption in the region over the next ten years is now expected to remain below "the more normal levels [17-19 million tonnes] recorded immediately prior to the 2008/2009 economic crash", says Fertilizers Europe. IFA agrees and also expects 2019/20 fertilizer demand in Western and Central Europe to remain 1.9 million tonnes below 2007/08 levels (Table 1).

Fertilizer product preferences

Nitrates have a particularly strong foothold in Europe's fertilizer market with ammonium nitrate (AN) and calcium ammonium nitrate (CAN) accounting for more than two-fifths (42%) of nitrogen consumption (Figure 3). Urea and urea ammonium nitrate (UAN) are also popular choices with Europe's farmers, together making up a third of regional N consumption. The application of NPK fertilizers is also commonplace and responsible for almost a fifth (17%) of European N consumption.

In 2013/14, around a quarter (26%) of EU nitrogen consumption was met by imports of 3.4 million tonnes, largely supplied by the countries of the Former Soviet Union (FSU), North Africa, Norway, the US and the Caribbean, according to Fertilizers Europe. Separate IFA figures for Western and Central Europe also confirm net nitrogen imports of 2.2 million tonnes in 2013 (Figure 3).

Ammonium phosphate fertilizers (35%), NPK compounds (33%) and straight fertilizers such as TSP and SSP (17%) are the main sources of applied P in Europe (Figure 3). Imported phosphate products (1.7 million tonnes), largely from the FSU, North Africa, Israel and Norway, took a 61% share of EU consumption in 2013/14. IFA also reports net regional phosphate imports of 1.5 million tonnes for Western and Central Europe in 2013.

Potash is mainly applied in Europe as NPK (48%), MOP (34%) and PK (10%) fertilizers (Figure 3). Potash imports (1.9 million tonnes) were equivalent to 71% of EU consumption in 2013/14, according to

Table 1: **Fertilizer consumption in W. and C. Europe*** IFA estimates and forecasts

Nutrient	2014/15e	2015/16f	2019/20f	Change, 2014/15 to 2019/20
Nitrogen	11,254	11,175	11,073	-1.6%
Phosphate	2,617	2,664	2,741	+4.7
Potash	2,873	2,916	3,045	+6.0%
Total	16,744	16,755	16,860	+0.7%
World				
Nitrogen	111,774	112,930	119,199	
Phosphate	41,308	41,758	45,725	
Potash	31,770	31,770	35,254	
Total	**184,458**	**186,458**	**200,179**	

**Includes EU member states (except Estonia, Latvia and Lithuania) plus Bosnia, Norway, Serbia and Switzerland.*

Source: IFA

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Fertilizers Europe, although IFA figures show that the Western and Central European region was a net exporter (0.7 million tonnes) of potash in 2013.

Dynamic trade

EU fertilizer imports have grown since the 1990s, due in part to a contraction of the region's fertilizer production base. The closure of old and loss-making plants has seen the number of operative EU fertilizer production units fall from 282 to 198 plants between 1994 and 2013, according to Fertilizers Europe.

The Western European fertilizer trade is particularly dynamic due to the scale of import demand from countries such as France, Germany, Spain and the UK (Table 2). France imports UAN and urea in particularly large volumes whilst Germany is an especially large importer of CAN. The import requirements of member states are partly met by EU-based producers – intra-EU trade – as well as by deliveries from outside the region. This is particularly true of nitrogen fertilizers.

Trader/producers such as Helm, Ameropa, Koch, Trammo and EuroChem supply urea to the EU from Algeria, Egypt, Indonesia, the Gulf and Russia. The same traders also move UAN into Europe from Egypt, Russia and Trinidad. Keytrade also supplies the EU with sizeable volumes of UAN produced by CF in North America. On the EU's doorstep, Yara is a major supplier and importer of urea, UAN and CAN to member states.

PhosAgro, OCP and GCT all directly supply the EU with Russian, Moroccan and Tunisian diammonium phosphate (DAP). Fertiberia also imports DAP from OCP in Morocco. Koch, EuroChem and Ameropa also trade DAP in Europe. ICL is a major importer of potash into the region.

European land use

Fertilizers are currently applied over a 134 million hectare area of EU agricultural land, according to Fertilizers Europe[1]. Fertilizer consumption in Europe has a particularly strong link with the cultivation of cereals, which cover more than half of EU arable land (107 million hectares) and a third of the region's total agricultural growing area (177 million hectares). Much of the EU's remaining arable land is dedicated to growing oilseeds, fodder, potatoes, sugar beet and protein crops (Table 3).

Fig 3: **Main fertilizer products produced, consumed andtraded in western and central Europe in 2013**

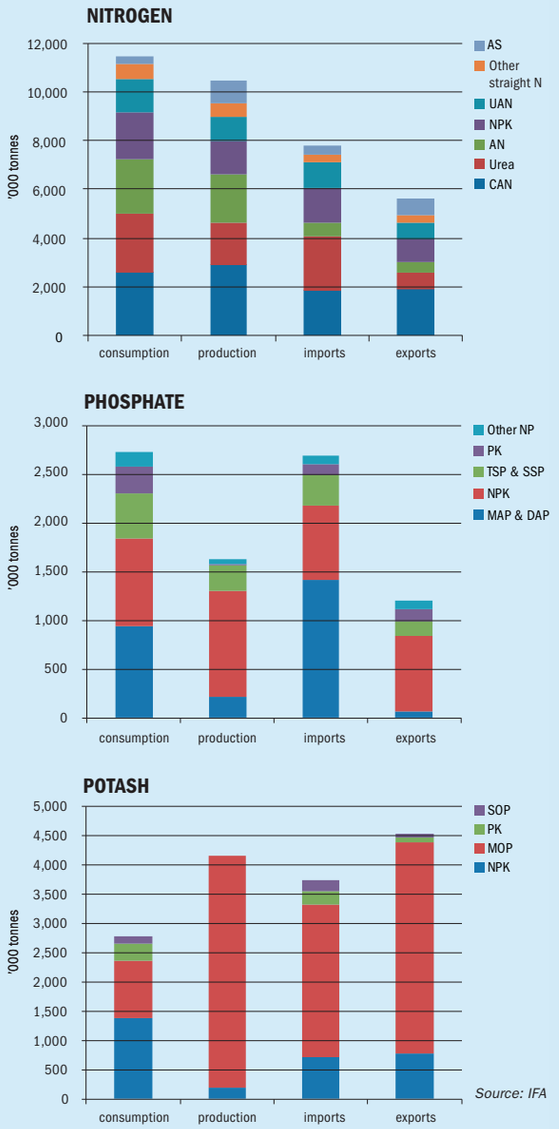

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Table 2: **Nitrogen and phosphate fertilizer imports for selected EU countries, 2013/14 and 2014/15**

Country/product	Imports (tonnes) 2013/14*	Imports (tonnes) 2014/15*
France		
Urea	1,430,808	1,486,456
UAN	2,174,422	2,146,551
AN	342,542	410,035
DAP	433,470	417,778
Germany		
Urea	670,523	763,507
CAN	2,274,604	2,307,920
UAN	245,396	289,823
DAP	372,937	327,745
United Kingdom		
Urea	858,723	1,013,459
AN	429,879	491,329
DAP	130,231	138,913
Spain		
Urea	739,926	810,107
CAN	269,061	318,201
DAP	371,172	274,071

**Year July to June* *Source: Fertecon European Fertilizer Report*

Permanent crops such as fruit orchards, vineyards and forests occupy an additional 12 million hectares of EU agricultural land. Around a third of EU agricultural land is also covered by permanent grassland (58 million hectares), most of which (36 million hectares) is left unfertilised.

The EU produced 332 million tonnes of cereals in 2014 (Table 3). This was a record harvest, easily exceeding the previous 2004 production peak of 316 million tonnes and about 30% higher than the 2007 cereals harvest.

Nearly half of EU cereal production is concentrated in just three member states, France, Germany and Poland. The latter two countries are also the region's largest producers of wheat and barley, collectively accounting for more than two-fifths of EU wheat production and over a third of barley production. Spain and the United Kingdom are the EU's other main barley producing countries. Four member states, France, Romania, Italy and Hungary, produce almost two-thirds of EU maize output.

The EU is the world's leading sugar beet producer. Growing is concentrated in France, Germany, Poland and the United Kingdom, which are together responsible for around 70% of the region's production. Poland and Germany, together with Romania, also have large areas dedicated to potato growing, and these three countries jointly account for nearly a half of EU potato production. This production share rises to around three-quarters when the output of France, the UK and the Netherlands is also included.

Improving yields, decreasing crop areas

Fertilizers applied to cereal and oilseed crops are responsible for almost two-thirds of total EU nutrient consumption, with wheat cultivation alone accounting for quarter of the region's nutrient use[1]. Fertilizer applications on fodder crops and grasslands are also sizable and account for over a fifth of EU nutrient consumption.

Looking ahead, EU fertilizer demand will be affected by changing patterns of cultivation over the next 10 years. The

Table 3: **EU crop production and harvested area**

	2014e crop area (million ha)	2014e production (million tonnes)	2015f crop area (million ha)	2015f production (million tonnes)
Wheat	24.4	149.9	24.2	145.7
Barley	12.4	60.8	12.3	59.5
Maize	9.6	78.2	9.3	58.7
Other cereals (durum, rye, oats, sorghum etc.)	11.7	43.2	11.7	40.9
Total cereals	**58.1**	**332.1**	**57.5**	**304.8**
Oilseeds	11.5	35.4	11.4	30.9
Fodder crops (green maize)	6	210	-	-
Potatoes	1.7	59.0	-	-
Sugar beet	1.6	115.6	97.6	1.4
Protein crops (field peas, broad beans etc.)	0.9	2.7	1.0	3.0

Source: Eurostat and European Commission, autumn 2015

EUROPEAN FERTILIZER CONSUMPTION

> **The EU produced 332 million tonnes of cereals in 2014. This was a record harvest, easily exceeding the previous 2004 production peak of 316 million tonnes**

growing area for barley, rye, oats, maize, potatoes and oilseed rape are all predicted to decline in the EU by 2025, for example. However, the impact of this on production should be more than offset by continuing yield improvements, which are likely to be particularly marked for maize and potatoes. Greater yields for cereals (+7%) are expected to more than compensate for any decrease in the harvested area devoted to these crops (-1.2%).

