Number 470

January | February 2016

Fertilizer INTERNATIONAL

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Fertilizer demand to rebound?

market

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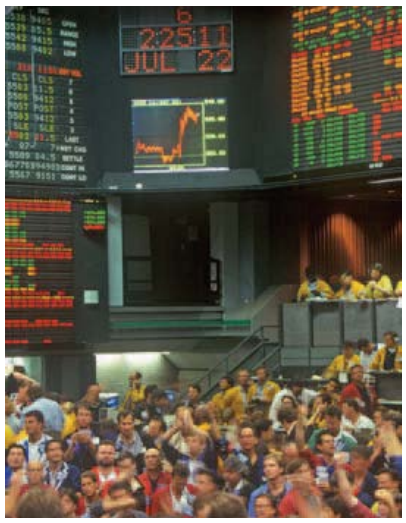

Cover: *The trading floor at the Chicago Mercantile Exchange. Joseph Sohm/Shutterstock.com*

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BCInsight

INTERNATIONAL Fertilizer

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REGULARS

Not just another year

“The rapidly worsening global economic outlook means that forecasts made as recently as last December are starting to look overoptimistic.

As one year ends and another begins, the start of January is traditionally a time to look forward as well as to reflect.

It’s therefore entirely natural that our first issue of the year looks back on 2015 and looks forward to the year ahead.

Some surprises emerged during our review of the phosphates market with Mike Rahm of the Mosaic Company (p43). Brazil clearly disappointed on the demand side in 2015, whilst China’s exports reached new heights – both developments confounding the predictions of a year ago.

We also take a look in this issue at the general prospects for the fertilizer industry in 2016, particularly the outlook for demand and supply (p18). Interestingly, the International Fertilizer Association (IFA) remains bullish about a revival in demand this year. “We see growth at 1.9 to 2 percent,” Abdulrahman Jawahery, IFA’s president, told the *Financial Times* in December.

Wisely, IFA always attaches health warnings to such pronouncements. Macroeconomic conditions, in particular, are a major downside risk in 2016, in its view.

The rapidly worsening global economic outlook means that forecasts made as recently as last December are starting to look overoptimistic. Mounting bad news over the emerging economies and further bouts of stock market volatility, currency devaluation and commodity price falls hardly engender confidence.

Regardless of short term economic fortunes, the fertilizer industry will undoubtedly still have a lot to celebrate in 2016. IFA expects a remarkable 100 new industry production units and expansion projects to be completed during 2015 and 2016 combined.

Our 2016 editorial programme also confirms that some striking, landmark achievements are expected over the next twelve months. This will certainly be a year when a number of major engineering projects – itself a testament to a massive investment in production – finally come to fruition.

Our May/June issue will cover one such remarkable engineering feat, the Mosaic Company’s giant New Wales sulphur melter. Its arrival will profoundly alter how sulphur is supplied and traded in North America and beyond.

In the same issue, we will also look at the progress of OCP’s $16 billion expansion programme in Morocco. Ten million tonnes of extra mining capacity and two million tonnes of additional fertilizer capacity are scheduled for completion by the year’s end, as part of OCP’s phase one plans.

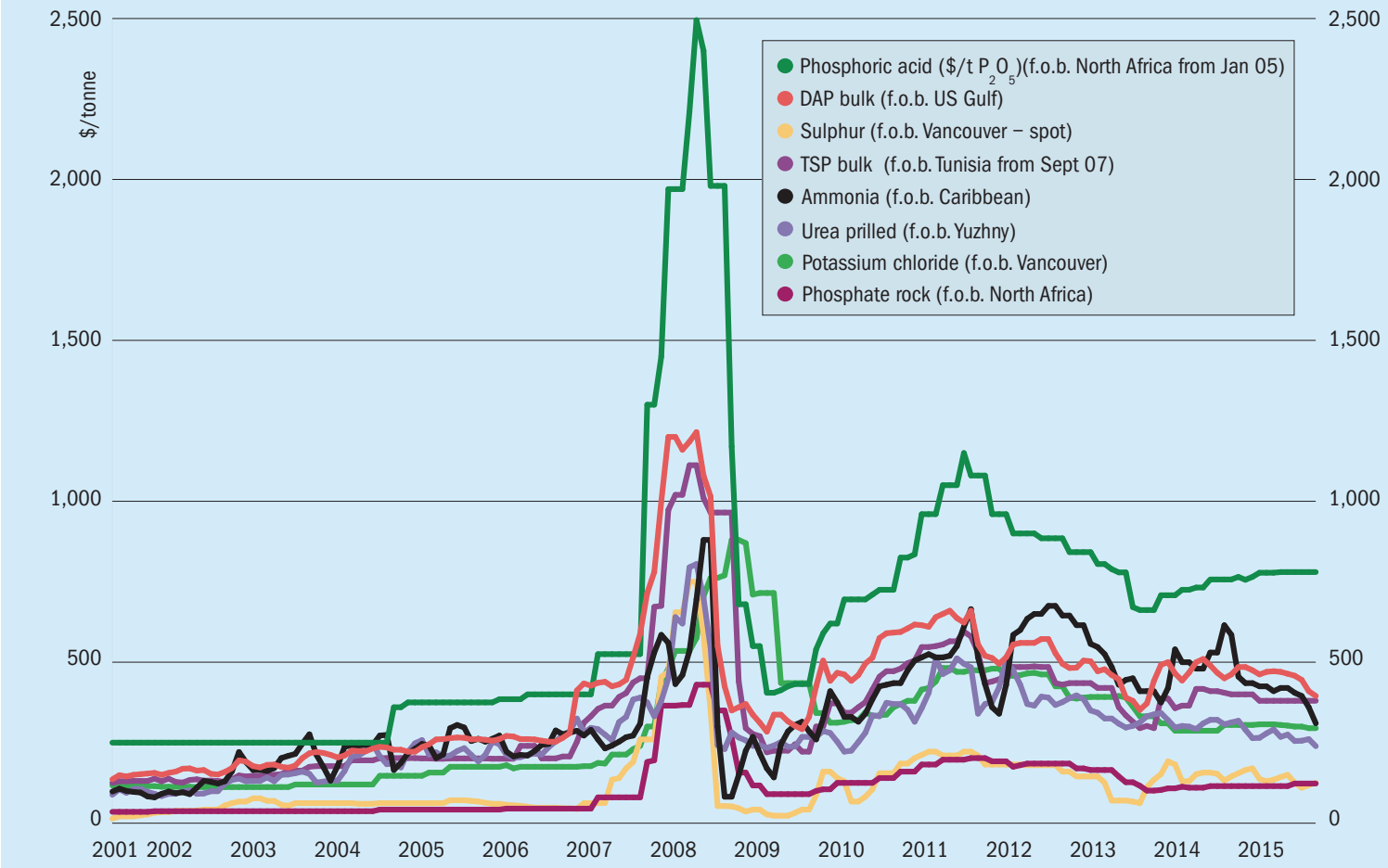
Not to be outdone, Ma’aden’s Wa’ad Al-Shamal joint venture should be commissioned in the second half of this year, and will be featured in our July/August issue. What is most striking is the staggering scale of production being developed by Ma’aden and its partners in Saudi Arabia. The Wa’ad Al-Shamal complex notably includes a 4.9 million t/a sulphuric acid plant, a 1.5 million t/a phosphoric acid plant and a 5.3 million t/a beneficiation plant.

Our September/October issue will also cover the expected commissioning of K+S’s Legacy solution mine, Canada’s largest mining venture and a vital flagship project for the company. K+S is confident that its huge capital investment in Legacy will turn into lucrative cashflow over the next few years, as Burkhard Lohr, its chief financial officer, makes clear in our profile of K+S (p48).

What all these projects demonstrate – regardless of the stiffening economic headwinds – is the industry’s long-term strategic focus, its commitment to investment and its talent for managing complex engineering ventures. Their successful completion will be a cause for celebration and should make 2016 a truly remarkable year. ■

Market outlook

Historical price trends $/tonne



Source: BCInsight

Market insight courtesy of Integer Research

AMMONIA

The start of 2016 saw a continuation of the fall in ammonia prices which began in mid-October 2015. Yuzhny ammonia prices fell to $275/t in late December and early January, the lowest levels since early 2010 and almost $200/t down on a year ago. Producers are restricting supply in a bid to halt further falls – most notably Ukrainian producer OPZ, which decided to take one of its two ammonia units offline to cut regional availability. The firm is not expected to restart this unit until prices exceed $300/t. Demand has been generally bearish. One exception was the late December award of a purchase tender by FACT in India for early January delivery.

UREA

A downbeat mood prevailed as the global urea market entered 2016, with prices under extreme pressure and no immediate signs of improvement on the horizon. In early January, Black Sea prices hit their lowest level since June 2010 at $230/t f.o.b., with other benchmarks following a similar trend. The combined impact of oversupply and low crude oil prices have been further aggravated by weakening global demand in the last quarter of 2015. Worsening economic conditions and currency devaluations in China have placed additional pressure on prices.

PHOSPHATES

The last two months of 2015 saw continuing phosphate market weakness. The price of OCP's last 2015 phosphoric acid delivery to India, at $715/t cfr, was some $95/t lower than its preceding contract, for example. The recent commissioning of IFFCO and JPMC's new phosphoric acid plant in Eshidiya, Jordan, was also a factor, as the plant's 200,000 t/a of new capacity competes directly with OCP and other exporters of phosphoric acid to India. In Russia, Phosagro agreed a sulphur price contract for 2016-2020 with Gazprom in mid-December. This ended a dispute that had threatened to curtail Phosagro's MAP production by as much as 72,000 tonnes.

POTASH

Global potash prices have continued to come under pressure, with further weakness in spot market pricing in recent weeks. The Brazil granular MOP price has now fallen below the symbolic $300/t cfr threshold to $275-285/t cfr, whilst Southeast Asian MOP is currently priced at around $285-305/t cfr. Those purchasing under annual contracts, namely China and India, are paying the highest market prices currently. Some Indian buyers have, however, managed to secure discounts of $15-20/t for final volumes being shipped under contracts running until the end of

March. This would bring prices down to $312-317/t cfr India, broadly in line with China's pricing ($315/t cfr) and closer to international market levels. Market weakness has persisted despite the return to supply management by Mosaic, PotashCorp and Belaruskali during the final months of 2015. That said, 2015 is still set to be the second highest year for potash demand after 2014.