Fertilizers Europe predicts that the net result of changes to EU agriculture over the next decade should be rising nutrient consumption for cereals (+3%) and oilseeds (+1%), unchanged consumption for sugar beet, and falling nutrient consumption for fodder crops (-3%) and grassland (-3%). Increases in K consumption are forecast for many crops, although these will negated by falls in N and/or P consumption in some instances.

West versus East and Central

At present, EU Fertilizer demand is concentrated in five key agricultural economies, France, Germany, Poland, Spain and the UK, which collectively account for around two-thirds of regional nutrient consumption (Table 4). Yet when it comes to the future of the EU fertilizer market, growth prospects will largely depend on rising consumption in the countries of East and Central Europe, collectively known as the EU-12, rather than West European countries, the so-called EU-15 member states.

The agricultural sectors of the EU-15 countries are typically highly-developed and mature. Fertilizer demand in these member states is therefore expected to change little over the next decade. Indeed, average fertilizer application rates in West Europe are likely to decline slightly (Table 5) as fertilizer use efficiency improves and farmers adopt precision farming techniques.

Nitrogen consumption, in particular, is expected to decline significantly in Belgium, Luxembourg, France, Germany,

Table 4: **The EU's five largest fertilizer consuming countries, 2014.**

Country	Nitrogen '000 tonnes N	Phosphate '000 tonnes P_2O_5	Potash '000 tonnes K_2O	Total nutrients '000 tonnes
France	2,200	430	469	3,099
Germany	1,622	251	435	2,308
Poland	1,154	364	446	1,964
Spain	1,002	392	335	1,729
UK	1,040	200	290	1,530
Total	**7,018**	**1,637**	**1,975**	**10,630**
Share of EU-27	63%	64%	70%	64%

Source: Fertilizers Europe/Eurostat

Table 5: **European fertilizer application rates for EU-15 and EU-12 countries, current and forecast**

	2013/14	2023/24f	2013/14	2023/24f
Nutrient	**EU-15 average kg/ha**	**EU-15 average kg/ha**	**EU-12 average kg/ha**	**EU-12 average kg/ha**
Nitrogen (N)	120	116	78	89
Phosphate (P_2O_5)	25	24	18	23
Potash (K_2O)	22	23	15	20

Source: Fertilizers Europe

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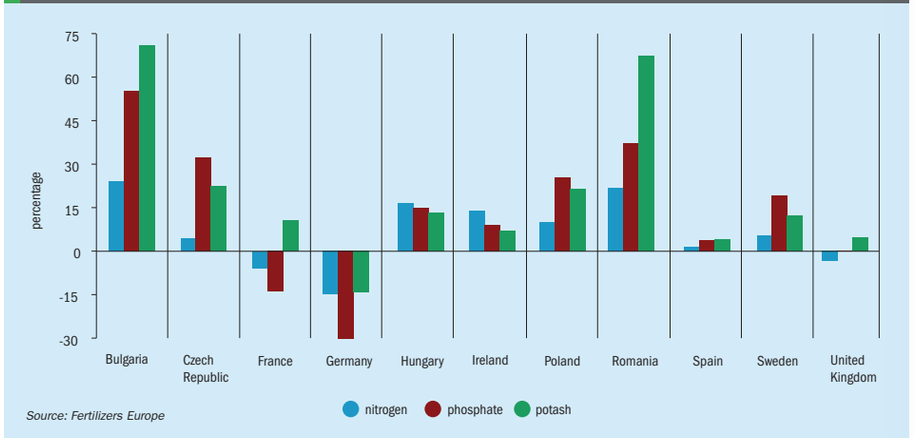
Fig 4: **Forecast fertilizer use in major EU markets: France, Germany, Poland, Spain and UK, and selected high-growth markets 2015-2025**



Source: Fertilizers Europe

Italy and the Netherlands by 2025. Not all EU-15 countries will follow this trend, however, especially in Europe's south. Nitrogen consumption is forecast to recover strongly in Greece and continue to grow in Spain and Portugal, for example, in the next 10 years.

The EU-12 countries, unlike their European neighbours to the west, are expected to offer a strongly growing market for fertilizer products over the next decade. Currently low application rates in East and Central Europe are likely to rise in future, boosting fertilizer consumption in the EU-12 region over the next 10 years (Table 5).

The market for nitrogen fertilizers should grow healthily, with N consumption in the EU-12 forecast to rise 12% by 2025. This will be matched by increased P and K consumption in almost all of the EU-12 countries, as well as in a number of EU-15 countries such as Austria, Belgium, Luxembourg, Denmark, Ireland, Greece, Portugal, Spain and Sweden.

A remarkable recovery

This upswing will contribute to a "remarkable recovery" in the EU phosphate and potash market over the next 10 years, predicts Fertilizers Europe. Among EU member states, growing N, P and K demand in Romania, Bulgaria, the Czech Republic and Poland – and to a lesser extent Ireland, Hungary, Sweden and the Baltic countries – should provide the most attractive opportunities for fertilizer producers and distributors (Figure 4).

IFA expects sluggish 0.2% annual growth in European demand over the next four to five years, with a marginal contraction in N consumption offset by modest increases for P and K. Growth in Central European fertilizer demand over the remainder of the decade should offset retreating demand in Western Europe in IFA's view.

Market analysts BMI Research broadly agree with this outlook for the EU fertilizer market. "We maintain our core view that Eastern Europe fertiliser demand growth will outperform Western European demand in the long term," the firm reported last year. It also expects the general decline in fertiliser consumption in parts of the EU to continue in future.

"We expect this dynamic to continue as consumption in Western European countries, such as the Netherlands, UK and France, will continue declining over the coming years," predicts BMI. "Emerging European countries will make up the bulk of growth in the sector in the long term, as farmers' incomes increase."

A good harvest but pessimistic signals

Early forecasts suggest a good 2015/16 EU cereals harvest of more than 300 million tonnes due to favourable weather conditions. First figures from member states indicate a decrease in EU wheat growing area (-3.5%) and increases in the planted area for barley (+1.5%) and durum wheat (+3.5%).

Early 2015/16 estimates also indicate a small increase in EU oilseed area (+1%). Winter rape sowings are reported to be higher in the Czech Republic, Lithuania and France, stable in Bulgaria but decreasing in Romania.

According to Fertilizers Europe, the main drivers of demand in the EU fertilizers market include:

- Weather and climate change
- Fertilizer and agricultural commodity price relationships
- EU biofuels policy, the Common Agricultural Policy (CAP) and EU environmental legislation
- General farm economics and farm preferences for organic versus inorganic fertilizers

The CAP and the EU's climate change and energy policies are likely to be the main internal drivers of EU fertilizer consumption over the next ten years, in Fertilizer Europe's view. Reforms to the CAP, covering the period 2014-2016, were agreed at the end of in 2013 and are currently being implemented.

IFA, in contrast, does not expect the reformed CAP to greatly affect European fertilizer demand. EU environmental regulations – together with policies promoting nutrient efficiency and recycling – will have more influence on the fertilizer outlook for the region in its view.

However, EU policies will not be the only – or even the most significant – drivers of demand in future. The fluctuating fortunes of the wider economy should not be discounted, as these have been the critical influence on EU fertilizer consumption in the recent past. Macroeconomic conditions will undoubtedly continue to shape the EU market in future – and is one reason for the current downbeat prognosis.

"The global economic crisis… within the food and energy sectors were key factors in the significant drop in fertilizer consumption between 2008 and 2010. After a slow recovery in 2011 and 2012, a rather pessimistic forecast in 2013, and a rather positive one in 2014, signals from the current forecast are quite pessimistic," concludes Fertilizers Europe. ■

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Vietnam: a growing NPK producer

PHOTO: KONSTANTIN KRISMER

The end of drought in Vietnam means growth in domestic fertilizer consumption is expected to resume. The Japan Vietnam Fertilizer Co Ltd (JVF), one of the country's leading NPK producers, provides an illuminating update on the Vietnamese fertilizer market in a wide-ranging interview with **David Hayes**.

Fertilizer use has grown substantially in Vietnam over the past decade driven by rising domestic fertilizer production and an increase in the total land area devoted to agricultural production. The Vietnamese government has also played an active role by encouraging farmers to raise their output to feed the growing population and boost export earnings.

Demand rises by nearly two-fifths

Demand for fertilizers has rocketed by 38% over the past seven years, according to the Ministry of Agriculture and Rural Development (MARD), and currently stands at 11 million t/a annually compared with 8 million t/a in 2008. Demand is mostly for NPK (circa 4 million t/a) and urea (2.5 million t/a). Consumption of other fertilizers products such as DAP, MOP and AS is also substantial, running at about 900,000 t/a for each.

"Total fertilizer demand is growing but not so quickly. It's growing by about 5-7% annually as the area of farmland is increasing very slowly and farmers' incomes are a bit better," commented a source at Japan Vietnam Fertilizer Co Ltd (JVF), one of the country's leading NPK fertilizer producers.

"In 2013 and 2014, Vietnam's rice exports overtook Thailand's. Farmers want to increase their yields, so they increase fertilizer use. That's one reason for the increase in demand."

Although growth was real, the company questioned the accuracy of official statistics. "Total chemical fertilizer demand is 11 million t/a according to the government, but that seems a bit high. The government says that NPK demand is 3.5-4 million t/a – that's too also much, but maybe 50% of that is low quality NPK."

Diverse and strategic farm sector

Agriculture is of major importance to the Vietnamese economy with the farming sector providing employment for more than 70% of the country's 90 million population, according to MARD.

Agricultural land presently covers about 13.4 million ha, equivalent to almost 80% of the country's land area. Although arable land increases by about 200,000 ha each year, the area of arable land per person remains unchanged due to population growth, with the total population forecast to reach 100 million by 2020.

Rice is Vietnam's largest crop, in terms of the area farmed as well as the tonnages produced, although coffee and sugarcane are also widely grown. Some 60% of Vietnam's total arable land area, about 8 million ha, is devoted to rice cultivation. Rice growing on this scale is also responsible for about half of national fertilizer demand. Other major crops grown in Vietnam include maize, rubber, cashew nuts and pepper. Maize and sugarcane are grown for domestic consumption whilst other crops are partly grown for export.