SULPHUR

Global sulphur prices have held stable to firm over the past month, despite the lack of support from the downstream phosphates market. The sulphur market entered the New Year sluggish with signs of waning. Middle East producers dropped prices for January contracts as the market slowed and buyers retreated to the sidelines. In the UAE, Adnoc posted its monthly price at $112/t f.o.b., while Tasweeq also announced at $119/t f.o.b. for exports out of Ras Laffan. Spot prices in China dropped to $128-134/t cfr at the end of 2015 on the back of weak demand. Sinopec has also been cutting offer prices in the domestic market. In Russia, Gazprom signed a five-year supply contract for molten sulphur with Phosagro based on market prices. ■

Market price summary $/tonne – Early-January 2016

Nitrogen	Ammonia	Urea	Ammonium Sulphate	Phosphates	DAP	TSP	Phosphoric Acid
f.o.b. Caribbean	310	n.m.	f.o.b. E. Europe 110-115	f.o.b. US Gulf	390-400	n.m	n.m
f.o.b. Yuzhny	260-270	230-232	-	f.o.b. N. Africa	445-450	355	670-840
f.o.b. Middle East	340-350	204-225**	-	cfr India	400-405	-	715*
Potash	KCl Standard	K_2SO_4	**Sulphuric Acid**		**Sulphur**		
f.o.b. Vancouver	280-310	-	cfr US Gulf	40-50	f.o.b. Vancouver	123-127	
f.o.b. Middle East	275-315	-			f.o.b. Arab Gulf	119-128	
f.o.b. Western Europe	-	€490-520			cfr North Africa	100-115	
f.o.b. FSU	263-306				cfr India	140-145+	

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:** No immediate relief is in sight for the increasingly distressed ammonia market, and prices are not expected to rebound until late February or early March. Stimulus to the market is most likely to come from the US, where demand is expected to increase ahead of the spring application season. This may help correct a global market where the ammonia balance is increasingly heading towards a heavy supply overhang. Elsewhere, weak demand is expected to continue until February at least, for example in South Korea where no new volumes are expected prior to this.
- **Urea outlook:** Things are likely to get worse in the urea market before they get better, as demand is not expected to improve significantly in the first two months of 2016. Spring demand in the US, and expectations that India could issue a new purchase tender in either March or April, are likely to be the first signs of improvement, and should start to relieve pressure on prices. Also, any further price falls in January and February are likely to incentivise buyers who have been cautious to return to the market so far this year.
- **Phosphates outlook:** The decision to continue with China's flat export tax on finished phosphates in 2016 should encourage Chinese producers to export throughout the year. The ending of phosphoric acid taxation should also make China more competitive internationally, although newly-commissioned phosphoric acid capacity from JPMC/IFFCO will increase export competition into India. In Brazil, low fertilizer inventories and the stimulus to agricultural exports from the weak Real should increase demand for MAP and help support prices going forward.
- **Potash outlook:** Progress on a Chinese contract settlement for 2016 is unlikely before February at the earliest. Other markets are therefore likely to refrain from buying in anticipation of a lower benchmark in China, which could dip below $300/t cfr. Restocking is expected in many key markets this year – although this will ultimately depend on macroeconomic conditions and crop prices. There is a mixed view on 2016 North American demand, as crop prices remain weak and farmer margins constrained, although spring sowing conditions are likely to kick in early. After a disappointing 2015, Brazil's volumes could well rebound this year, possibly approaching the record 9 million tonnes levels seen in 2014. Prices, on the other hand, are expected to remain under pressure due to intense competition.
- **Sulphur outlook:** The impact of fresh supply and export availability from the Middle East, and the ability of markets to absorb these, will be closely watched in 2016. North Africa will be a key outlet due to the ramp-up of OCP's processed phosphates capacity. However, demand from downstream phosphates has been weak and may limit the upside to the market. Continuing weakness in commodity markets is also weighing on the outlook, as oil, metals and fertilizer prices all remain in a lull. Expectations on sulphur supply growth have also been downgraded due to the declining oil price and the pressure this places on high-energy cost producers, such as oilsands in Western Canada. The sulphur market is expected to remain stable to weak during the first quarter of the year. Activity in China could potentially provide a floor to the market, should trade and restocking in China improve ahead of the spring season. ■

Fertilizer Industry News

PHOTO: BBC WORLD SERVICE

UNITED KINGDOM

ICL's Boulby mine to switch from potash to polyhalite

ICL is to phase-out potash mining at its Boulby mine in the UK by 2018 and develop the site as a polyhalite mine instead.

Around 220 of the company's employees and 140 contractors are expected to lose there jobs as part of ICL's restructuring of UK operations announced on 12 November last year. The main reason for the restructuring was "the reduction in the level of economically-feasible potash reserves at Boulby", ICL said in a statement.

Geological problems have thwarted ICL's plans to boost Boulby's potash production to three million t/a. Potash reserves at Boulby were downgraded from 16-17 million tonnes to 7.5 million tonnes last September, after the problems emerged.

"The reality of our potash reserves running out by 2018 means that we must develop a new business strategy if we are to continue mining at Boulby," said Peter Smith, ICL's executive vice president for potash. "That strategy is based on moving our focus to *Polysulphate*™ production."

To help guarantee Boulby's future, Smith announced significant new infrastructure investment to increase polyhalite production capacity at the mine to one million t/a by 2020.

"We will invest £20 million this year in the site infrastructure, with a potential investment of a further £20 million that would enable us to expand production from an estimated 150,000 tonnes this year to one million tonnes by 2020, with a long-term potential for up to three million tonnes," said Smith. "In addition we are carrying out a feasibility study into building a granulation plant at a cost of approximately £40 million."

Smith said the Boulby mine was "in a strong position" as the site is the only producer of polyhalite currently, but confirmed that employment levels were unlikely to return to past levels, even when the switchover to polyhalite production was completed.

ICL's UK operations made a loss in the third quarter of 2013 and throughout 2014. Smith admitted that the deterioration of potash prices throughout 2015 had also affected the financial viability of its business in the UK. Boulby Mine's operator, Cleveland Potash, has been a subsidiary of ICL since 2002. ■

BRAZIL

Anglo American confirms sale of its phosphates business

Anglo American is seeking a buyer for its Brazilian phosphates and niobium business. The mining giant announced the sell-off on the 8 December, confirming earlier rumours about the disposal of its phosphate assets (*Fertilizer International*, 469 p10).

Anglo American's Brazilian operations produced around half a million tonnes of phosphate in the first half of last year, generating a $52 million operating profit. Their sale forms a minor part of a massive restructuring and $3.7 billion cost-cutting programme, instigated by Anglo American in response to the commodities price collapse last year.

The mining multinational plans to cut its workforce by almost two-thirds and slim down its operations from six to three business units covering diamonds, industrial metals and bulk commodities.

"While we have continued to deliver our business restructuring and performance objectives across the board, the severity of commodity price deterioration requires bolder action," Mark Cutifani, Anglo American's CEO, said in a statement to investors. "We will set out the detail of the future portfolio in February."

The planned restructuring should deliver "a resilient Anglo American" and bring about "a step change in the transformation of the company", according to Cutifani.

GERMANY

K+S granted temporary wastewater disposal permit

K+S KALI GmbH will be able to continue to inject saline wastewater at its Werra plant until the end of this year, after being granted temporary permission by Kassel Regional Council.

However, the council has capped the injection of wastewater at the company's

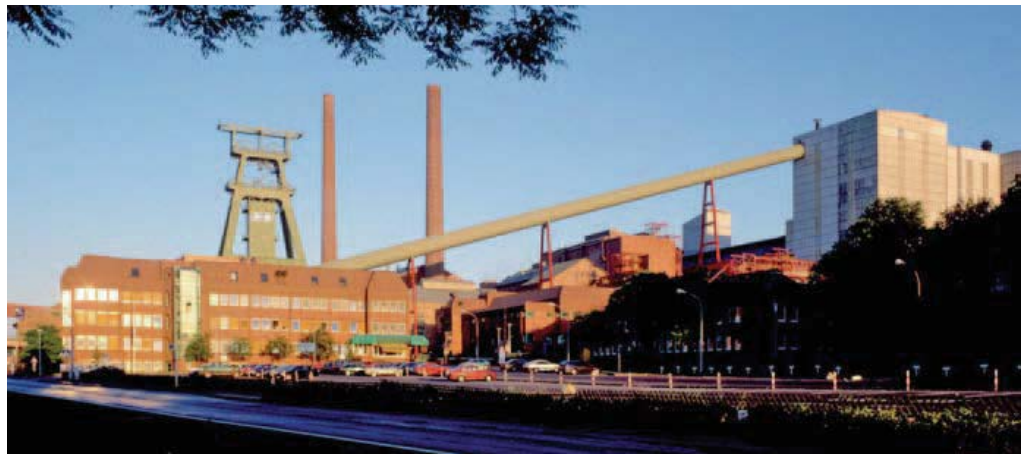


PHOTO: K+S AKTIENGESELLSCHAFT

The Werra plant is K+S KALI GmbH's largest.

Hattorf site at a maximum volume of 120,000 cubic metres per month. The temporary permission was also granted on the basis of an annual injected volume of 725,000 cubic metres.

K+S is seeking permission to inject up to two million cubic metres per year (down from 4.5 million cubic metres annually previously) into an underground dolomite layer until the end of 2021. The council is still carrying out a technical assessment of saline disposal methods used by K+S and is expected to make a final decision on the renewal of the wastewater permit over the summer.

"The very limited continuation of injection is a step in the right direction," K+S managing director, Ralf Diekmann, said. "Nonetheless, until the final decision regarding our injection application, we will have to continue to align production and disposal of the saline wastewater [resulting] from our operations to the water flow of the Werra river."

K+S looked at the option of discharging saline wastewater into the Werra river at the beginning of December but decided to temporarily cease production at its Hattorf and Unterbreizbach sites for several weeks instead. K+S said in November that its earning would "probably not" be affected by current wastewater permitting issues.

RUSSIA

EuroChem secures €0.6bn for Kingisepp ammonia plant

A group of five banks have agreed to finance EuroChem's one million t/a Kingisepp ammonia plant. EuroChem announced the signing of a €557 million loan agreement with Crédit Agricole, HSBC, ING, Société Générale and UniCredit Bank Austria on the 29 December.

Construction of the €900 million Kingisepp plant, located next to EuroChem's existing Phosphorit phosphate plant in Russia, began late last year (*Fertilizer International*, 468 p 12). Maire Tecnimont is building the plant, having secured a €660 million EPC contract for the project last summer (*Fertilizer International*, 467 p12). Kingisepp is expected to come on-stream in late 2018, and is one of five possible

ammonia projects being jointly planned by EuroChem and Maire Tecnimont (*Fertilizer International*, 366 p14).

"This milestone facility secures long-term funding for one of the Group's most strategically important projects, while the non-recourse nature of the facility preserves the Group's borrowing flexibility," commented Alexander Gavrilov, EuroChem's deputy finance director.

SAUDI ARABIA

Extra $1bn for Wa'ad Al-Shamal project

The Saudi Industrial Development Fund (SIDF) has agreed a package of four loans worth $1.07 billion (SAR 4 billion) for the Ma'aden Wa'ad Al-Shamal Phosphate Company, a subsidiary of Saudi Arabian mining company Ma'aden.

The loan package provides a fresh injection of finance for the Wa'ad Al-Shamal phosphate project, a joint venture between Ma'aden (60%), Mosaic (25%) and SABIC (15%), and will be repaid over a seven to eight year period.

Construction of the 3 million t/a DAP plant and a 1.1 million t/a ammonia plant at Ras Al-Khair will each benefit from a SAR 900 million loan. A further SAR 1 billion will finance the construction of the project's 4.9 million t/a sulphuric acid and power plant at Wa'ad Al-Shamal. A fourth SAR 1.2 billion loan is earmarked for the construction of a 1.5 million t/a phosphoric acid plant and 5.3 million t/a phosphate processing plant, also part of the Wa'ad Al-Shamal complex.

The loans complete the debt financing of Wa'ad Al-Shamal. The project should be commissioned and enter production in the second half of this year.

INDONESIA

JPMC launches new joint venture

Jordan Phosphates Mine Company (JPMC) has announced the formation of Petro Kaltim Abadi, a joint venture (JV) with the Indonesian government.

The two partners plan to jointly develop a new 200,000 t/a phosphoric acid plant in the Pantang area of Indonesia. JPMC and the Indonesian government say they will each finance 30% of the new $300 million venture. The remainder of the finance is expected to come from state-owned development agencies in Indonesia, according to analysts Integer Research.

Two similar ventures, including one in Indonesia, have provided JPMC with a secure market for its Jordanian phosphate rock– and also enabled the firm to become a more integrated producer.

The Petro Jordan Abadi phosphoric acid plant in Indonesia, a JV between JPMC and Petrokimia Gresik, successfully entered production in 2014. The world-scale Jordan India Fertilizers (JIFCO) phosphoric acid plant at Eshidiya, Jordan – which became operational last October – was also developed by JPMC as a JV with India's IFFCO.

In addition to the Petro Kaltim Abadi project, JPMC has also signed a preliminary agreement for a second Indonesian phosphoric acid plant, according to *The Jordan Times*. The two new ventures combined could provide a market for up to 1.5 million t/a of Jordanian phosphate rock.

CANADA

Quebec government approves Lac à Paul phosphate

The Quebec government has approved Arianne Phosphate's Lac à Paul phosphate project.

The Quebec cabinet issued a ministerial decree in support of the project on 22 December. Arianne also received environmental approval from BAPE, Quebec's environment agency, last October, having submitted an Environmental Impact Assessment (EIA) for the proposed mine in 2013.