Maize production is the second largest consumer of fertilizer in Vietnam, and is considered by the government to be the second most important food source in Vietnam after rice. Expanding domestic corn production is a current government priority, as more than one million tonnes of maize has been imported annually in recent years due to domestic shortfalls.

Rubber is an important expanding market for fertilizers due to Vietnam's position as the world's fifth largest producer and fourth largest exporter. Demand for fertilizer on rubber estates is growing gradually and now accounts for about 5% of total domestic fertilizer demand.

Drought hits demand

Unsurprisingly Vietnam's two main planting seasons are peak periods for fertilizers demand.

"April to June is the biggest season in Vietnam, it's the rainy season and farmers apply fertilizer to all their crops including rice paddy, coffee and sugar cane which are three major crops," the JVF source explained. "The semi-peak season is from November to early in the new year when there is the second rice planting. This is the dry season. Coffee is harvested in October and November, farmers then apply fertilizer for the following year."

While fertilizer use is expected to continue growing over the longer term, a temporary fall in fertilizer consumption has occurred in Vietnam during the past 12 months. This recent decline is linked to falling agricultural output brought on by the severe drought that has affected most of Southeast Asia. Central Vietnam has been worst affected as there are fewer major rivers flowing through the region.

Southern and northern Vietnam, in contrast, have been more fortunate, being watered by the Mekong and the Red River, respectively. The delta regions of the Mekong and Red River together cover about 80% of the Vietnam's total flat land area. Even here, though, rice production and planting have been hit by the lack of rain and high summer temperatures.

Although the impact of the drought on fertilizer use is still emerging, the percentage reduction in nutrient demand is likely to be in double digits, according to our JVF source.

"Some people are saying that total demand for fertilizer has reduced 15% to 20% overall – all types of fertilizer have been affected. There has been a serious drought in the whole of Vietnam, especially the central region.

"Central Vietnam is mainly coffee growing and cash crops, but in the past year there has been less rain so farmers cannot apply fertilizer. In the worst affected areas, farmers have cut their tree branches, they have sacrificed their harvest to save the trees. This has happened in the worst affected areas with coffee trees, but the branches will grow back."

Domestic production and imports

While farmers are hoping that rainfall will return to normal this year, Vietnam's fertilizer manufacturers are also hoping to grow their domestic sales in the face of tough competition from low priced fertilizer imports from neighbouring China.

Local fertilizer production meets about 70% of Vietnam's overall nutrient needs at present, says the Ministry of Agriculture and Rural Development. However, the country has to import its entire potash and ammonium sulphate (AS) requirements as these are not produced locally. In 2014, some four million tonnes of fertilizer was imported, including 900,000 tonnes each of AS and potash, alongside DAP, urea and NPK.

Rising farm incomes, and better education for farmers, has seen chemical fertilizer use in Vietnam grow over the past decade. The relationship between balanced nutrient application and crop yield improvements is becoming more widely understood.

"Farmers originally preferred single fertilizers. Some farmers have shifted to NPK but many still prefer single straight fertilizer or cheap priced blended NPK,"

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the JVF source remarked. "The increase in demand seems to cover the whole of Vietnam. Big farmers use more fertilizer while small farmers use less."

Farmer education is playing a key role in increasing general understanding about how fertilizers function – and the benefits of greater use.

"We advise them to use high-quality fertilizer products and get more yield as this will increase farmers' profits," the source said. "Once they experience high yield and profits they become a fan of our products. Yes, more big farmers are our customers, but both big and small farmers do use our products."

NPK producers

The growth in NPK use has led to a rapid rise in the number of NPK producers over the past decade. Fertilizer industry estimates suggest that several hundred NPK companies are operating in Vietnam, including a large number of small family businesses that blend fertilizers.

About eight large NPK companies are located in southern Vietnam. These include state-owned Binh Dien Fertilizer Co, a subsidiary of Vietnam National Chemical Industries Corporation (Vinachem). It supplies about 30% of Vietnam's total NPK requirement and operates five factories with a combined fertilizer production capacity of 1.05 million t/a.

Other Vinachem subsidiaries in the south producing NPK are Southern Fertilizer Corporation with over 300,000 t/a of NPK capacity and Canto Fertilizer Corporation with an estimated 200,000 t/a of NPK capacity.

Japan Vietnam Fertilizer Co Ltd and Baconco are also sizable NPK producers in Vietnam. Baconco, acquired by Thai company Thoresen Asia from its former French owner, possesses 200,000 t/a of NPK capacity.

PetroVietnam Fertilizer and Chemicals Corporation (PVFCCo), Vietnam's leading urea producer, is the latest company planning to enter the high quality NPK market. In mid-2015, it awarded a $37 million EPC contract to build a 250,000 t/a NPK plant at the Phu My fertilizer complex in Ba Ria-Vung Tau Province. The plant will use technology licensed from Spain's Incro SA. Completion is expected mid-2017.

PVFCCo's Phu My urea complex will also be revamped as part of this contract, increasing capacity from 450,000 t/a currently to 540,000 t/a. Italy's Technip Group, the original contractor for the Phu My urea plant, is part of the current construction consortium.

Demand for NPK in Vietnam grew from 2.1 million tonnes to 4 million tonnes over the nine-year period between 2005 and 2014, according to government figures. Although domestic NPK production capacity has grown over this time, Vietnam still imports about 300,000 t/a of high-quality NPK.

PVFCCo's ambition is to replace most of the country's high-quality NPK imports with domestic products from the Phu My fertilizer complex, once the plant is built. The new plant will increase the number of companies able to produce high-quality NPK in the south to four – the others being Japan Vietnam Fertilizer Co Ltd, Baconco and Vinachem's Binh Dien Fertilizer.

Established in 1999, Japan Vietnam Fertilizer Co Ltd (JVF) is a joint venture between Sojitz Corporation of Japan, Vietnam's state-run Vinachem Corporation, and Central Glass Corporation. JVF's 350,000 t/a nameplate capacity plant is located in Dong Nai Province, adjacent to Ho Chi Minh City, and uses Japanese NPK technology.

"We pay careful attention to controlling our NPK quality. The JVF brand is very famous among Vietnamese farmers. We now distribute our products to the whole of Vietnam," the JVF source said. "We sell most of our fertilizer in Vietnam. There are some small exports to Cambodia and Laos."

Agronomic support

As one of Vietnam's longest established and best known NPK producers, JVF operates a longstanding field trial programme to inform farmers about the importance of balanced and site-specific plant nutrition.

"We do soil testing in selected areas and recommend a suitable NPK application, then conduct field trials to show the efficacy of our NPK. After the demonstration we arrange a seminar to show the results," the JVF source explained.

"We sell to the whole of Vietnam. Our NPK is used mainly to grow coffee, paddy, sugarcane and fruits such as lychees and oranges. Vietnam is one of the top coffee exporters after Brazil and the second largest rice exporter after Thailand."

Although the long-term growth trend for NPK and other fertilizers is expected to continue, Vietnam remains a price sensitive market with smaller farmers likely to switch to cheaper products or reduce fertilizer use depending on price trends.

"As long as the price gap remains within a certain range it does not affect NPK sales but if the gap becomes bigger then some farmers will shift to using single fertilizer," the source said.

"The NPK market has good potential here. NPK consumption is increasing gradually but the basic problem is that farmers prefer cheap NPK. Also, there are hundreds of NPK manufacturers and many supply low-quality products; this could affect farmers' profits in future. It's not certain that low-price NPK contains the correct chemicals; using the wrong chemicals will affect the soil fertility."

Urea oversupply problems

Government support for Vietnam's agricultural sector includes ensuring the country is self sufficient in urea production. Vietnam reached self sufficiency in urea for the first time in 2012, after the Ca Mau urea plant in the south of the country and Ninh Binh urea plant in the north were both completed.

The increased availability of low-cost urea imports from neighbouring China, however, and their purchase by the country's small farmers, means that Vietnam is now facing an oversupply of urea – a problem exacerbated by previous large-scale state investment in domestic production. One consequence is that Vietnam's urea producers are increasingly targeting export sales to alleviate strong domestic competition from low-priced imports.

Cheap urea imports are a headache for Vietnam's urea industry. The country's total urea supply was 3.25 million tonnes in 2013, around 45% above actual demand that year (2.2 million tonnes), according to a report by Vinachem, the owner of two coal gasification technology urea plants in north Vietnam. This figure includes the two million tonnes produced by the country's four urea plants along with 1.2 million tonnes imported from China.

"There was a urea shortage here so Vietnam imported. Now they are self sufficient. But sometimes China's urea price is competitive with Vietnam's price and they import again. Although Vietnam is self sufficient in urea, there's been no change in urea demand recently – so it does not affect NPK demand," the JVF source concluded. ■

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phosphates & potash INSIGHT

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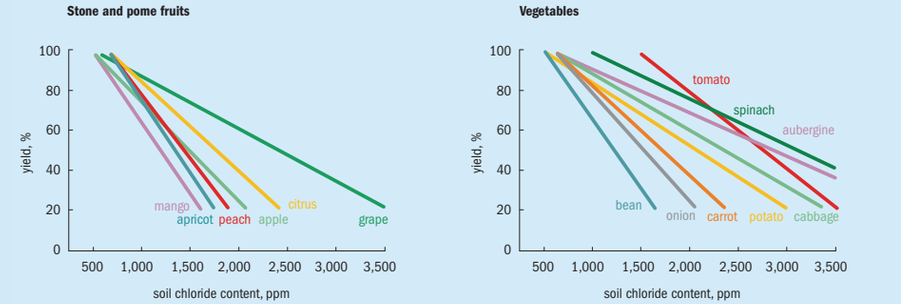
Chloride in potash: its good and bad effects

Applications of MOP and other chloride-containing fertilizers need to be carefully managed for crops such as berries, stone fruits, nuts, tobacco and broad beans. Selection of chloride-free sources of potassium also offers distinct advantages for certain crops, especially those cultivated under saline growing conditions. Chloride, nonetheless, plays an important role in disease prevention, and is required in high quantities by sugar beet.

Fig 1: **The effect of chloride on selected fruit and vegetables**



Source: K+S

Potassium chloride (KCl, muriate of potash, MOP) has a number of well-known natural advantages as a fertilizer and a source of K. It is widely available, relatively low-cost and readily soluble in water. Equally importantly, KCl has the highest potassium content of any of the mineral forms of potash.

Potassium chloride delivers K to plant roots both quickly and effectively, and also mixes well with other nitrogen and phosphate fertilizers. Indeed, the evidence suggests that the use efficiency of N and P fertilizers improves when applications are combined with K[1].

Potassium plays a key role in photosynthesis and the formation of sugars. It also has a direct function in protein synthesis and cell growth and development. Evidence has emerged in recent years that K is also the most important nutrient when it comes to mitigating the effects of salinity, cold, frost, waterlogging, drought and other stresses on crop production, as well as protecting against insects, pests and various diseases[1].

In contrast, the chloride component of KCl benefits some crops but can have adverse effects on others under specific conditions.

Different crops exhibit a range of responses to chloride. Applications of MOP and other chloride-containing fertilizers can usually be applied at up to 140 kg of Cl per hectare with no negative effects on crop growth or yield[2]. However, careful or restricted application sometimes becomes necessary for a limited number of chloride-sensitive crops – especially when exacerbated by adverse growing factors such as soil salinity and salt stress.

Chloride, salinity and irrigation

About 30% of irrigated land globally suffers from salinity, according to the FAO, equivalent to more than 100 million hectares worldwide. In some countries, such as Egypt, Pakistan and Iraq, as much as 35-50% of irrigated land is salt-affected. Around 10 million hectares of irrigated land is also abandoned globally because of salinity, according to some estimates.

Chloride levels and salinity, in both soil and irrigation water, can become elevated due to one or more of the following:

- Use of saline irrigation water
- Influx of seawater into groundwater in coastal areas
- Poor soil drainage due to a lack of rainfall, especially in greenhouses, or a lack of leaching.

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Table 1: **Classification of crops based on their susceptibility to chloride**

Classification	Crop	Product
Chloride-loving: Chloride based fertilisers are preferred.	Sugar beet, fodder beet, celery, Swiss chard, coconut	Korn-Kali® 60er Kali®
Chloride tolerant: Chloride based fertilisers can be used but most vegetables prefer sulphate based fertilisers because of their sulphur demand.	Cereals, maize, oilseed rape, asparagus, cabbage, beetroot, rhubarb Grassland, clover, oil palm, rubber, rice, groundnut, cassava, soybean, sugar cane, banana, cotton	60er Kali® Korn-Kali® Magnesia-Kainit®
Partly chloride tolerant: Chloride based fertilisers can be used if they are applied on time before the start of vegetative growth.	Sunflowers, grape vines, stone fruits, blackcurrants, seed potatoes, potatoes for human consumption, tomatoes, radish, kohlrabi, peas, spinach, carrots, leek, horse-radish, chicory, pineapple, cucumber, kiwifruit, coffee, tea	Patentkali® KALISOP® Korn-Kali®
Chloride sensitive: (Only fertilisers containing potassium in the form of sulphate should be used).	Starch potatoes, potatoes for processing, tobacco, redcurrants, gooseberry, raspberry, strawberry, blackberry, blueberry, mango, citrus, pepper, chilli, avocado, cashew, almond, peach, cocoa, hops, pomes and stone fruits (especially cherries), bush beans, broad beans, cucumber, melon, onion, lettuce, early vegetables, all crops under glass, conifers, flowers and ornaments as well as seedlings and transplants of most plants	Patentkali® KALISOP®

Source: K+S

Table 2: **Crop sensitivity to foliar injury from chloride in sprinkler irrigation water**

Crop	Sensitivity to foliar injury (Cl concentration, mmol/litre)
Almond, apricot, citrus, plum	<5
Grape, pepper, potato, tomato	5-10
Alfalfa, barley, corn, cucumber, sesame, sorghum	10-20
Cauliflower, cotton, sugar beet, sunflower	>20

Source: Xu et al. (2000)

- Overuse of Cl-containing fertilizers (KCl, NH_4Cl etc.)

Interest has grown in the management of fertilizer use under saline conditions in recent years due to increasing use of saline water and recycled sewage water for agriculture[2]. Irrigation water containing less than 150 mg/litre of Cl can be used on most crops. The salinity of irrigation water does become problematic, however, if it starts to disrupt plant nutrient uptake.

The suppression of plant nitrogen uptake due to nitrate inhibition by chloride is a particular issue. Salinity is known to reduce nitrate uptake in citrus trees, for example, resulting in nitrogen deficiency. Plant phosphate uptake is also supressed at high chloride concentration[2]. High sodium levels associated with saline conditions can have deleterious effects as well, leading to Ca and/or K deficiency in some plants.

Competition between nutrients (antagonisms) can be used advantageously though. Nitrates, for example, are able to reduce the sensitivity of plants to chloride stress by acting as an uptake inhibitor. Because of this, nitrate is able to alleviate symptoms of chloride toxicity in avocado. Similar antagonisms between nitrate and chloride have been reported for barley, broccoli, citrus, corn, kiwifruit, melon, lettuce, peanut, potato, strawberry, tobacco, tomato and wheat. Phosphate can also help alleviate salt stress. The application of P has been shown to have a beneficial influence on the yield of millet and clover grown in saline soils.

Chloride, plant growth and yield

Chloride is required by plants for photosynthesis, fluid pressure control (osmoregulation) and for specialist parts of the leaf (stomatal guard cells). Although chloride application is rarely needed at rates over 10 kg/ha, relatively large amounts of Cl are essential for some crops such as kiwifruit and sugar beet[2]. Palms and coconuts also need Cl to help the outer layer of their leaves to function (it maintains charge balance in guard cells).

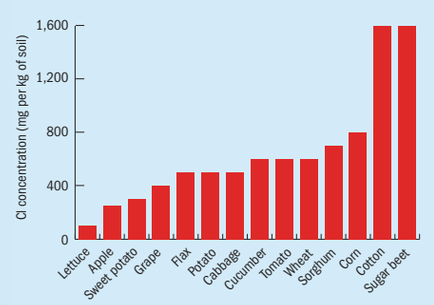
Yield response to chloride varies widely (Figure 1) with some crops exhibiting a high degree of tolerance. As a general rule, woody plants such as citrus trees as well as beans are more susceptible to Cl toxicity than non-woody plants. Corn, for example, will tolerate Cl in soil at 340 kg/ha without any detrimental effects on growth and yield. Cotton yield and quality are also unaffected by Cl concentrations below 1,600 mg/kg. Other crops, such as rice, wheat, sorghum, tomatoes, aubergines, bananas and peaches, can also tolerate Cl in fertilizers at rates of 1,350-1,800 kg/ha each season[1]. Critical soil Cl toxicity concentrations for different crops are shown in Figure 2.

The presence of chloride in sprinkler irrigation water can also result in foliar injury (Table 2).

Sugar beet is one crop that exhibits clear yield improvements with increasing Cl. This holds true for applications up to 1,600 mg/kg – possibly rising to 3,200 mg/kg in clay soils[1]. Beets can typically tolerate up to 51 mg/g of Cl in their leaves. Substantial growing responses to Cl-containing fertilizers have also been observed for coconut, kiwifruit, oil palm, spring wheat and barley[2]. Salinity can also improve the taste and quality of tomatoes and melons.

Symptoms of chloride deficiency are even observed in some crops grown on inland soils, such as those found in continental interiors at a great distance from the sea. One example is the mid-west

Fig 2: **Critical soil chloride toxicity concentrations for selected crops**



Source: Xu et al. (2000)

Table 3: **Salt indices for selected fertilizer products**

Product	Salt index
Potassium chloride (MOP)	116.3-109.4
Ammonium nitrate (AN)	104.7
Urea	75.4
Potassium nitrate	73.6
Ammonium sulphate (AS)	69.0
Calcium nitrate (CAN)	52.5
Potassium sulphate (SOP)	46.1
Potassium magnesium sulphate (SOPM)	43.2
Monoammonium phosphate (MAP	34.2
Diammonium phosphate (DAP)	29.9
Ammonium phosphate	26.9
Superphosphate	7.8-10.1

Source: FAO

PHOTO: SYNGENTA

Sugar beet is a chloride-loving crop.

US wheat belt where chloride provided through rainfall does not meet crop Cl demand of 4-8 kg/ha. Wilting, curling, bronzing and chlorosis of leaves – similar to the signs of Mn deficiency – and severe root inhibition are typical symptoms of Cl deficiency.

However, the application of chloride-containing fertilizers such as MOP does need careful management for some crop species. Applications for crops with a moderate tolerance, such as soybean, pea, strawberry, peanut, apple and sugarcane, should lie in the range of 675-1,350 kg/ha. Other crops, especially pepper, cabbage, lettuce, rape, tobacco, potato and sweet potato, are more chloride sensitive and Cl applications should not exceed 675 kg/ha each season[1].

Selection of a fertilizer with a lower salt index (Table 3) is one option for chloride-sensitive crops, particularly under saline growing conditions. This lowers the risk of salt burn and damage to seedlings and young plants.

Chloride-free fertilizer options

Potassium sulphate (sulphate of potash, SOP, K_2SO_4) is the most commonly used alternative to potassium chloride. Whilst MOP may be the default choice as a potassium fertilizer for cereals and oilseeds, SOP often finds favour for more chloride-sensitive, higher-value cash crops, notably fruits, vegetables, tobacco and tree crops (*Fertilizer International*, 458, p48). The other obvious advantage of SOP is that it is also a source of sulphur and can therefore be applied to address sulphur-deficiency.

Other chloride free fertilizer options include:

- Potassium magnesium sulphate ($K_2Mg_2(SO_4)_3$, SOPM, langbeinite)
- Potassium nitrate (KNO_3)
- Monopotassium phosphate (MKP, KH_2PO_4)
- Polyhalite ($K_2Ca_2Mg(SO_4)_4.2H_2O$)

Of these, polyhalite is garnering much attention at the moment. ICL Fertilizers launched its UK-sourced polyhalite product *Polysulphate* last year. *Polysulphate* has been successfully trialled as a low-chloride, multiple nutrient (sulphur, magnesium, potassium and calcium) fertilizer for a variety of crops, including cabbages, winter wheat and potatoes (*Fertilizer International*, 468, p36).

Sirius Minerals, the developer of the UK-based York Potash project, has also commissioned extensive agronomic trials evaluating crop responses to its polyhalite product, *POLY4* (*Fertilizer International*, 468 p18). Results suggest that a number of staple crops and high-value cash crops exhibit a high response to POLY4, due to its K, Mg and S content, making it a "more comprehensive" fertilizer than MOP.