The granting of the decree means Arianne is free to proceed with the final permitting and financing of its open-pit phosphate mining project, located in Quebec's Saguenay-Lac-Saint-Jean region

"Arianne now has the permission it needs to go ahead with the development of its proposed $1.2 billion phosphate project," said Jean-Sebastien David, Arianne's chief operating officer. "Arianne will now look to finance the construction of its Lac a Paul mine… and will continue its on-going discussions with potential corporate, strategic and financial partners."

The Lac à Paul phosphate project plans to produce up to three million t/a of high-grade phosphate concentrate (39% P_2O_5) from igneous apatite. Construction could begin as early as this spring with the start of production scheduled for 2017/18.

SOUTH AFRICA

Foskor strike ends

Four hundred workers returned to work at Foskor's Richards Bay site in the first week of December, ending a strike that lasted for over a month.

Production at the major sulphuric acid, phosphoric acid and phosphate fertilizer complex was hit by a strike action at the end of October. Striking employees eventually returned to week after Foskor agreed to pay a bonus said to be worth 70% of their monthly salary.

Richards Bay may have operated at 10% capacity during the strike and produced as little as 18,000 tonnes of sulphuric acid, 6,250 tonnes of phosphoric acid and 3,000 tonnes of MAP during the month-long strike, according to calculations by analysts CRU.

Technical problems, power shortages and strikes resulted in lower plant operating rates and reduced sulphur imports into South Africa last year. South African phosphoric acid exports fell to 111,000 tonnes between January and September 2015, for example, less than half of the 265,000 tonnes exported during the same period in 2014.

ETHIOPIA

Yara awards potash mine contract to SNC-Lavalin

The Yara Dallol potash project took a major step forward in November with the announcement of the award of an engineering, procurement and construction management (EPCM) contract to Canada's SNC-Lavalin.

SNC-Lavalin will oversee construction and help Yara Dallol – a subsidiary of Norway's Yara International – deliver a 600,000 t/a sulphate of potash (SOP) solution mine in the remote Dallol region of north-east Ethiopia.

As well as providing EPCM services, SNC-Lavalin will also carry out front-end engineering design (FEED) for the $740 million project, and assist with the start-up and commissioning of the new mine.

Construction is due to be completed in the second half of 2018. The mine has sufficient reserves for a 23-year life, according to a definitive feasibility study published last February (*Fertilizer International*, 468 p58).

"We are proud to have been selected by Yara to bring our proven expertise in potash project development to this exceptional project in Ethiopia," said José Suárez, SNC-Lavalin's mining president.

Yara also sold a 25% stake in Yara Dallol to Liberty Metals & Mining Holdings in

November for $51 million. The deal leaves Yara International with a 52% share of the project, the remaining 23% belonging to XLR Capital Limited.

"The Dallol project will support Yara's strategy for further development of premium fertilizer for high-value crops, and this transaction underlines the attractiveness of the project," said Svein Tore Holsether, Yara's CEO.

Yara Dallol is one of a numbr of greenfield potash ventures located in Ethiopia and across the border in Eritrea. Allana Potash Corp, Circum Minerals and Danakali Ltd are all currently developing projects in this part of East Africa (*Fertilizer International* 468, p58).

ZAMBIA

Yara buys distributor Greenbelt Fertilizers

Yara International has announced its purchase of Greenbelt Fertilizers, a leading distributor of fertilizers in Zambia, Malawi and Mozambique, for $51 million.

Greenbelt, which began distributing fertilizers in Zambia in 2004, owns three blending plants and three warehouses. The distributor is a relatively modest enterprise which sold 80,000 tonnes of fertilizers in 2014/15 and posted earnings of $5 million.

But Yara clearly expects fertilizer demand to grow in the region, saying Zambia and its neighbours "make up a fast-growing agricultural region with low but increasing fertilizer application rates".

"This acquisition re-confirms Yara's long-term commitment to Africa. Greenbelt fits well with Yara and will further improve our downstream position within a fast-growing agricultural region," said Terje Knutsen, Yara's head of downstream.

The acquisition is expected to be finalised in the next three months, subject to competition authority approval.

RUSSIA

Gazprom and PhosAgro agree sulphur supply deal

PhosAgro has signed a five-year liquid sulphur contract with Gazprom Sulphur to supply its Cherepovets plant and Apatit subsidiary Balakovo.

The new agreement runs until the end of 2020 and should enable PhosAgro and Balakovo to fully meet growing production demand for liquid sulphur, PhosAgro said in a statement.

"This agreement will enable long-term production planning and predictable delivery volumes for PhosAgro's plants," said Andrey Lazukov, Gazprom Sulphur's CEO.

PhosAgro CEO Andrey Guryev added: "We are pleased to restart our partnership with Gazprom Group companies, and hope that they will be long-term and constructive in all areas of doing business."

In November, PhosAgro announced a slowdown in fertiliser production at Balakovo, blaming Gazprom's failure to fulfil its contractual obligations to supply sulphur. It warned that a lack of sulphur risked a 72,000 tonne cut in phosphate fertiliser production at the plant during December. Similar problems also affected PhosAgro's Cherepovets plant.

Gazprom blamed a lack of railcars for the recent sulphur supply difficulties, but says PhosAgro has now agreed to allocate extra tanker cars to help transport liquid sulphur to its production sites.

People

Rainer Gerling joins the board of K+S

Dr Rainer Gerling joined the board of K+S KALI GmbH in January, succeeding Dr Ralf Diekmann.

On taking up the position, Dr Gerling assumed responsibility for production across the whole of K+S. He was previously plant director of the company's Werra production site in Germany.

"It is a big and exciting task, that I am very pleased to perform," commented Gerling on taking up the role.

Dr Diekmann has now retired from K+S after a long and successful career with the company, culminating in his appointment to the board in 2007. He started working for K+S as a research associate for its predecessor company, Kali und Salz AG, 35 years ago.

Dr Diekmann congratulated his successor and wished him every luck in the role and "a lot of success completing the vision zero in operational safety".

Two new vice presidents at CF Industries

Christopher Bohn has been elected senior vice president of manufacturing by the board of directors of CF Industries Holdings, Inc. He took up the position at the start of January, replacing Phillip Koch who is due to retire in early March this year.

Bohn will oversee the company's nine nitrogen complexes located in Canada, the United Kingdom and the United States. He will also be responsible for the company's distribution facilities, corporate engineering and environmental health and safety.

"Chris has provided substantial leadership since he joined CF Industries in 2009, contributing both to the overall strategy development for the company and the execution of that strategy," said Tony Will, president and chief executive officer of CF Industries.

Bohn joined CF Industries in 2009 and has led CF's supply chain group since January 2014. He previously served as the company's vice president for corporate planning. Bohn holds an MBA from Northwestern University's Kellogg Graduate School of Management.

In a related promotion, Terry (Terrell) Huch replaced Christopher Bohn as vice president of supply chain from January. Huch assumes responsibility for the company's raw materials procurement and will also lead on supply chain and logistics for barge, pipeline, rail and truck transportation.

"Terry has made substantial contributions to CF in investor relations, gas procurement and corporate strategy since joining us," said Tony Will, president and chief executive officer of CF Industries. "His understanding of our business and his thoughtful, analytical approach will serve us well as he leads our supply chain organization into its next phase."

Huch was previously senior director of financial evaluations & analysis for CF Industries and holds an MBA in finance from Carnegie Mellon University.

Anders Heine Jensen and Henrik Stiesdal join Haldor Topsoe's board

Henrik Stiesdal and Anders Heine Jensen have been elected to the board of directors of Haldor Topsoe A/S, expanding board numbers by two seats to twelve in total.

Haldor Topsoe's chairman, Henrik Topsoe, welcomed the two high-level appointments: "We have been able to attract two very capable and experienced people, who understand the nature of the business we're in, especially the essential energy sector. I'm sure that they will be a very positive addition to the board and I know that the entire board looks forward to working with Anders and Henrik."

Henrik Stiesdal has played a major role in the development of the Danish wind power industry and retired as chief technology officer of Siemens Wind Power in 2014. Anders Heine Jensen is CEO of Burmeister Wain Scandinavian Contractors (BWSC) A/S. He is also a board member of the Danish Energy Industries Federation currently.

Calendar 2016

FEBRUARY

2-4

22nd AFA Annual International Fertilizer Forum & Exhibition,
CAIRO, Egypt.
Contact: AFA Conference Section
Tel: +20 2 2417 2347
Email: info@afa.com.eg
Web: www.afa.com

29 – 3 March

Nitrogen+Syngas 2016,
BERLIN, Germany.
Contact: CRU Events
Chancery House,
53-64 Chancery Lane,
London WC2A 1QS, UK
Tel: +44 20 7903 2444
Email: conferences@crugroup.com
Web: www.crugroup.com

MARCH

13-15

Phosphates 2016,
PARIS, France.
Contact: CRU Events
Chancery House,
53-64 Chancery Lane,
London WC2A 1QS, UK
Tel: +44 20 7903 2444
Email: conferences@crugroup.com
Web: www.crugroup.com

14-17

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

JUNE

10-11

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The southern tip of Gezira island with Cairo Opera (foreground), Cairo ciity centre and Tahrir Square across the Nile.

PHOTO: ARAD MOJTAHEDI

The AFA welcomes you to Cairo

The theme of the 22nd Arab Fertilizer Association Annual Fertilizer Forum & Exhibition is 'Fertilizer & Water for Sustainable Agriculture'. This year's Forum will be held at the Semiramis Intercontinental Hotel, Cairo, 2-4 February 2016. AFA Secretary General, **Mohamed Zain**, provides a preview of what is the Arab region's showcase annual fertilizer event.

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

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

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

Mr Mohamed Zain, AFA Secretary General, looked forward to welcoming delegates to Egypt in February:

"We are privileged to welcome you all in such a wonderful city of Cairo, to attend the 22nd AFA Annual Fertilizer Forum and accompanying exhibition, from 2-4 February 2016 with the theme 'Fertilizer & Water For Sustainable Agriculture'. The 2016 Forum will provide you with the opportunity to interact during the three-day function with the heads of Arab and international fertilizer companies, chairmen of related international organizations, together with executives and general directors from all over the world.

"This event notably attracts over 600 senior fertilizer industry executives from more than 40 Arab and non-Arab countries. The expansion in attendance at the annual conference reflects the growing importance of Arab fertilizer producers in the world market. With an abundance of a range of fertilizer raw materials, including natural gas, phosphate rock, sulphur and potash, the Arab region is already a fertilizer industry hub.

"The topics addressed by a high-calibre list of speakers are extremely diverse and will cover a range of fertilizer-related issues and developments of international and regional interest. The Forum will further highlight the latest fertilizer issues through international experts in this field.

"We hence are looking forward to your participation. Looking forward to meeting you in Cairo."

The 2016 AFA Forum programme include three days of plenary sessions starting on Tuesday 2 February. The overall theme of these sessions will be the role of fertilizers in increasing agricultural productivity and ensuring food security.

A growing world market share

Arab fertilizer producers broke fresh production and export records in 2014. A natural abundance of a wide-range of raw materials – including natural gas, phosphate rock and potash – has enabled the Arab Region to establish itself as a major international fertilizer industry hub.

The latest production and export figures reveals how Arab producers have consolidated their global leadership in urea, phosphate rock, phosphoric acid and TSP markets, whilst also being key players in the ammonia and sulphur sectors (Table 1).

In 2014, the Arab region's exports accounted for around:

- 38% of the world urea market
- 60% of phosphate rock trade
- 49% of TSP the market
- 64% of the phosphoric acid market
- 50% of the DAP market
- 22% and 5% of the sulphur and potash markets, respectively

Arab producers currently have a 10% share of total world **ammonia** production. Saudi Arabia is the leading Arab supplier accounting for 25% of regional production, followed by Qatar (22%), Egypt (16%) and Oman (8%). Arab ammonia producers also shipped approximately 4.5 million tonnes in 2014, a 24% share of the world total. Saudi Arabia was again the leading regional exporter with a 48% share, followed by Algeria (25%), Qatar (12%) and Egypt (5%), respectively.

Arab producers have a 12% of total world **urea** production and a 38% share the export trade. Qatar is the leading regional producer, contributing 29% to total Arab region production, followed by Saudi Arabia (21%), Egypt (17%), UAE (10%) and Oman (8%). Urea production in the region is highly export-oriented. Qatar-based QAFCO is the region's leading urea producer and exporter, shipping 5 million tonnes out of a total production of 5.4 million tonnes in 2014. These volumes represent 29% and 33%, respectively, of total Arab region urea production and exports.

Arab **phosphate rock** producers have a 25% share of world production and a 60% share of world trade. OCP, Morocco, is the regional leader with a 56% slice of total Arab region production. Jordan (15%), Egypt (11%), Tunisia (8%) and Saudi Arabia (7%) are also major regional producers. OCP, the world's largest exporter of phosphate rock, has a 48% share of the region's exports. Jordan, Egypt and Tunisia also contribute significantly to phosphate rock exports in the region.

Arab **phosphoric acid** producers have a 16% share of world production and a 64% share of world trade. Morocco again predominates in this sector, with a 66% share of regional production. The other leading regional producers are Saudi Arabia (10%), Tunisia (9%) and Jordan (8%).

Arab countries also have a sizeable slice of the **TSP** market, amounting to 29% of world production and 49% of world trade. OCP is again the market leader, supplying 52% of regional TSP output, together with Tunisia (27%) and Lebanon (13%).

In **DAP** markets, Arab countries contribute 26% of world production and 50% of world trade. **OCP** is once again the leading regional supplier (44%) followed closely by Saudi Arabia (40%) and supplemented by production from Tunisia (9%) and Jordan (7%). Saudi Arabia is emerging as a major player in the world DAP market, being responsible for 33% of Arab regional exports.

Jordan's APC is the sole **potash** producer in the Arab region, its output accounting for 4-5% of world production and trade.

Arab countries, especially those in the Gulf, enjoy a high profile in the sulphur sector globally, contributing 14% to world production and 22% to world trade. Saudi Arabia leads the way with a 45% share of regional sulphur production, supplemented by sizable output from the UAE (29%), Kuwait (12%) and Qatar (11%). Most regional sulphur production is export-oriented.

Investment in new capacity

New capacity continues to be developed throughout the Arab region, enhancing the contribution Arab countries make to global fertilizer capacity and world trade. Looking to the future, by 2020, additional production capacity in Arab countries will undoubtedly raise the region's contribution to world fertilizer production and trade even further.

Table 1: **Arab countries' fertilizer production and exports** 2013-14, million tonnes

Product	Production 2013	Production 2014	Arab region share of world total (%) 2014	Exports 2013	Exports 2014	Arab region share of world total (%) 2014
Ammonia	15.17	16.22	10	3.35	4.48	24
Urea	17.87	18.92	12	14.94	15.58	38
Ammonium nitrate	1.28	1.22	10	0.08	0.08	<1
Phosphate rock	44.21	48.94	25	15.33	18.14	60
Phosphoric acid	6.50	6.84	16	2.37	2.41	64
TSP	1.93	1.82	29	1.82	1.87	49
DAP	7.88	8.33	26	6.31	6.86	50
Potash	1.75	2.09	4	1.58	2.02	5
Sulphur	7.06	7.27	14	6.72	6.85	22

Fertilizer demand to rebound?

PHOTO: LIUDMYLA ALKHOVIK / SHUTTERSTOCK.COM

Encouragingly, the International Fertilizer Association (IFA) expects growth to return to the fertilizer market in 2016. We review prospects for the coming year, assessing the key agricultural drivers and weighing-up the latest short-term fertilizer supply and demand forecasts.

The fertilizer industry has struggled with deteriorating macroeconomic conditions and a deepening commodities price crash over the last 12 months.

Faltering expansion in key emerging economies saw world economic growth weaken as 2015 progressed. The IMF is currently forecasting 3.1% growth in global GDP for 2015, 0.3% less than 2014 growth and 0.4% below the IMF's April 2015 forecast. More encouragingly, the world economy looks set to bounce-back in 2016 with GDP growth recovering to 3.6% year-on-year.

Economic backdrop worsens

China's deceleration has been particularly significant, with the country's growth likely to fall from 7% in 2015 to nearly 6% in 2016 – considerably down on the +10% annual growth levels witnessed between 2000 and 2010. Major commodity exporters such as Russia and Brazil have been hit hard by slower Chinese import growth, due to its impact on international trade and commodity prices.

The commodity price falls of the last year have in turn triggered a round of currency depreciations, most acutely in Brazil (-33%), Ukraine (-31%) and Russia (-27%). Sizable exchange rate falls were also seen in Australia (-20%), Canada and the EU (-14% each).

China's slowdown also contributed to a meltdown in the metals and energy markets, as exemplified by the 50% fall in the price of oil to a five-year low last year. Current commodity price weakness is expected to persist into 2016. Early signs are not promising. The oil price crashed to an 11-year low of less than $35 per barrel in early January, for example, driven down by overproduction and gloomy economic news from China.

Agricultural commodities have followed the general downward trend, although drops in corn, wheat and soybean prices to date have been modest compared to oil and iron ore price falls. Nevertheless, the FAO's Food Price Index fell to its lowest level since 2009 last summer, a reflection of weaker prices across a wide range of agricultural commodities. More positively, Rabobank expects currency weakness in Brazil, Ukraine and Russia to result in "very aggressive" agricultural commodity exports from these countries in 2016.

Analysts at the Mosaic Company also link declining crop prices to the "giant step up" in global grain and oilseed production in recent years. "The global harvest had never exceeded 2.8 billion tonnes prior to 2013/14, but production has averaged 3.0 billion tonnes during the last three years. As a result, crop prices have declined in response to the rapid rebuilding of inventories," they comment.

Table 1: **World cereal production** (million tonnes)

	2015/16 f	2014/15 e	2013/14
Wheat	726-736 (+0.4-1.1%)	721-733	714-716
Coarse grains (Maize, rye, barley, oats, sorghum etc.)	1,270-1,302 (-2.1-2.5%)	1,297-1,331	1,281-1,313
Rice (milled)	474-491 (-0.6-1.0%)	478-494	478-495
Total	**2,473-2,530 (-0.9-1.2%)**	**2,500-2,558**	**2,475-2,523**

Source: FAO, USDA and IGC end of 2015 forecasts.

Table 2: **World production of major oilcrops** (million tonnes)

	2015/16f	2014/15e	2013/14
Soybeans	318.2 (-0.5%)	319.7	283.4
Rapeseed	64.3 (-10%)	71.4	71.9
Cottonseed	40.9 (-8.9%)	44.9	44.7
Groundnuts	38.4 (1.3%)	37.9	38.9
Sunflower seed	39.9 (-2.4%)	40.9	42.4
Palm kernels	15.8 (2.8%)	15.4	14.7
Copra	5.5 (-2.9%)	5.7	5.6
Total	**523.0**	**535.9**	**501.6**

Source: FAO Food Outlook October 2015

Agricultural demand

World cereals grew by 0.7-1.4% to a record 2.50-2.56 billion tonnes in 2014/15, driven by larger wheat and maize harvests. (Table 1). The global cereal crop in 2015/16, in contrast, is forecast to contract by 0.9-1.2% to 2.47-2.53 billion tonnes on the back of lower international prices and rain shortfalls in India, Thailand, the EU and Canada. Higher wheat production in Turkey, Morocco, France and Ukraine in 2015/16 is unlikely to offset lower maize and rice volumes.

The International Grain Council (IGC) in its latest forecast expects the growing of wheat to contract 0.5% to 221 million hectares globally. This is in response to low wheat prices and dry conditions in Black Sea countries, the north-east EU and the US Southern Plains. Irregular and below-average rainfall in the southern hemisphere is also affecting maize plantings in Brazil, Argentina and South Africa.

World cereal inventories will, however, remain stable in 2015/16 at 565 million tonnes, compared to a 559 million tonnes a year ago, based on the latest USDA figures. China's cereal stores at the end of 2015/16 are projected to stand at 250 million metric tonnes, equivalent to 45% of world stocks.

Low prices and large inventories affect oilseeds

The 6-7% increase in global oilseed output to 536-547 million tonnes in 2014/15 was largely delivered through yield improvements and a larger harvested area. A bumper soybean crop last year (+13%) helped offset smaller rapeseed, groundnut and sunflower harvests.

In contrast, global oilseed output in 2015/16 is forecast to contract by 1-2% to 531-523 million tonnes, driven down by large inventories and low prices according to USDA. Gains in groundnut and palm kernel production are unlikely to offset smaller rapeseed, sunflower seed and cottonseed harvests (Table 2). Any growth in palm oil production in 2015/16 (2-3%) is set to come almost exclusively from Indonesia.

Ample availability kept cereals, oilseeds, sugar and cotton prices low in 2015. The broad expectation is that agricultural prices will stay depressed in coming months – unless unfavourable weather affects production in the major exporting countries.

"As things stand, we do not foresee a marked upturn in fortunes for grains and oilseeds in 2016: prices will remain at the current, relatively low levels," predicts ABN Amro. "High stock levels and sustained high output projections will keep prices under pressure in the coming year, but we do think the bottom will have been reached by then."

Fertilizer demand expected to rebound in 2016

Stagnant economic growth, commodity price falls and faltering emerging markets all took their toll on the fertilizer industry last year. As a consequence, global fertilizer demand is expected to decline 0.1% to 183.1 million tonnes in 2015/16[1].

IFA expects the fall-off in phosphorus demand (down 0.9% to 40.8 million tonnes) and potassium demand (down 0.2% to 31.9 million tonnes) in 2015/16 to exceed the uptick in nitrogen demand (up 0.1% to 110.4 million tonnes). Regionally, demand is likely to fall in Latin America, Oceania and West Asia, according to IFA, and stagnate in East Asia.

The good news, however, is that IFA expects the international fertilizer market to eventually return to growth in 2016. "We see growth at 1.9 to 2 percent," Abdulrahman Jawahery, IFA's president, told the *Financial Times* in December. He also expected industry profitability to be boosted by lower US gas prices, and sales to be helped by higher demand for specialty fertilizers.

Others were more sceptical. Commenting on the 2016 outlook for the fertilizer sector, analyst Steve Hansen at Raymond James said: "Global fertiliser fundamentals remain broadly anaemic, with few encouraging pricing signals."

Global fertilizer demand is forecast to rebound to 186.6 million tonnes in 2016/17, according to IFA figures (Table

Table 3: **Global fertilizer demand forecast** (million tonnes)

Nutrient	2016/17f	2015/16f	2014/15e	2013/14	2012/13
N	112.0 (+1.4%)	110.4 (+0.1%)	110.3	109.9	108.6
P_2O_5	41.6 (+2.1%)	40.8 (-0.9%)	41.1	40.5	41.4
K_2O	33.0 (+3.3%)	31.9 (-0.2%)	32.0	30.4	29.2
Total	**186.6 (+1.9%)**	**183.1 (-0.1%)**	**183.4**	**180.7**	**179.1**

Source: IFA

3). Growth in K demand is expected to be particularly firm (+3.3%, to 33.0 million tonnes), due in part to increased supply in China. This is likely to be supplemented by more modest demand growth for N (up 1.4% to 112.0 million tonnes) and P (up 2.1% to 41.6 million tonnes).

IFA's positive demand forecast for 2016 does come with health warnings though. It assumes no major changes in market fundamentals, improving N and P use efficiency in China, and support from India's subsidy regime for balanced fertilizer applications.

Sales, trade and supply

IFA expects industry sales to expand by 1-2% to 245 million tonnes nutrients this year, up from 241 million tonnes in 2015[2]. (Fertilizers typically account for about four-fifths of nutrient sales with the remainder earmarked by industrial markets.) Actual production levels for the year may turn out to be lower, in IFA's view, particularly for potash and DAP. This is due to the build-up of inventories in countries such as China and India late last year.

Global trade prospects for 2016 are also broadly positive. IFA expects rises in both MOP (+4-5% to 47-48 million tonnes) and DAP (+3% to 17-18 million tonnes) trading to contrast with static urea trade volumes (46-47 million tonnes) for the year.