Chloride's positive effects

Whatever the merits of the alternatives, MOP is likely to remain a mainstay as the most-commonly applied potassium fertilizer for many commercially-produced crops. After all, it is generally the case that the yield and quality of crops improve greatly when adequately supplied with MOP – compared to when supply is inadequate or deficient.

The positive role chloride can play in disease protection should also not be neglected when judging the relative merits of chloride-containing and chloride-free fertilizers. The chloride content of fertilizers is known to control a number of crop diseases, including rust disease and root rot in barley, stem blight disease and stalk rot in corn, and brown heart disease in potato. ■

References

1. Ren, L. et al., 2015. The Value of KCl as a Fertilizer with Particular Reference to Chloride: A Mini Review. *Research Findings*, International Potash Institute, e-ifc No. 40, March 2015.
2. Xu, G. et al., 2000. Advances in Chloride Nutrition of Plants. *Advances in Agronomy*, Volume 68. Academic Press.

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Phosphates 2016

welcomes you to Paris

CRU events will convene the 2016 Phosphates International Conference & Exhibition in Paris at the Marriott Rive Gauche between 13-15 March.

CRU's annual phosphates conference, now in its ninth year, has gown into a must attend industry event. The whole of the sector's value chain is represented, with a veritable 'who's who' of phosphate producers and allied companies now attending. An impressive 420 delegates from 36 countries attended last year's event in Tampa, for example.

Phosphates 2016 provides an opportunity to gather in Paris, one of the world's great capitals, and hear the very latest from the industry's top flight. Experts have been lined up to speak about the global and regional outlook for phosphates, and recent technical developments, in a series of lively and topical programme presentations.

Market trends, phosphates supply, product innovation, sustainability, new start-ups and major industry investments will all be covered in Paris this year. A session focusing on the potash market is also offered for the first time.

Engineering aspects of the industry also fall under the spotlight. Mining, processing and production will all be highlighted in wide-ranging technical showcase presentations throughout the three-day event. ■

PROGRAMME OF PRESENTATIONS

MONDAY 14 MARCH

09:00-10:30 GLOBAL OUTLOOKS

- **CRU Phosphate market outlook**
  Juan von Gernet, CRU
- **The geopolitical outlook for the Middle East and Sub-Saharan Africa: Possible trajectories**
  Charles Hecker, Control Risks
- **Capital markets perspectives on the phosphate sector**
  Ingo Hofmaier, Hannam & Partners

11:00-12:00 GLOBAL OUTLOOKS

- **Producer update**
  To be confirmed
- **Key raw materials outlook: Ammonia and Sulphur**
  Anders Isberg, CRU

13:30-15:45 REGIONAL OUTLOOKS

- **Challenges and opportunities in the African market**
  Speaker to be confirmed, OCP
- **The US market: Maintaining competitiveness in a challenging environment**
  Wayne Welter, JR Simplot
- **Brazilian market update**
  Carlos Heredia, Yara
- **Asia market outlook**
  Chris Lawson, CRU

16:15-17:55 TECHNICAL PROGRAMME

- **A place in the market for small capacity 'boutique' phosphate mines**
  John Sinden, JSA Limited
- **The Togolese carbonate phosphate project: A gateway to Africa**
  Jimmy Rabinowitz, Elenilto Group
- **Case study: Design and engineering of a long-distance slurry pipeline**
  Mohamed Faical Guennoun, Jacobs Engineering
- **Modular flotation plants: A total cost of ownership comparison**
  Luis Rudolphy, Outotec (Finland) Oy

TUESDAY 15 MARCH STREAM A

09:00-10:30 MARKET OUTLOOK

- **Harnessing innovation: Outlook for the micronutrient and specialty fertilizer market**
  Irina Evstigneeva, PhosAgro
- **Food and industrial phosphates market outlook: A producer's view**
  Julia Presnova, Prayon SA
- **Feed market outlook**
  Speaker to be confirmed, Group Roullier

11:00-12:30 MARKET OUTLOOK

- **Phosphate sustainability outlook**
  Willem Schipper, Willem Schipper Consulting
- **Case study: P Recovery at Slough WWTP**
  Rosanna Kleeman, University of Surrey
- **P Sustainability case study**
  Andrea Ulrich, Swiss Federal Office for Agriculture

14:00-15:00 POTASH MARKET SPOTLIGHT

- **NPK application balance and agricultural outlook**
  Speaker to be confirmed
- **CRU's specialty potash market outlook**
  Seán Mulholland, CRU
- **Potash producer spotlight**
  Speaker to be confirmed

TUESDAY 15 MARCH STREAM B

09:00-10:30 TECHNICAL DEVELOPMENTS

- **Solving water scarcity issues and water conservation through pump selection** Simon Sims, Flowrox
- **Process technology and pilot plant results for the recovery of P_2O_5 from phosphate mine tailings** Curtis Griffin, PegasusTSI Inc
- **Shell Thiogro – A case study for innovation in fertilizers**
  Cyrille Allais, Shell

11:00-12:30 TECHNICAL DEVELOPMENTS

- **The EcoPhos process together with rock beneficiation: valorisation of the phosphate containing co-product; From rock to phosphoric acid** Marc Sonveaux, EcoPhos
- **New technological advancements to disruptive phosphoric acid production techniques** Tip Fowler, JDCPhosphate Inc
- **Design for maximum sulphuric acid plant reliability – the key to maximum profitability for your site**
  Michael Fenton, Jacobs & Chemetics

14:00-15:00 TECHNICAL DEVELOPMENTS

- **Hemi: The economic, easy and energy efficient phos acid process**
  John Wing, John Wing PE, LLC
- **Phosphoric acid reactor cooling system design**
  Eric Ramella, Jacobs Engineering
- **Defoamer application in phosphoric acid production**
  Guoxin Wang, ArrMaz

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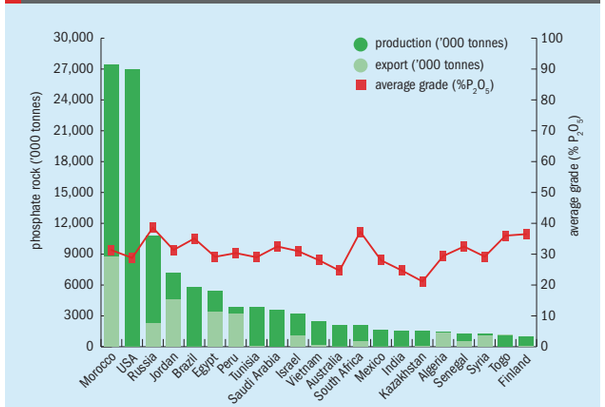
Phosphate ore makes the grade

We examine the region-to-region variation in phosphate rock grade in key producing countries, including Morocco, China, the US and Russia, and assess the impact grade has on production costs and pricing.

Global production of phosphate rock exceeded 196 million tonnes in 2014 and capacity is forecast to grow to nearly 233 million tonnes this year and 255 million tonnes by 2019 (*Fertilizer International*, 467 p49).

China's 80 million tonne production in 2014, equivalent to two-fifths of world output, exceeded the combined output of the next five top phosphate rock producing countries, Morocco, the USA, Russia, Jordan and Brazil (Figure 1). This makes China the dominant world producer, although less than 0.5% of its output is exported and traded internationally. Instead, almost all of China's phosphate rock is consumed domestically within its borders to manufacture value-added phosphate products, particularly diammonium phosphate (DAP).

Fig 1: **Production, export and grade of major phosphate rock producing countries, excluding China, 2014**



Figures are for commercial phosphate rock, including beneficiated rock concentrate, used to manufacture phosphoric acid, elemental phosphorus and downstream phosphate products. *Source: IFA*

In contrast, Morocco, the world's second largest producer, exported just under nine million tonnes of phosphate rock in 2014, giving the country a 30% share of the 29 million tonne global traded market. Jordan, Egypt, Peru, Russia, Algeria, Togo and Israel are also major phosphate rock exporters (Figure 1).

Why grade matters

As with any naturally-occurring resource, the grade of phosphate rock varies within and between ore deposits. Grade is influenced by the genesis of the ore, particularly whether it is igneous or sedimentary in origin, its subsequent geological history and the amounts of impurities (gangue minerals) present. As a general rule, the grade of phosphate rock mined from a single deposit will fall over time and, concomitantly, mining costs will increase. This is because it makes economic sense to mine the lowest cost portion of the phosphate ore body first – which is typically the highest grade rock with the least amount of overburden closest to the processing plant.

The grade of mined and processed phosphate rock is traditionally quoted on a 'bone phosphate of lime' (BPL) basis. BPL expresses grade in terms of equivalent tricalcium phosphate content (% $Ca_3(PO_4)_2$), and can be calculated from phosphate content (% P_2O_5) using a simple conversion factor (1% P_2O_5 = 2.1852 % BPL).

Grade is an important metric because a BPL above 68% (31% P_2O_5) is generally desirable for wet process phosphoric acid production, the principal end market for phosphate rock. This is not the only criterion, however, and acid production has a number of other important quality demands (Table 1).

Beneficiation is commonly used to remove deleterious impurities, most commonly silica, dolomite, calcite and clay, to produce a commercial, saleable rock concentrate suitable for phosphoric acid manufacture. Downstream acid plants can accept and tolerate some variation in feedstock quality as long as phosphate grade is above 28% P_2O_5. Some modern phosphoric acid plants have more stringent requirements and will only consume phosphate rock above a 31-32% grade threshold.

The three most critical criteria needed to make phosphate rock saleable are a high phosphate content, a low calcium/magnesium ratio (CaO:MgO <1.6) and a low magnesium content (MgO <1%). Low levels of iron

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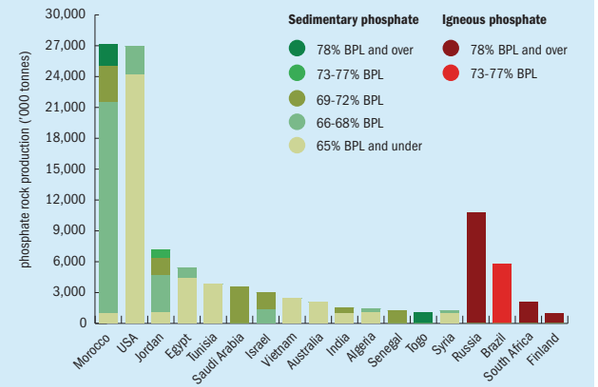
Fig 2: **Phosphate rock production by BPL grade category, excluding China, 2014**



Source: IFA

and aluminium (<2-3% Fe_2O_3 and Al_2O_3) are also valued, although contents of up to 5% can be tolerated by phosphoric acid plants. The presence of high levels of chloride (above 0.03%) can be worrisome as this causes increased stainless steel corrosion (Table 1).