On the supply side, about 100 new ammonia, phosphoric acid and potash production units and expansion projects are expected by IFA during 2015 and 2016. Unsurprisingly, such a large number of projects will alter supply/demand balances. Supply-driven balance increases are expected for both phosphoric acid and urea in 2016, whereas a demand-driven balance reduction is expected for potash.

A massive 20 million tonnes of new urea capacity is expected to ramp-up global capacity from 207 million tonnes to 227 million tonnes during 2015 and 2016[2]. Thirty new urea units should come on-stream over this period with two-thirds of these located outside of China.

Global phosphate fertilizer capacity (DAP/MAP/TSP) is also set to increase by 11% (3.8 million tonnes) to 47.2 million tonnes by the end of this year. Almost all of the 2015 and 2016 capacity additions for phosphates are due to come from Morocco (1.8 million tonnes), Saudi Arabia (1.4 million tonnes) and China (0.5 million tonnes).

IFA expects global MOP capacity, which fell 2% from 83.5 million tonnes at the end of 2014 to 82.2 million tonnes at the end of last year, to recover and grow by 8% during 2016 to 88.9 million tonnes. These MOP capacity increases will come almost exclusively from four producers, PotashCorp (3.0 million tonnes), K+S Legacy (2.0 million tonnes), Agrium (1.0 million tonnes) and Uralkali (0.9 million tonnes).

El Niño introduces uncertainty

Commenting on the fertilizer industry outlook for the year, IFA is at pains to point out that its latest short-term forecasts are subject to a large number of uncertainties.

Geopolitical and economic developments, fertilizer taxes, and subsidy changes are foremost among these, as is the risk of weather-related crop shortfalls due to a record-breaking El Niño. Downside risks, in particular, prevail in the 2016/17 outlook as these mainly hinge on global economic prospects.

The weather could emerge as a key driver in 2016 agricultural commodity markets, according to Rabobank. It expects El Niño, one of the strongest on record, to affect sugar, cocoa, palm oil and coffee crops in particular. Grains should continue to trade close to current levels, in Rabobank's view, as weather risks are likely to be counterbalanced by currency weakness in key producing countries.

> **"We still see more upside than downside risks across agricultural commodities.**

"Despite large [grain and oilseed] stocks and currency pressure from a strong US dollar, we still see more upside than downside risks due to likely weather events across commodities," commented Stefan Vogel, Rabobank's head of global agri commodity markets.

Mike Rahm, vice president of market and strategic analysis at the Mosaic Company, also points out that current farm economics, at least in the US, are very different to a decade ago.

"The last time oil was at $35 a barrel in 2004, the price of corn was about $2.85 per bushel, and the average trend yield was 144 bushels per acre, generating about $410 per acre," calculates Rahm. "Today, corn is still trading around $4 per bushel but trend yields have increased to about $166 bushels per acre – that's about $665 dollars per acre of revenue."

The current agricultural commodity situation is therefore not "hopeless" in Rahm's view. "The challenge remains producing enough grains and oilseed to meet projected demand," he concludes. ■

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No immediate renaissance for Iran

Qeshm Island in the Strait of Hormuz, Iran

PHOTO: NASA

The suspension of UN, EU and US sanctions will provide Iran with access to previously blocked export markets and could herald a revival of investment in its fertilizer industry. However, the country's National Petrochemical Company (NPC) recently decided to shelve some urea projects due to excess output and current market conditions. The availability of less-risky investment opportunities elsewhere may also mean that the renaissance of Iran's fertilizer sector is some way off.

The potential for nitrogen fertilizer production in Iran is huge, particularly as the country has plans to monetise its vast gas reserves by pursuing an ambitious programme of downstream petrochemical projects. The imposition of increasingly stringent sanctions on Iran in recent years has, however, thwarted such ambitions by stifling foreign investment and the country's access to global technology and engineering expertise.

Sanctions have hit Iran's foreign earnings particularly badly. As recently as 2011/2012, Iran earned $118 billion from oil and gas export revenues. These revenues fell precipitously to $63 billion in 2012/13, only to decline further to $56 billion in 2013/14, according to IMF figures.

The Iran nuclear agreement: a game changer?

The deal

The five permanent UN Security Council Members plus Germany reached a comprehensive nuclear agreement with Iran, known as the Joint Comprehensive Plan of Action (JCPOA), in July last year. This places limitations on Iran's nuclear programme and initiates the lifting of UN, EU and US sanctions, which intensified in 2012.

The agreement will formally enter into force on 'Implementation Day', expected in the first half of 2016, following final International Atomic Energy Agency (IAEA) verification. After Implementation Day, sanctions will be officially suspended, allowing Iran to ramp-up oil exports above the current sanctions-imposed cap of 1.1 million barrels per day (mb/d).

Strings are attached though and sanctions could 'snap-back' if Iran is judged to have violated its commitments under the agreement. Sanctions will finally come to an end after eight years, although nuclear restrictions on Iran, and the IAEA's verification of these, will continue for 15 years.

The consequences

Iran could potentially increase oil production by 0.5-0.7 mb/d within a few months of sanctions being lifted, eventually reaching its 2011 pre-sanctions production level of 3.6 mb/d, equivalent to about 4% of global production. Iran also has the option of exporting from its 40 million barrels of floating oil storage.

The impact of Iranian exports on global oil and gas markets is likely to be large over the longer term, according to the World Bank, if the country is able to attract the necessary foreign investment and technology it requires.

The 173 billion cubic meters of natural gas produced by Iran in 2014, equivalent to 5% of world production, was mostly consumed domestically. Iran has the potential to produce and export significant volumes of natural gas over the longer-term, according to the World Bank. The country has the world's largest known reserves, some 18% of the world total, based on the BP's *2015 Statistical Review of World Energy*. This places Iran's reserves ahead of those of Russia (17%) and Qatar (13%).

Iran will ultimately need to move up the value chain and export more value-added petrochemicals, including ammonia and nitrogen fertilizers, if it wishes to maximise revenues from its gas reserves. ■

Immediate aftermath

The suspension of sanctions this year – if implemented – could reverse the dramatic decline in Iran's export revenues. The main consequence of Iran's re-emergence is likely to be a significant boost to global oil and petrochemicals supply (see box). Such a development, coming on top of existing market overcapacity, will only add to current downward price pressures.

Iran's 59 million t/a capacity petrochemicals industry is running at an overall operating rate of around 60%, according to consultancy Nexant. With the suspension of sanctions, Iran could potentially ramp-up production relatively quickly, in theory adding up to 24 million t/a of petrochemicals to global markets, although this assumes that plants are adequately maintained and sufficient feedstock is available.

The realisation of Iran's potential as a petrochemical and fertilizer producer will ultimately hinge on its ability to attract capital, new technology and the engineering expertise needed to revamp and expand investment-starved plant infrastructure.

Production capabilities

Iran's fertilizer industry is notable for its world-scale nitrogen production and sulphur recovery facilities, both of which reflect the underlying strength of its petrochemicals sector. In 2013, national nitrogen capacity was around 4.4 million t/a and sulphur capacity 1.8 million t/a (*Fertilizer International*, 453 p 14). Iran also possesses some phosphate capacity (450,000 t/a) but relies on imports for its potash supply. The country imported 68,300 tonnes of potash (K_2O basis) from Belarus in 2014.

Iran produced 1.6 million tonnes of sulphur in 2013. Much of the country's production is based on sour gas processing using relatively-old Claus sulphur recovery units (Table 1). Petrochemical complexes at Razi and Kharg island jointly produce around 500,000 tonnes of sulphur annually and the Khangiran gas refinery supplies a further 400,000 tonnes each year, according to the National Iranian Gas Company, the state body that controls much of the nation's sulphur production (*Fertilizer International*, 453 p 14). The Khanigran refinery is particularly productive as it recover sulphur from highly sour natural gas containing 3.5% H_2S.

Additional sulphur recovery capacity is expected at Assaluyeh as part of Iran's

Fig 1: **Iran's main nitrogen plants**

Table 1: **Iran's major sulphur producers**

Producer	Sulphur recovery units	Capacity t/d	Sulphur forming/ granulation units
Petrochemical complexes			
Razi Petrochemical Co	Claus	2 x 630 t/d	2 x 800 t/d
	Claus	1 x 700 t/d	
Kharg Petrochemical Co	Claus	515 t/d	-
Gas refineries			
South Pars gas refinery Phase 1		606 t/d	-
Phases 2 & 3		400 t/d	-
Phases 4 & 5		400 t/d	-
Khangiran (Shahid Hasheminejad Gas Refinery Co)	Claus	4 x 650 t/d	6 x 750 t/d (pastillation units)
Ilam Gas Refinery Co	Claus	2 x 173 t/d	2 x 300 t/d (Sandvik rotoform pastillation units)
Oil refineries			
Tehran Oil Refinery Co	Claus	100 t/d	-
Tabriz Oil Refinery Co	Claus	20 t/d	-
Bandar Abbas Oil Refinery Co	Claus	130 t/d	-
Isfahan Oil Refinery Co	Claus	103 t/d	-

Source: National Iranian Gas Company

ambitious plans to develop the South Pars natural gas field. A further 750 t/d of sulphur granulation capacity was brought on-stream last spring, for example, with the inauguration of South Pars Phase 12.

Five nitrogen complexes at Assaluyeh (Pardis Petrochemical Co), Bandar Imam (Razi Petrochemical Co), Bojnurd (Khorasan Petrochemical Co), Kermanshah (Kermanshah Petrochemical Co) and Shiraz (Shiraz Petrochemical Co) provide Iran with around 4.4 million t/a of urea capacity and 3.9 million t/a of ammonia capacity (*Nitrogen+Syngas*, 311 p20).

Iran's largest fertilizer complex, the 3.6 million t/a Razi Petrochemical Co operation at Bandar Imam Khomeini, Khuzestan province, produces ammonia, urea, sulphur and sulphuric acid. The complex, which dates from 1968 and is 50% owned by the Turkish fertilizer firm Gübre Fabrikaları, is also the country's sole producer of phosphoric acid and DAP. The site is operating at just over half capacity currently, with DAP production (85,000 tonnes) particularly depressed at around a fifth of capacity (Table 2).

The suspension of sanctions, by granting access to global markets for trade and finance, should allow Iran to expand its oil and gas output and the downstream production of petrochemicals relatively quickly. But investment in Iran carries with it many risks, according to analysts IHS Chemicals. Potential pitfalls include a high level of political risk combined with legal uncertainties and a plethora of administrative and bureaucratic obstacles. Yet Iran's petrochemicals sector remains fundamentally attractive as an investment proposition, due to the availability of low-cost natural gas feedstock, and the country's geographical access to major markets.

Urea export boom

Global urea capacity is expected to increase by over a fifth (44 million tonnes) to 252 million t/a by 2019. About 15 million t/a of this extra capacity is being developed specifically for the export market by gas-rich countries such as Algeria, Nigeria and Turkmenistan.

Iran now looks set to join this export-oriented urea production boom. IFA, for example, expects Iran to bring on-stream two new 1.1 million t/a ammonia/urea plants over the next two years. The Pardis III plant in Assaluyeh is forecast to enter production in 2016 to be followed by the completion of the Shiraz III project a year later. As a consequence, Iran's overall urea production capacity is expected to grow by 50% from 4.6 million t/a currently to 6.7 million t/a over the next four years or so.

Iranian urea production has, however, declined in recent years and fell by more than a tenth between 2012 and 2014, according to IFA, with exports falling by two-fifths over the same period. Sulphur production and exports also fell between 2012 and 2013 (Table 3).

Although constrained by sanctions, a large proportion of Iran's nitrogen and sulphur production capacity is earmarked for international markets. Iran exported almost half its 3.6 million tonnes of urea production in 2014. Exports (1.8 million tonnes) were mainly destined for India (740,000 tonnes), Turkey (457,000 tonnes) and Iraq (170,000 tonnes).

Exports account for an even larger slice of Iranian sulphur production. More than two-thirds (1.1 million tonnes) of Iran's sulphur output in 2013 (1.7 million tonnes) was exported, with China (895,700 tonnes) and India (151,000 tonnes) being the main export markets.

Iran to repair, refit and then ship

Iranian ammonia and urea exports have become increasingly restricted in recent years, according to analysts Profercy, as sanctions have tightened. But the country's urea exports have still been running at up to 3 million t/a, around 6-7% of world export supply, Profercy reports. Around 80% of this volume has gone to India, supplemented by shipments to South East Asia, Central and South America and Europe.

India, in particular, has benefitted from the cheap price of Iranian urea, something that could well change with the lifting of sanctions.

"Iranian suppliers have been forced to accept discounted prices for sanctions-affected products, hitting profitability of this trade," comments Profercy. "Clearly, if Iranian product is no longer restricted, this could be a negative for the Indian exchequer with Iran having real export options from which it can achieve improved prices for its granular urea."

Although there are still political obstacles to overcome, Profercy concludes that

Table 2: **Razi Petrochemical Co fertilizer complex, capacity and production**

Product	Number of plants	Capacity (t/a)	2015 production* (t)	Operating rate (%)
Ammonia	3	1,336,000	900,000	67
Urea	1	594,000	350,000	59
DAP	2	450,000	85,000	19
Sulphuric acid	2	627,000	260,000	41
Granular sulphur	1	508,000	315,000	62
Phosphoric acid	1	126,000	80,000	63
Total	**10**	**3,641,000**	**1,990,000**	**55**

**Estimate* *Source: Razi Petrochemical Co*

Table 3: **Iranian fertilizer production and exports**

Fertilizer	Year	Production ('000 tonnes)	Exports ('000 tonnes)
Urea*	2014	3,615	1,765
	2013	3,968	2,254
	2012	4,133	2,941
Sulphur	2013	1,649	1,124.7
	2012	1,692.7	1,247.9
Phosphates*	2013	35	-
	2012	30	-
	2011	30	-

**DAP or phosphoric acid, P_2O_5 basis* *Source: IFA*

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"Iran is moving ever closer to a return to the world market as a participant free of restrictions".

Analysts CRU agree that greater access to markets will mean Iran no longer needs to "dump" urea on Indian markets. This in turn should allow Chinese and Black Sea producers to achieve higher netbacks on their Indian business.

"Following the lowering of sanctions, Iranian nitrogen producers will likely repair and refit weary plants that have been absent from Western engineering services and parts since 2011," predicts CRU. "Urea and ammonia production should increase as productivity improves at refitted plants and Iranian access to the major Atlantic and Mediterranean nitrogen markets is restored."

A startling project slate

Although exact figures vary, the revitalisation and expansion of Iran's oil and gas industry, both upstream and downstream, will require investment on a massive scale. The country is said to be seeking a long term investment of $85 billion to develop its petrochemicals sector, according to some industry reports late last year.

Around $70 billion alone is needed to finish stalled petrochemical projects at various stages of completion, according to Abbas Shari Moqaddam, the head of Iran's National Petrochemical Company (NPC). Moqaddam had previously valued the foreign investment opportunity in Iranian petrochemicals at $30 billion.

Unfortunately, obtaining reliable information on Iranian petrochemical production and projects is notoriously difficult.

However, the NPC did release detailed information on a slate of 67 projects in a 90-page report last spring[1]. The eventual completion of these projects could see Iran's petrochemical capacity more than double, from around 59 million t/a currently to 120 million t/a tonnes. The report carries particular weight as the NPC, a state-owned subsidiary of the oil ministry, is ultimately responsible for the development and operation of the country's petrochemicals sector.

Of the 67 projects listed by the NPC, a group of 26 projects within the Pars Special Economic/Energy Zone at Assaluyeh is especially significant as their development would deliver nearly 60% (35.7 million t/a) of the projected petrochemicals capacity increase, including four major ammonia/urea schemes.

Table 4: **Iran's petrochemical project slate**

Product	Capacity ('000 t/a)
Methanol	19,140
Urea	10,750
Ammonia	7,445
Ethylene	5,318
HDPE	1,940
Propylene	1,582
MEG	1,500
LLDPE/HDPE	1,200
PP	750
Styrene	675
LDPE	600

Source: ICIS/National Petrochemical Company

A further eight projects planned as part of the Mahshahr Petrochemical Special Economic Zone would add 1.4 million t/a to petrochemicals capacity. The remaining half (23.9 million t/a) of the planned capacity increase depends on the realisation of a further 33 petrochemicals projects in other parts of Iran. Further Special Economic Zones may be needed to encourage their development, according to the NPC.

The 67 projects, which include five world-scale cracking plants, would add a total of 5 million t/a to Iran's ethylene capacity and a massive 19 million t/a to the country's methanol capacity, based on an analysis by ICIS (Table 4). Ten nitrogen projects on the list would also increase Iran's urea capacity by a staggering 11 million t/a, if realised, a figure that rises to over 12 million t/a if two additional investment opportunities are added (Table 5).

Iran's current slate of nitrogen projects were initiated between 2006 and 2014 and are scheduled to be completed over the next two years. This timescale is largely notional and is unlikely to be kept to given past slippages. Most projects are at a very early stage of development and less than a third are complete, as of March 2015. Further progress is also largely contingent on investment being secured.

Only two of the 12 nitrogen projects, the 93% complete '7th Ammonia/Urea' project (Shiraz Petrochemical Co) and the 76% complete '16th Ammonia/Urea' project (Pardis Petrochemical Co), are close to being finished (Table 5). Both projects are included in IFA forecasts and likely to reach fruition this year or next.

Seven of the ammonia/urea projects on the NPC's list are of identical specification, being based on a 680 t/a design capacity for ammonia and a 1,075 t/a design capacity for urea. Casale is providing the ammonia technology and Stamicarbon the urea technology for plants of this specification. Stamicarbon has a strong track record in Persia, with 10 Iranian plants on its current reference plant list. The company should therefore be well-placed to benefit from any revival of inward investment. Toyo, Haldor Topsoe and Saipem are named as technology-providers for other projects.

Methanol and urea no longer a priority

Fresh doubts about Iran's plan to boost petrochemicals production emerged at the end of last year, following statements by NPC planning and development director, Hamid Reza Rostami.

Rostami told Iran's Shana news agency in November that the NPC had decided to defer the development of new methanol and urea projects because production was already excessive, making the construction of new plants unnecessary. He said some projects were being "deprioritised" and put on hold due to market conditions. Iran's petrochemical plans required investment of $8-10 billion in Rostami's view.

"Construction of some methanol and urea projects are being put off to a later time," Rostami said. "Iran is no longer seeking only investors in its petrochemical sector, rather it eyes investors with technologies and project management skills."

No immediate renaissance

Difficulties in accessing global finance and technology in the immediate aftermath of the lifting of sanctions means many Iranian petrochemical projects could be delayed further, according to ICIS. Although new Iranian capacity, even on a modest scale, would still add to imminent global overcapacity.

"Extra Iran production will pressurise the new Middle East projects coming on stream," comments ICIS Consulting's Karl Bartholomew. "The question is: do we have enough demand? With the Middle East and US increasing production – and if Iran is able to increase operating rates – we will have a lot of basic petrochemicals looking for a home."

Table 5: **Iran's current nitrogen project slate**

Project	Company	Location	Product	Capacity ('000 t/a)	Technology	Completion	Progress* (%)
7th Ammonia/Urea (Shohadaye Marvdasht)	Shiraz	Marvdasht, Shiraz	Ammonia Urea	680 1,075	Casale Toyo	2016	93.4
16th Ammonia/Urea (Pardis Ammonia/ Urea Phase 3)	Pardis	Pars Special Economic/Energy Zone, Assaluyeh	Ammonia Urea	680 1,075	Kellogg Stamicarbon	2016	76
11th Ammonia/Urea	Lordegan	Lordegan, Charmahal Va Bakhtiari	Ammonia Urea	680 1,075	Casale Stamicarbon	2017	32.5
10th Ammonia/Urea	Zanjan	Zanjan	Ammonia Urea	680 1,075	Casale Stamicarbon	2017	22.2
14th Ammonia/Urea	Hengam	Pars Special Economic/Energy Zone, Assaluyeh	Ammonia Urea	725 1,075	Haldor Topose/ Saipem	2017	18.8
12th Ammonia/Urea	Golestan	Agh-ghala, Golestan	Ammonia Urea	680 1,075	Casale Stamicarbon	2017	15.3
9th Ammonia/Urea	Masjid Soleiman	Masjid Soleiman	Ammonia Urea	680 1,075	N/A N/A	2017	6.8
13th Ammonia/Urea	Hormoz Urea	Pars Special Economic/Energy Zone, Assaluyeh	Ammonia Urea	680 1,075	N/A N/A	2017	5.4
8th Ammonia/Urea	Lavan	Pars Special Economic/Energy Zone, Assaluyeh	Ammonia Urea	680 1,075	HEDCO Stamicarbon	2018	2.1
15th Ammonia/Urea	Ardabil	Ardabil	Ammonia Urea	680 1,075	N/A Stamicarbon	2018	Initial stages
2nd Ammonia/Urea	Kermanshah	Kermanshah	Ammonia Urea	396 660	N/A N/A	N/A	Initial stages
Sarakhs Ammonia/Urea	Naft/Razavi Oil & Gas	Sarakhs	Ammonia Urea	680 1,075	N/A N/A	N/A	Initial stages
Total			**Ammonia**	**7,921**			
			Urea	**12,485**			

**March 2015*

Source: National Petroleum Company

Chemical exports from Iran, similar to the rest of the Middle East, are likely to be targeted at Asia, Africa and Europe in Bartholomew's view.

Integer Research's lead nitrogen analyst, Laura Cross, does not foresee "any significant changes in the nitrogen market" following the lifting of sanctions, at least in the short-term

"The first consequence would be access to previously restricted export markets, which would incentivise Iranian producers to increase their utilisation rates," said Cross. "But ramping up transport logistics and port capacity in order to process increased nitrogen exports is neither quick nor cheap."

Because of this, Iran's current urea trade with India (1-1.5 million t/a) and exports to neighbouring countries and Latin America (0.5-1 million t/a) may well continue as normal at least in the short-term.

"The most logical markets for Iranian product would include Latin America, which has room for further urea imports, and the Far East which historically imported ammonia from Iran," said Cross. "Indeed, there is a significant Iranian nitrogen capacity that is not currently utilised – and in the longer term the country is well placed to displace nitrogen trade from elsewhere, political conditions permitting."

Iran may eventually emerge as "a well-positioned, relatively low-cost source of nitrogen production", suggests Cross, if unrestricted investment and exports are eventually secured. But a lot hinges on how investors perceive the risks and merits of pursuing Iranian nitrogen projects, in her view, especially "when there are currently ample opportunities elsewhere in the nitrogen market".