Igneous versus sedimentary

Grades of phosphate rock vary widely between countries with Kazakhstan (21.2 % P_2O_5) at one end of the scale and Russia (35.6% P_2O_5) at the other (Figure 1). Although most of global production is from sedimentary marine phosphorite deposits, phosphate rock is mined from igneous sources by producers in Finland, Russia, Brazil and South Africa (*Fertilizer International*, 466 p66). Phosphate rock concentrates of igneous origin only account for around a tenth of total world production, but their purity (typically > 35% P_2O_5) places them at the high-grade end of the market.

Because of their different origin, the grade of phosphate rock supplied by Finland, Russia, Brazil and South Africa is roughly 4-7% higher than the average grade supplied by China, Morocco and the US, the world's top three producing countries.

Classifying world phosphate rock production by BPL category (Figure 2) confirms that the two highest grade categories of rock, 73-77% BPL (6.8 million tonnes) and 78% BPL and above (17.2 million tonnes), are mostly mined in Finland, Russia, Brazil and South Africa, largely from igneous deposits. High grade ore is not exclusively igneous in origin though. Other countries, particularly Morocco, Jordan and Israel, are capable of producing a wide range of different phosphate rock grades. Saudi Arabia, Senegal and Togo also produce relatively high-grade phosphate rock. The US, in contrast, is responsible for more than half the volume of rock in the 65% BPL and under category, and therefore emerges as the world's largest producer of relatively low-grade phosphate rock.

A link does exist between phosphate rock grade and premium pricing, as Kimberly Gustin, research manager at analysts Integer Research, explains: "Producers do in practice sell according to grade and expect to get a certain price. They also target production based on the amount of P_2O_5 in their rock. If grade is low, they may target the direct application phosphate rock (DAPR) market, for example, whereas if it's higher they may well sell as a feedstock for MAP and DAP production instead."

Are grades deteriorating?

Looking back at production since 2010, there is scant evidence of a systematic global decline in phosphate rock grade. Production levels for the highest and lowest BPL grade categories both dropped by 2-3% over the last four years, whilst production of moderate grade rock (66-68% BPL) increased by nearly 7% over this period (Figure 3).

However, warnings emerged last year that China's reserves of high-grade phosphate rock could be exhausted within 15 years at current levels of consumption[1]. These concerns were prompted by a report on China's phosphate supply chain by industry analysts China Chemicals Market (see box)[2]. The prospect of depleted reserves in China, currently the world's largest phosphate rock producer, is likely to trigger fresh anxieties about the availability of phosphate and productions costs over the long-term. However, such concerns are just the latest in a long line of phosphorus 'scarcity crises'.

At least five such crises have been identified stretching back to the 1870s, the most recent one occurring in 2010[3]. These supposed crises have generally led to highly polarised arguments about the extent of global reserves. However, past concerns over depletion have largely evaporated when fresh appraisals revealed reserves were much larger than originally thought.

Reserve and resource estimates are fluid and can change dramatically with the discovery of new deposits and better quality information on the extent of existing ones. Some industry observers even argue that worries over P scarcity are partly due to a lack of understanding about the dynamic nature of reserves and the reasons behind this[4].

Over the last six years, for example, USGS estimates of global phosphate rock reserves have increased four fold, changing from 16,000 million tonnes in 2010 to 65,000 million tonnes in 2011 – and stand at 67,000 million tonnes currently Much of the increase in reserves since 2010 is attributable to a large upward revision in Moroccan reserves from 5,700 to 51,000 million tonnes in the IFDC's landmark report on world phosphate resources[5].

China was also widely-thought to have relatively small phosphate production potential until around 12-13 years ago. The country's phosphate reserves prior to 2003 were estimated at just 210 million tonnes. Reserves were subsequently revised upwards to 6,600 million tonnes following the release of official data by the Chinese government, making Chinese reserves the world's largest for several years (Figure 4). The USGS has since revised Chinese reserves downwards to 3,700 million tonnes.

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Table 1: **Typical phosphate rock quality requirements for wet process phosphoric acid production**

Quality factor	Impact on wet process	Acceptable level
P_2O_5 grade	• Lower grades increase amount of rock that must be purchased, transported and crushed	• Phosphoric acid plants generally accept a wide range of P_2O_5 grades. BPL>68% is desirable
CaO:P_2O_5 ratio	• Higher ratios result in an increase in sulphuric acid consumption • CaO generally comes from carbonates such as calcite, dolomite and carbonate-rich apatite	• CaO:P_2O_5 ratio<1.6 is desirable
Dolomite (MgO)	• Mainly used to indicate dolomite ($CaMg(CO_3)_2$) levels • Dolomite increases sulphuric acid consumption and decreases filtration rates when filtering gypsum from the phosphoric acid product • Some amounts of MgO are also present due to ionic substitution of Mg within the francolite (carbonate-rich apatite) lattice	• MgO<1% desirable
Fe_2O_3 and Al_2O_3	• High amounts will decrease plant capacity and decrease P_2O_5 recovery • Small amounts are beneficial in reducing corrosiveness by complexing with fluoride ions	• Less than 2-3% is desirable • Up to 5% may be tolerated
Silica (SiO_2)	• High amounts will increase erosion of equipment and may build up in vessels • Adds to the amount filtered with the solid gypsum dihydrate • Some active silica is beneficial by reducing the formation of hydrofluoric acid	• Phosphate concentrates average around 2% SiO_2
Organics	• Increases the amount and stability of foam • Increases fluid viscosity, resulting in slower filtration rates • Phosphate ores high in organic matter can be calcined to reach acceptable levels	• Maximum amounts vary depending on characteristics of organic matter
Chlorides (Cl)	• High chlorine levels can increase corrosion of equipment	• Concentrations above 0.03% increase corrosion of stainless steel • Higher-quality alloys can handle concentrations around 0.1%
Sodium and potassium (Na and K)	• Often present as fluorides • Can cause scaling, corrosion and precipitation	• Typical phosphate concentrate contains 0.1-0.8% Na_2O
Cadmium (Cd)	• No noticable adverse effects on phosphoric acid production • Cd is toxic and hazardous to human health • The amount of Cd in the food chain from phosphate fertilizer is the subject of debate, and a few countries have set limits	• Netherlands has Cd limit of 15mg Cd/kg P_2O_5

Source: SME

Some researchers are concerned about the recent variability in reserve estimates and are pressing for more transparent, comparable, reliable, and credible data on world reserves[6]. Others in the industry find it understandable that large, resource-hungry countries such as China, which view phosphorus as a vital strategic mineral, are reluctant when it comes to reserves disclosure.

"It becomes less and less likely that the major phosphate rock producers will disclose their hands, especially where the production base is financed through the world's stock exchanges or belongs to state-owned companies which are principally interested in food security or national self-sufficiency," comments Aleff Group's Julian Hilton.

Grade, costs and prices

Any decline in phosphate rock grade will reduce production yield and will also raise costs if more processing is necessary to remove impurities. Yet, contrary to a general belief that the lowest cost and highest grade phosphate ore has already been mined, average global phosphate rock production costs have fallen substantially in real terms over the last three decades[7]. Whilst it is true that average mining and beneficiation costs have increased by 27% in cash terms, from $30/t f.o.b. in 1983 to $38/t f.o.b. by 2013, this actually translates to a $22/t fall in real terms, once 1983 costs are adjusted for 2013 prices ($60/t).

Production costs have undoubtedly risen in parts of the world. In Florida, for example, deteriorating grades, longer pumping distances from mine to plant, and increased expenditure on wages, utilities and fuel, have all contributed to higher industry costs. Why, then, have average global phosphate rock production costs fallen in real terms?

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Phosphate depletion in China

China's reserves of high-grade phosphate rock could be exhausted within 15 years at current rates of consumption. That is the stark warning in a recent report on the country's phosphate sector by analysts China Chemicals Market (CCM). It fears that rising Chinese phosphate industry costs will result in a severe loss of competitiveness unless action is taken on resource depletion[2].

Varying reserve estimates

China has phosphate reserves of around 17,800 million tonnes, estimates CCM. This is much higher than the current 3,700 million USGS estimate due to the inclusion of an extremely large volume of lower-grade (<25% P_2O_5) rock. CCM admits that only a small percentage of these reserves can be mined and concentrated commercially with current technology. CCM figures for higher-grade phosphate reserves in China (3,915 million tonnes above 25% P_2O_5) do correspond more closely with the USGS estimate

Chinese reserve figures have certainly varied significantly over the last 12-13 years. The USGS originally estimated China's reserves at 6,600 million tonnes but this was later downsized to 4,100 million tonnes in 2008, based on official information received, and then to 3,700 million tonnes subsequently. The latter figure is identical to the IFDC's estimate which dates from 2010. The IFDC also concluded that around 2,300 million tonnes of 'Grade I' ore (30% P_2O_5 and above) and 'Grade II' ore (24-30% P_2O_5) are the main focus of phosphate rock mining in China, commenting that "only a portion of this ore is likely to be recoverable".

The USGS estimate for Chinese rock phosphate remains the benchmark reserve figure currently. "Based on the P_2O_5 content and high MgO in Chinese rock, I would keep the estimate at 3,700 million tonnes – which is close to CCM's number for rock above 25% P_2O_5," suggests Stephen Jasinski, a minerals commodity specialist at the USGS.

Most of China's easily exploitable deposits have already been exhausted. Only 40% of its mines are now opencast and many of these are on sloping terrain, making extraction difficult. High-grade (≥30% P_2O_5) phosphate rock is at most risk of depletion, according to CCM, with only 1.7 billion tonnes remaining. The high levels of MgO present in more than 90% of the country's phosphate rock also affects yields and can be deleterious to the quality of downstream products.