Cross urged caution, saying this was yet another reason for believing that the renaissance of Iran's nitrogen industry will only occur over the longer-term. ■

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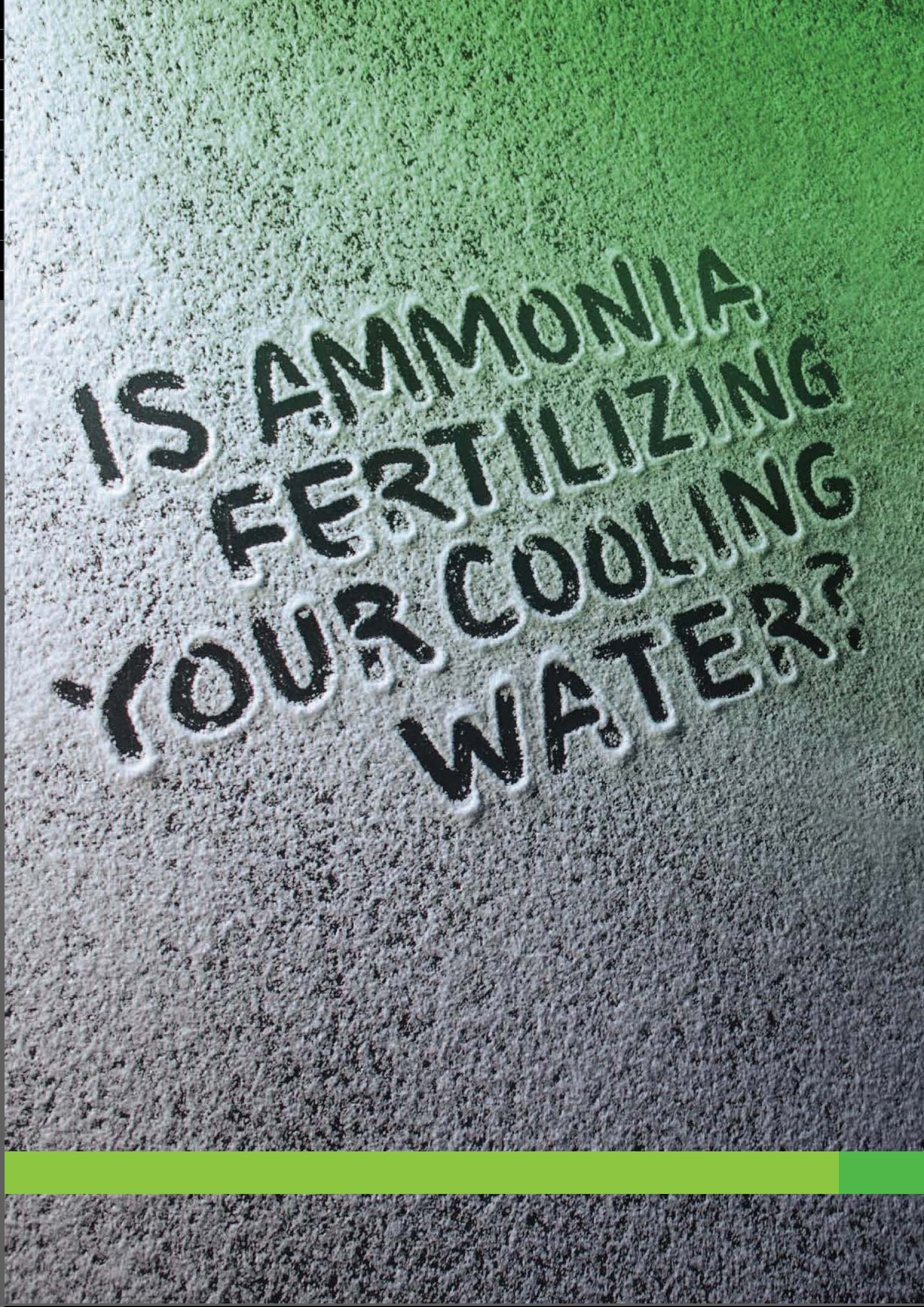
IS AMMONIA
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YOUR COOLING
WATER?

Fertilizers for fine wines and vines

We look at vital contribution nutrients make to successful grape growing at commercial vineyards across the globe. Wine grapes are grown for the quality of their berries and juice, whereas yield, taste and appearance are the most valued characteristics of table grapes. The application of potassium and nitrogen, in particular, strongly influences wine quality, colour and taste.

The global wine industry has overcome adversity and expanded into new regions in 2015. North America winemakers have coped well with low rain levels last year and the industry is continuing to invest in new vineyards in countries such as the UK.

California's vintners, for example, although affected by severe drought, are expecting a stellar 2015 vintage. "The quality of the 2015 vintage for California state-wide is excellent," said Wine Institute president and CEO, Bobby Koch.

"This is a vintage of exceptional quality," added Montse Reece of Pedroncelli Winery in Sonoma County. "This has been an early and light harvest, with smaller berries and concentrated fruit flavours."

England's cool, wet and variable climate has not prevented it establishing a small but increasingly well-regarded sparkling wine sector. The quality of award-winning English wines is such that renowned French champagne house Taittinger bought up 70 hectares of Kent farm land in December. This plot of south-facing chalkland is said to be ideal for growing Chardonnay, Pinot Noir and Pinot Meunier vines, and Taittinger plans to produce an English version of champagne, named Domaine Evremond, within five years.

Production and yield

In 2013, more than 77 million tonnes of grapes were harvested globally from a land area or around 7 million hectares (Figure 1). Yield improvements over the last decade have seen world production grow by 13.6 million tonnes and harvested area contract by 336 thousand hectares.

China, Italy, Spain, the United States and France are the five leading grape growing countries and collectively produced 40.3 million tonnes in 2013, more than half of the world's harvest (Figure 2). Over half of global wine production is also concentrated in just four countries, France, Italy, Spain and the United States.

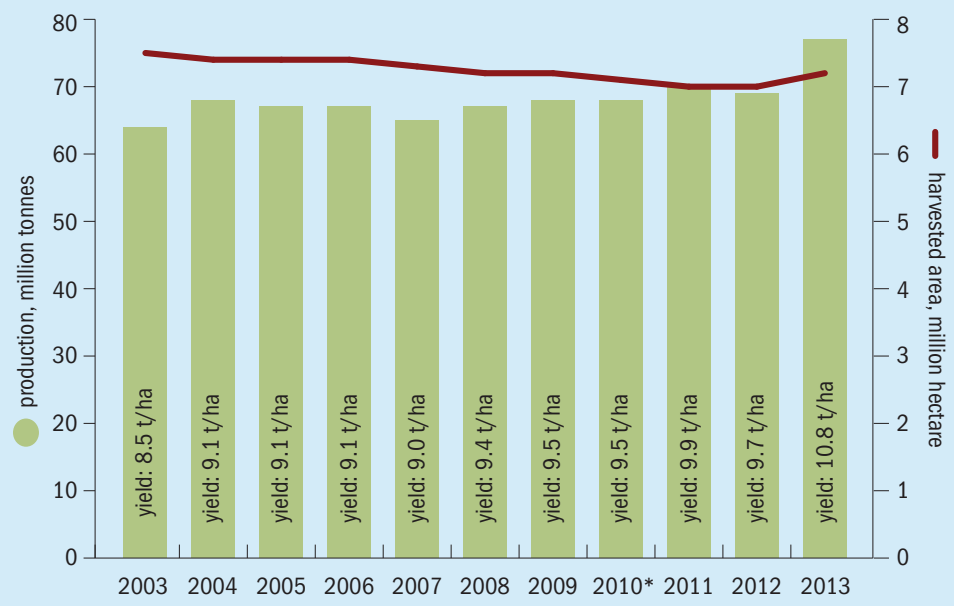
Chile, China, Argentina, Australia and South Africa are also leading winemakers, each producing over one million tonnes in 2013. Iran and India produce over 2 million tonnes of grapes annually but produce little or no wine, according to FAO statistics.

In 2011, around 43 million tonnes, roughly 60% of global grape production, was pressed to produce grape juice and wine. The growing of table grapes, more than 21 million tonnes in 2011, accounts for around 30% of global production and is concentrated in Asia (59%), Europe (17%) and South America (13%). China's production of table grapes has expanded dramatically in the last decade, growing from 1.8 million tonnes in 2000 to 6.5 million tonnes by 2011. Dried grape production, although significant (1.2 million tonnes), accounted for less than 2% of world grape production in 2011.

Average global grape yields have risen by over a quarter in the last 25 years. Yield improvements have been particularly strong in Asia and the Americas, whereas those of mature European producers have remained largely static.

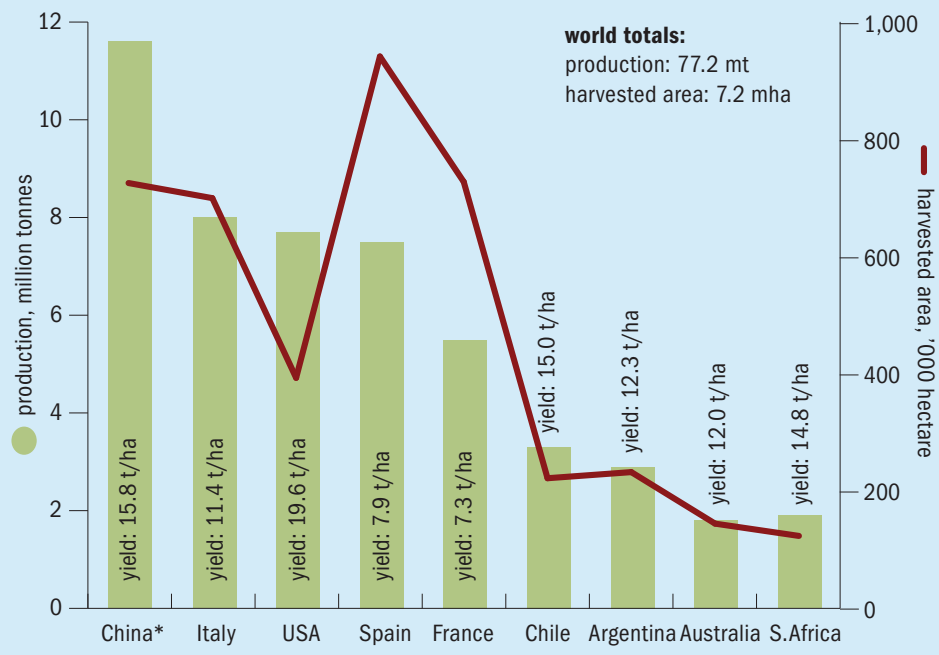
The belief that many winemakers limit yield and vigour due their focus on quality is confirmed by statistics. According

Fig 1: **Grapes: world harvested area, production and yield, 2003-2013**



*recorded the lowest European grape harvest for 30 years. Source: FAOSTAT

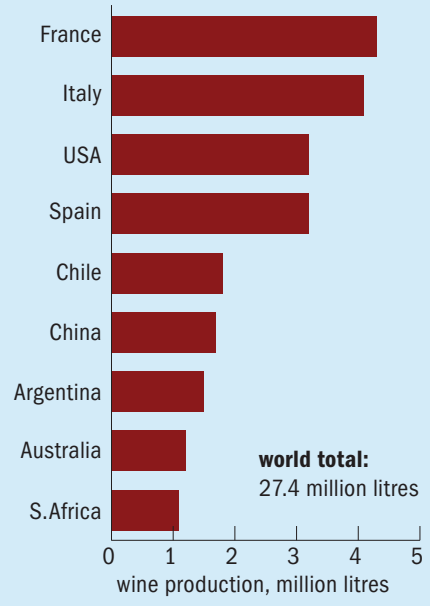
Fig 2: **Grape growing by country, 2013**



*mainland

Source: FAOSTAT

Fig 3: **Wine production by country, 2013**



Source: FAOSTAT

to the International Organisation of Vine and Wine, the average yield (12 t/ha) of Egypt, China, India and Turkey, the main fresh and dried grape producing nations, is almost 50% higher than the average yield of wine producing countries such as Argentina, France, Italy and Portugal.

Varieties and growth stages

Grapevines belong to the genus *Vitis* and consist of about 60 species of perennial flowering vines that mainly originated in the northern hemisphere. Most commercially-grown grapes are cultivars of *Vitis vinifera*, a European species native to the Mediterranean and Central Asia, although some fruit and wine is also produced from American and Asian species, including:

- *Vitis labrusca*, a native of the Eastern United States and Canada that includes the Concord cultivar
- *Vitis riparia*, a North American wild vine used extensively in commercial viticulture, both in hybrid grapes and as a grafted rootstock
- *Vitis rotundifolia*, collectively known as muscadines, is native to the Southeastern United States

It is common practice to graft *Vitis vinifera* grapevines onto the rootstock of North American varieties, typically hybrids of *Vitis berlandieri*, *Vitis riparia* and *Vitis rupestris*, to provide resistance to phylloxera, a sap-sucking insect pest.

As with other crops, vine growth and yield depend on the availability of major and minor nutrients due to their role in plant metabolism and photosynthesis. Controlled application of fertilizers is needed to ensure balanced growth between foliage and crop and the rapid ripening of high quality wine and table grapes.