"Although China's total phosphorus reserves are vast, the country's high-quality deposits are relatively small and will run out sooner rather than later," reports CCM.

Rising costs

There is risk that high-grade phosphate rock in China will be exhausted by 2030 if consumption continues at its current rate. Dramatic cost rises are predicted for China's phosphate mining sector and downstream industries – if this were allowed to happen. Any rise in costs would further undermine the competitiveness of China's phosphate sector relative to international competitors such as Morocco and Saudi Arabia.

Increased transport and labour costs are an inevitable consequence of the switch from opencast to underground mining. But it is declining phosphate rock grades that are likely to hit Chinese production costs the hardest. According to CCM, a 5% decrease in phosphate rock grade would double costs, from an average of $31/t at 28% P_2O_5 content to $73/t for 23% P_2O_5. Most of this projected rise is attributable to higher beneficiation costs. Froth flotation, which is widely-used for phosphate beneficiation in China, typically adds around $28/t to rock production costs.

Avoiding the consequences

Policies to prolong the life of China's high-grade phosphate rock reserves and more R&D funding for low-cost production techniques could help the country avoid the worst effects of mine depletion. Taxes on high-grade phosphate rock have already increased to $9.75/t in China accompanied by a cut in the tax on low-grade rock to $1.62/t.

Mining license restrictions are another way of limiting the extraction of high-grade phosphates, and are already in operation in Hubei, Hunan, Sichuan, Guizhou and Yunnan provinces. Such restrictions could be rolled out nationally and further strengthened by introducing mining quotas and mining zones. High export tariffs and export quotas for phosphate rock, or even an export ban, are the main other policy options for the Chinese government. ■

Table 2: **China's phosphate reserves, 2013**

Grade (% P_2O_5)	Reserves (million tonnes)	Reserves (%)	Estimated year of exhaustion	Production cost ($/t)
30% and above	1,660	9	2030	
25-30%	2,255	13	2049	30-56
20-25%	2,730	15	2068	65-85
15-20%	6,010	34	2103	
10-15%	2,190	12	2114	
5-10%	480	3	2117	
2-5%	2,440	14	2127	
Total	**17,765**			

Source: CCM/Industrial Minerals

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Fig 3: **World production by grade, 2010-2014**

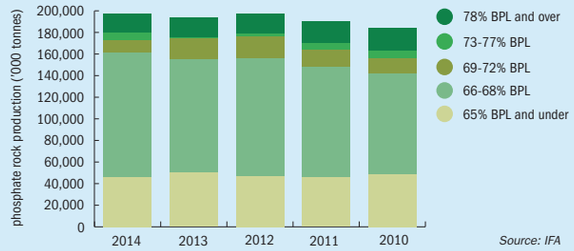
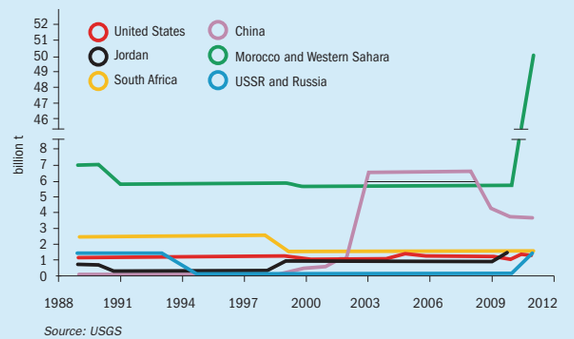


Fig 4: **Phosphate rock reserve estimates for select countries from 1989-2011**



"The influence of these Florida mines with rising costs is waning," explains Michael Mew, principal consultant at analysts CRU. "Falling US phosphate rock capacity has been offset by increased output from China – where costs are generally lower."

Mew also doubts whether the 27% increase in the cash cost of rock production has influenced market prices to any great extent. "Phosphate market prices rise and fall as a result of changing market supply/demand dynamics. However, cash production costs do provide a theoretical floor for market pricing – and is important in determining the longer-term path of market pricing."

Site costs versus business costs

CRU breaks down phosphate rock production costs into two cost components. The first of these, 'site costs', covers consumables, energy, labour and raw materials. Average site costs dropped below $40/t at the end of last year due to the sharp fall in energy prices, although they can range from $25-60/t depending on the producer.

The other cost component is termed 'business costs'. This measures the value of phosphate rock in the end-use market, partly by taking account of freight cost variations, itself a reflection of the different distances between mining sites and key market destinations. It also factors in pricing discounts or premiums caused by differences in rock quality.

Analysing phosphate production costs in this way reveals that "US and Russian producers are very competitive", according to CRU, because proximity to market and low freight costs keeps their business costs down to around $20-30/t.

China, interestingly, is at the other end of the spectrum with business costs of around $105-125/t. "China's low-quality rock and high transport costs… mean that modest site costs are undermined by business cost disadvantages that leaves them uncompetitive in the international market," says Daniel Solomon, CRU's fertilizer pricing analyst.

> **"Today's tailings pile is tomorrow's reserve, given new technology.**

New technologies, improving resource efficiency

Future innovations in mineral processing could expand the current global reserve base by driving-down what is commercially-acceptable as a phosphate rock grade, according to Aleff Group's Julian Hilton. "New technologies are rapidly emerging for processing lower value ores. Hence, regarding a BPL value of 70 as the standard for selling phosphate rock on the commodity market is likely to fall in future, perhaps even into the 50s."

Similarly, CRU's Michael Mew suggests that JDC Phosphate's attempts to commercialise the new Improved Hard Process (*Fertilizer International*, 465 p51) also holds out the hope that "today's tailings pile is tomorrow's reserve, given new technology". ■

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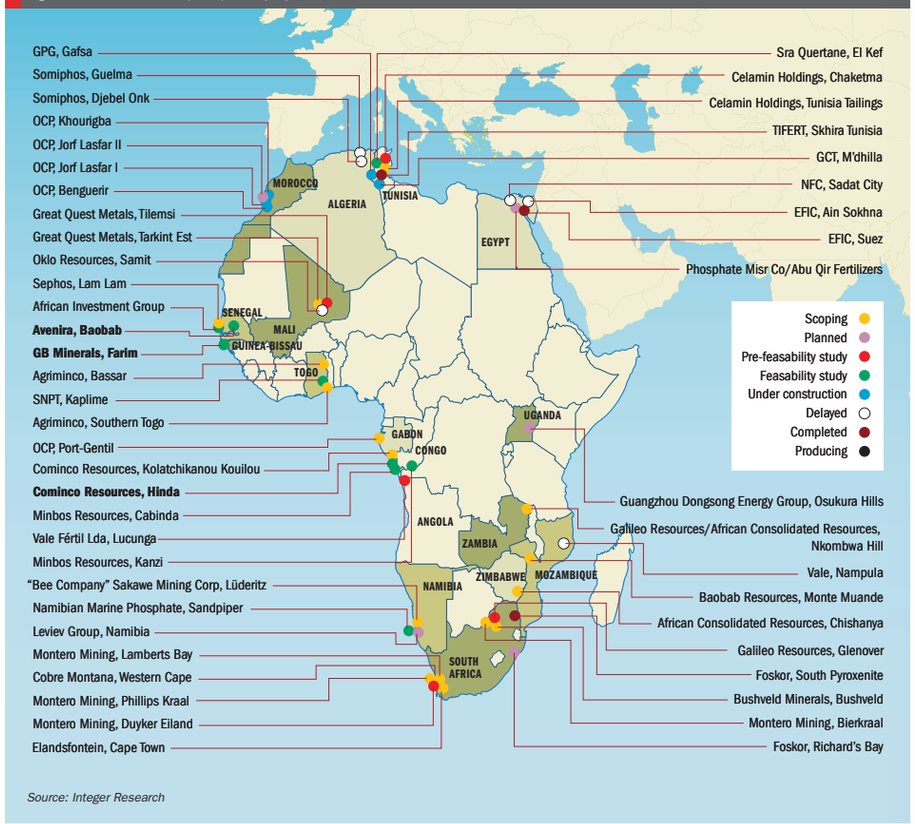
West Africa's vanguard phosphate ventures

More than thirty phosphate mining projects are currently under development in Sub-Saharan Africa. West Africa is already a major phosphate rock producer and it is in this region – in Senegal, Togo, Guinea-Bissau and the Republic of Congo – where the next crop of African phosphate projects looks likely to reach fruition.

Fig 1: **Selected African phosphate projects**



Source: Integer Research

Morocco's OCP is the dominant phosphate industry presence on the African continent and is continuing to invest and expand its activities on an impressive scale. The company expects to have added ten million tonnes of phosphate mining capacity and 1.8 million tonnes of fertilizer capacity by the end of this year, as it completes the first phase of its $16 billion 2008-2025 investment programme. The completion of these investments and the company's achievements to date will be the subject of an OCP special feature in our May/June issue.

Elsewhere in North Africa, recent developments at Misr Phosphate's El Wady project in Egypt were a hot topic at February's Arab Fertilizer Association (AFA) Forum in Cairo. But it is in Sub-Saharan Africa, particularly a cluster of relatively small states on West Africa's Atlantic coast, where governments, investors and junior mining companies have been especially active over the last 12 months.

West Africa advances

Africa has become a hotspot for junior phosphate miners in recent times, to the extent that the continent arguably boasts the largest number of prospective phosphate projects of any region globally (Figure 1). How many of these numerous ventures will ever come to fruition is debatable, given their varying degrees of attractiveness – in terms of project fundamentals, geography, local business environment and political stability.

Unsurprisingly, the weak investment potential of some phosphate projects, and the inhospitable financing climate for mining juniors, means many have stalled since our previous assessment of the region's phosphate resources in 2013 (*Fertilizer International*, 454 p62).

Instead, real progress and substantial investment in Sub-Saharan Africa over the last year has been largely restricted to a handful of phosphate ventures in Togo, Guinea-Bissau, Senegal and the Republic of Congo.

ICS revamp, Senegal

Developments in Senegal over the last two years exemplify West Africa's advance as a phosphate producing region. Senegal's turnaround started when Indonesia's Indorama Group bought a majority stake in Industries Chimiques du Senegal (ICS) in August 2014, with a promise to invest $226 million in the struggling Senegalese phosphates producer.

Indorama, which bought its stake from Archean Group, currently owns 78% of ICS, whilst Indian co-operative IFFCO retains a 7% share. Senegalese phosphate and phosphoric acid production is largely targeted at the Indian market. IFFCO stepped-in to recapitalise ICS in 2009 to help secure supplies to India and ease the company's financially woes. However, ICS's production never rose above 50% of capacity subsequently, despite this intervention.

Indorama's main priority in 2014, therefore, was to return ICS to full production capacity by throttling in investment over a 14 to 20 month period. Around $100 million was initially spent refurbishing ICS's phosphate mine at Taiba, 100 km from the capital Dakar, as well as two phosphoric acid plants at nearby Darou, and its Mbao fertiliser production site on the outskirts of Dakar. Debt owed to subcontractors was also cleared as part of plans to boost production.

Indorama's investment seems to be paying-off. The output of Taiba mine, for example, is said to be running at 3,500 t/d currently, and phosphoric acid production at Darou has reportedly doubled to 2,030 t/d.

ICS has the capacity to produce 300,000 t/a of fertilisers, greater than current Senegalese demand. Plans for a second plant at Mbao could see its fertiliser production capability eventually rise to one million t/a. Such an expansion would enable ICS to ramp-up fertilizer exports to the Economic Community of West African States (ECOWAS) and the rest of the continent.

Baobab project, Senegal

Senegal's phosphate reserves of 50 million tonnes are the largest in West Africa, based on current USGS estimates. The country produced 1.3 million tonnes of phosphate rock (average 32.5% P_2O_5) in 2014, two-fifths of which (536,000 tonnes) went for export. Encouragingly, Senegalese phosphate rock exports rose to 300,000 tonnes in the first half of 2015, a 36% year-on-year rise, according to the latest trade statistics.

Senegalese annual phosphate production could soon be boosted by a further half a million tonnes after Australian developer Avenira Ltd, formerly Minemakers, gained final government approval for its Baobab phosphate mine project last November.

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Production from the mine, located 145 km east of the port of Dakar, could start as early as July and eventually ramp-up to 500,000 t/a.

The project is now fully funded to production, according to Avenira. Available finance includes $12 million of existing Avenira cash and $3.1 million from a recent share issue. Senegalese partner, Mimran Natural Resources, will also directly invest $11 million in return for a 20% stake in the project under a binding deal agreed in January.

Avenira's small mine permit, granted last May, allows unlimited mining within a 5 km^2 area of the Gadde Bissik East concession. Indicated and inferred mineral resources within the permit were recently updated to 12.6 million tonnes (21.0% P_2O_5) and 16 million tonnes (20% P_2O_5), respectively.

The Baobab project was originally launched by fertilizer project developer Agrifos in 2011. Avenira joined the project in 2014 and acquired 100% of the project from Agrifos last autumn. Avenira and Agrifos, through its subsidiary Vulcan Phosphates, are also co-investors in JDC Phosphates, a firm set up to commercialise phosphoric acid production by the Improved Hard Process (IHP). Avenira obtained an exclusive IHP technology license for Senegal as part of the Agrifos buy-out.

Kpeme project, Togo

Moves to secure private investment in Togo's phosphate mining and downstream sector took a major step forward last September after the Togo government awarded a tender to develop a $1.4 billion phosphate complex in the country. The tender for the Kpeme project was won by a consortium led by Elenilto, a mining, oil and gas group controlled by the Israeli billionaire Jacob Engel. Highly-experienced Chinese phosphate producer Wengfu is also participating in the consortium as a strategic partner to Elenilto, and is expected to part-finance the project.

The complex will produce 3 million t/a of rock concentrate, 500,000 t/a of phosphoric acid and 1.3 million t/a of phosphate fertilizers products, according to Elenilto, and could begin making sales within three years.

Elenilto will use economies of scale and cheap natural gas sourced from the West Africa Gas Pipeline (WAGP) to keep production costs low. The short 30 km distance between the complex and its Atlantic coast port also confers cost advantages.

"Elenilto has identified the local market shortage and demand for fertilizers products, and shall supply phosphate, fertilizers and phosphoric acid to Africa and the international market," commented Alon Avadani, CEO of Elenilto. "The fertilizers project is the first and the biggest of its kind in West Africa and shall enjoy relative low operating expenses due to the availability of gas from the WAGP, the close proximity to the port and the size of project."

Hopes will be high that the award of the Kpeme tender will mark a turnaround moment for Togo's economy and return the country's phosphate production to the three million t/a levels of the 1990s. The lucrative 30-year concession secured by the Elenilto consortium could ultimately generate tens of billion of dollars in revenues and create a thousand new jobs.

Togo possesses world-class phosphate reserves of 30 million tonnes (USGS estimate) and remains one of the world's largest producers, supplying 1.1 million of high-grade (36% P_2O_5) phosphate rock in 2014. Phosphate mining is of strategic importance to Togo's economy with overseas shipments generating a significant slice of the country's export earning. Phosphates accounted for 27% of Togo's export revenues in 2013 ($49 million), down from 47% of total exports in 2012 ($97 million) due to international price falls.

Togo's phosphate mines were privatised in 2001 only to be renationalised as the Société Nouvelle des Phosphates du Togo (SNPT) six years later. SNPT's mining and production operations, located in Hahotoe, 35 km east of the country's capital, Lome, employ around 5,000 workers. The state-owned firm launched a $150 million investment programme in 2010.

Togo's phosphate rock production was originally forecast to reach 1.5 million tonnes in 2015, with phosphate exports earnings expected to hit $163 million for the year. However, rock output actually dropped 9% year-on-year to 521,600 tonnes between January and June 2015 due to strike action, with exports showing an even steeper 18% fall over this period, according to SNPT.

Farim project, Guinea-Bissau

Canada's GB Minerals Ltd plans to start producing phosphate rock from its $194 million Farim project in Guinea-Bissau within two years. Detailed plans for a 1.75 million t/a phosphate mine were unveiled in a feasibility study for the project last November. Highlights of the study included:

- Proven high-grade (30% average P_2O_5) mine reserves of 44 million tonnes, sufficient for a 25 year mine life
- Measured and indicated resources of 105.6 million tonnes (28.4% P_2O_5 grade) and inferred resources of 37.6 million tonnes (27.7% P_2O_5)
- Capex investment requirement of $194 million and Opex production costs of $52/t
- Project net present value (NPV) at 10% of $497 million
- Internal rate of return (IRR) of 34.5% after tax

The Farim project is edging closer to the construction. The award of an engineering, procurement, construction and management (EPCM) contract for the project is expected by the end of March. Site clearance and preparation work is also due to start once the rainy season ends. The phosphate mine complex will be commissioned within 19 months of the start of detailed engineering, under the current project timetable.

GB Minerals also completed pilot tests for phosphoric acid and diammonium phosphate (DAP) production in January. Merchant grade (50-52% P_2O_5) phosphoric acid and DAP were successfully obtained from Farim phosphate rock.

"The successful phosphoric acid and DAP tests clearly demonstrate the viability of the Farim project and further support our belief that the Farim phosphate deposit is one of the highest quality in the world," said Luis da Silva, GB Minerals CEO, adding: "The company is in active discussions with multiple parties for key offtake agreements and we hope to start updating shareholders on these discussions."

GB Minerals says it is currently "striving towards" financing the project through a combination of debt and equity. The firm is also channelling a recent $729,000 advance from one of its shareholders, A.B. Aterra Resources Limited, into project development.

Hinda project, Republic of Congo

The Hinda phosphate project in Republic of Congo (ROC) has taken some important steps forward over the past 12 months. Project owners, Cominco Resources Ltd, showcased its ambitious plans to develop the ROC's phosphate resources at last spring's 'Phosphates 2015' conference in Tampa (*Fertilizer International*, 466 p60) and followed this up by releasing a definitive feasibility study (DFS) for the Hinda project over the summer.

Cominco's plans involve mining 20 million t/a of ore at Hinda, located in the Atlantic coastal province of Kouilou, and upgrading this on-site to 4.1 million t/a of saleable phosphate rock (32% P_2O_5), using reverse froth flotation to remove carbonate and silica. Transporting the rock concentrate obtained to an export facility at Point Indienne on the Atlantic coast will require the construction of a 42 km slurry pipeline. The project's DFS revealed:

- Proven and probable ore reserves of 404.9 million tonnes (11% P_2O_5) sufficient for a mine life of 24 years
- Measured and indicated resource of 581.5 million tonnes (10.4% P_2O_5)
- Capital costs of $601 million and production costs of $35.6/t for first five years
- Project net present value (NPV) after tax of $1.87 billion
- Internal rate of return (IRR) of 38% after tax
- Payback on development cost within five years

Cominco describes Hinda as one of the world's largest and deepest undeveloped phosphate deposits, based on its average 60 m thickness and its continuous extent over a 20 km distance. The project is now moving into the front end engineering design (FEED) phase. Construction should start this year, possibly before the end of March, with production commencing 24 months later, according to the latest update from Cominco.

Looking probable

West Africa is continuing to advance as a phosphate rock producing region with a range of new ventures currently under way in Senegal, Togo, Guinea-Bissau and the ROC. On balance, the projects and production expansions described above are more likely than not to come to fruition over the next three to four years.

Avenira's Baobab project in Senegal is fully funded, for example, and the start of construction looks imminent. The chances of Cominco's Hinda project in the ROC being commissioned are rated as probable by analysts CRU. GB Minerals' Farim project in Guinea-Bissau and Elenilto's Kpeme project in Togo are both listed in Integer Research's current base-case for phosphate projects. The base-case includes projects considered to be firm, together with those not yet finalised but with strong credentials, and is the scenario most likely to occur in Integer's view.

Consequently, the region looks set to play a greater role in the international phosphate rock trade in future, predicts CRU: "Notably, most if not all of the new operations in West Africa do not have integrated phosphoric acid or downstream production. If all of these projects and planned production increases all go ahead, West Africa is set to become a much larger exporter of phosphate rock by the end of the decade."

Others are more sceptical. "The market price of rock phosphate is at its lowest level since 2007 and no one is sure that it will rise significantly," Imad Bouziane, a vice president at Nitron Group, said recently. "Under these conditions, investments carry a lot more risk and investors are reluctant to follow through."

He added: "Given the current market situation, the production costs of the Farim project in Guinea-Bissau remain, from my point of view, high. The same holds true for Togo, where the layer of phosphate targeted… is deep and expensive to extract."

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