Essential macronutrients such as nitrogen, phosphorous, potassium, calcium and magnesium are taken up in relatively large quantities by grapevines and are found in healthy plants at levels of up to 3%. Micronutrients, including iron, manganese, molybdenum, copper, zinc and boron, are required in much smaller quantities but are no less essential, particularly when high yields are required. Some nutrients are provided in commonly-applied fungicides such as Bordeaux mixture (Cu) and those used to combat oidium (S) and mildew (Mn, Zn).

Reductions in vine growth and yield, and increased susceptibility to disease and winter injury, occur when one or more of these elements is deficient (Table 1). Deficiencies also have a direct impact on grape and wine quality by affecting the pH, colour, phenolic content, fermentation and flavour of harvested fruit.

Vineyard productivity and profitability therefore ultimately depend on nutrient availability and the correctly timed application of fertilizers.

For grapevines, the timing of fertilizer applications is influenced by six critical growth stages over the course of the season:

- **Bud burst:** buds swell and shoot between the vine stem and the petiole
- **Early flowering:** the first flowers open
- **Fruit set:** berries start to develop
- **Berry fill:** berries grow in size
- **Veraison:** berries soften, change colour and start to ripen
- **Post-harvest:** reserves build-up in the roots and trunk prior to winter dormancy

Nutrients and quality

Yield, taste and appearance are the main production objectives of table grape growers, whereas berry and juice quality are paramount for wine grapes. Over application of fertilizers can be detrimental to quality. Too much N, for example, typically reduces fruit and wine colour and increases susceptibility to 'bunch rot', a disease caused by the fungus Botrytis cinerea.

Similarly, excess K can adversely affect wine quality by lowering the acidity of berries and the 'must' (pressed grape juice containing skins, seeds and stems). Over application of K also increases vulnerability to grape stem necrosis (stiellaehme), and can induce Mg deficiency by supressing its uptake [1].

The nitrogen requirement of vineyards typically varies with their market niche. A low nitrogen requirement, for example, is associated with fine wine production, or cultivation in colder climates with a short growing season, whereas vineyards producing fresh table grapes typically have the highest nitrogen requirement.

Table 1: **Main nutrient functions and deficiency signs in grapevines**

Nutrient	Function/influence	Signs of deficiency
Nitrogen	• Shoot growth in spring • Prevents premature leaf fall in autumn • Initiates inflorescence • Berry growth and development after fruit set	• Overall reduction in growth • Leaves become uniformly light-green or yellow
Potassium	• Shoot growth in spring • Berry size and ripening	• Yellowing (white varieties) or bronze-reddening (red varieties) of older leaf margins • Leaf margins become necrotic and curl upwards as the deficiency worsens and chlorosis develops • Poor fruit set
Calcium	• Skin strength of berries • Controls disorders such as bunch stem necrosis	• Shoot tips become stunted and may die
Magnesium	• Fruit formation • Berry ripening • Seed germination	• Wedge-shaped bright yellow (white varieties) or red (red varieties) areas extending inwards between the veins on older leaves • Necrosis extends inwards from the leaf margins when deficiency severe
Phosphorus	• Shoot growth in spring • Inflorescence initiation • Fruit set	• Stunted shoots • Poor fruitfulness • Bronze/red colouration between the main veins in older leaves early in the season
Sulphur	• Present in chlorophyll, amino acids, and enzymes	• Similar symptoms to N deficiency • Leaves become uniformly yellow
Boron	• Cane maturation and fruit set	• Shoots with a zigzag appearance • Yellow mottling between the veins of older leaves • Small-red-brown spots on edges of leaves • Fruit set poor and different size berries (millerandage)
Iron	• Prevents premature leaf fall in autumn	• Stunted shoots • Young leaves show chlorosis • Leaves very pale with necrotic blotches when deficiency severe
Manganese	• Required for chlorophyll synthesis	• Older leaves with yellow mottling between the veins
Zinc	• Fruit set • Controls intermodal elongation	• Shoots with a zigzag appearance • Mottled, light-coloured leaf colouring • Small, poorly developed bunches with different size berries (millerandage)
Copper	• Cane maturation	• Short internodes and dead shoot tips • Small, yellow and distorted leaves
Molybdenum	• Fruit set • Used by nitrogen-fixing bacteria	• Necrosis of leaf margins • Poor fruit set and stunted shoot growth

Source: Proffitt & Campbell-Clause (2012)

Nutrients and wine making characteristics

Berry size affects colour by controlling anthocyanin, the main colorant in red wines, and the level of flavour-providing compounds such as tannins. The anthocyanin content of wine ranges from 0.1-8 g/l, with higher levels generally associated with good quality, fine red wines.

The potassium content of grapes is also important as it affects pH, and influences the taste and the sugar/acid balance of wines. Acceptable levels of potassium in the must of French wines are 1-2.5 g/l, for example.

The nitrogen content of wine grapes strongly influences the fermentation process. Alcohol production generally requires a must with a yeast-available nitrogen content of more than 140 mg/l. Nitrogen composition is also important and the presence of the amino acid arginine is particularly valued as it indicates 'nitrogen richness'. Total nitrogen content and arginine concentration are both linked to the timing and application rates of nitrogen fertilizers.

Grapevine nutrient needs

Nutrient uptake and removal will vary according to grapevine variety, rootstock, crop yield, soil and climate, and will also depend on whether the vineyard is rain-fed or irrigated. Planting density is another factor and can range from 1,000 to 10,000 vines per hectare.

Yields, in particular, are highly variable (5-35 t/ha) and depend on both vineyard practice and whether production is for fine wine, ordinary wine or table grapes. Typical macronutrient and micronutrient removal rates are shown in Table 2.

In practice, however, the net removal of nutrients at harvest is generally much lower than the rates in Table 2. This is because the practice of returning vine stems and leaves to soil also returns about 70% of N and 60% of P and K uptake[1].

Fertilisation requirements are generally determined annually using plant analysis, combined with observations of grapevine vigour and fruit quality. Plant analysis provides an accurate assessment of nutrient status and can also reveals any hidden

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Table 2: **Example nutrient removal rates for grapevines in mature vineyards**

		Major nutrient uptake/removal (kg/ha/year)				
Source	**Yield (t/ha)**	**N**	**P_2O_5**	**K_2O**	**MgO**	**CaO**
IFA	7-25	22-84	5-35	41-148	8-25	28-204
Haifa	20	160	60	190	48	360
		Micronutrient uptake/removal (g/ha/year)				
Source	**Yield (t/ha)**	**Fe**	**B**	**Mn**	**Zn**	**Cu**
IFA	7-25	292-1,121	37-228	49-787	110-585	64-910
Haifa	20	895	180	630	470	730

Source: IFA/Haifa Chemicals

deficiencies before these are displayed by the grapevine.

Nutrient status is checked by analysis of the whole leaf (French method), the petiole (Californian method) or the leaf blade (South African method). Sampling typically takes place at veraison or the end of flowering, although some vineyards sample at both stages. For each element, nutrient status is categorised as deficient, marginal, adequate, high or toxic depending on the results (Table 3).

The nutrient status classification in Table 3 was developed from Californian and Australian agronomic data and is suitable for high yielding (8-15 t/ha or more) irrigated vineyards[2].

To supplement plant analysis, the nutrient availability and retention characteristics of soils can be assessed by measurement of pH, organic matter and cation exchange capacity.

Nitrogen for strong, early growth

Nitrogen promotes strong, early growth and improves grapevine yields by boosting bunch size and berry weight. Vines with an abundant supply of N have dark green foliage, grow vigorously and form dense canopies.

Excess nitrogen adversely affects vine productivity. Shading from too much vegetative growth results in less fruitful buds and also reduces fruit set. The availability of too much nitrogen in the later stages of growth also delays maturity and increases the risk of grape disease prior to harvest.

Grapevines consume about 50% of their annual nitrogen requirement during a rapid period of spring growth after bud break. However, nutrient uptake is generally slow during bud break and demand at this stage is primarily met from internal nitrogen stores[3].

Nitrogen uptake instead peaks during flowering and veraison, a critical stage in grape berry ripening marked by a change in colour. The late spring application of N, at the fruit set stage when the risk of frost has passed, is ideal as it coincides with rapid demand from developing grape clusters, shoots and leaves. Subsequent post-harvest application of nitrogen is also an excellent way of ensuring N is taken up and stored to support growth the following season.

Potassium to promote grape growth

Grapevines also require large quantities of potassium as it plays a vital role in berry growth and controlling the acidity and pH of grape juice.

Developing fruit clusters are the main sink for potassium in grapevines and demand for K becomes particularly critical during veraison, the period of berry growth and ripening. Root uptake for K is also at its highest during this period, although around half the K needed to support fruit growth is typically met from vine reserves.

Potassium deficiency is not particularly prevalent except in vineyards with sandy

Table 3: **Grapevine nutrient status based on petiole (leaf stalk) analysis**

Nutrient	Deficient	Marginal	Adequate	High	Toxic
Major nutrients and elements					
Nitrogen (%)	<0.7		0.8-1.1	>1.2	
Nitrate (mg/kg)	<340	340-499	500-1,500	1,500-2,500	>2,500
Phosphorus (%)	<0.15	0.15-0.24	0.25-0.50	>0.50	
Potassium (%)	<1.0	1.0-1.3	1.3-3.0	>3.0	
Calcium (%)	<1.0		1.2-2.5		
Magnesium (%)	<0.30	0.30-0.39	>0.40		
Sodium (%)			0.1-0.3	0.4-0.5	>0.50
Chloride (%)			<1.0	1.0-1.5	>1.5
Micronutrients					
Zinc (mg/kg)	<15	15-26	>26		
Manganese (mg/kg)	<20	20-29	30-60		>500
Iron (mg/kg)		7	70		
Copper (mg/kg)	<3	3-6	>6		
Boron (mg/kg)	<25	25-30	31-70	71-100	>100

Source: Proffitt & Campbell-Clause (2012)

Table 4: **Example fertilizer recommendations for Spanish wine and table grapes**

	Nutrient requirement (Kg/ha)				Fertilizer recommendations (kg/ha)			
	N	P_2O_5	K_2O	MgO	KNO_3 (13-0-46)	Phos. Acid (0-61-0)	AN (34-0-0)	$MgSO_4$ (0-0-0-0+13)
Wine grapes, annual total	24	12	42	8	92	19	8	80
	N	P_2O_5	K_2O		KNO_3 (13-0-46)	MAP (12-61-0)	AN (34-0-0)	
Table grapes, annual total	100	50	150		325	81	141	

Source: Haifa Chemicals

soils. Factors such as soil compaction, poor drainage, water stress and pest damage to root systems can, however, limit K uptake and contribute to deficiency. Sparse clusters of poorly-coloured, small-size berries are symptomatic of severe K deficiency.

Potassium is usually applied during early spring a few weeks after bud break but before veraison. Fertigation by drip irrigation is generally more efficient than banded application of K, particularly in soils with a large capacity to fix potassium.

Fertilizer recommendations

Solid fertilizers can be applied in vineyards by broadcasting, banding or below surface, as follows:

- Broadcast application across the whole vineyard area
- Banded application on the soil surface along the vine row
- Placed 15–30 cm below the soil by ripping
- Placed 10–15 mm below the soil by shallow cultivation

Fertigation is also a popular and effective way of supplying N, P and K directly and uniformly to the active root zone of individual grapevines. It can also regulate nutrients to coincide with different growth stages.

Certain nutrients (N, Mg, Zn, Mn) can also be applied as foliar sprays to the canopy, often in chelate form to improve uptake.

Foliar application during the growing season can quickly address plant deficiencies, especially if soil conditions restrict the availability of certain nutrients.

The use of cover crops, mulches and organic fertilizers, such as composts and manures, by vineyards is also widespread. Organic matter low in N such as pine bark and peat are preferred by vineyards producing fine wines[1].

The International Fertilizer Association (IFA) recommends relatively large additions of fertilizers and deep manuring prior to grapevine planting. This ensures that nutrients with limited mobility (P, K and Mg) are available and also corrects the high acidity associated with Al or Cu toxicity[1]. Pre-planting application rates depend on soil and sub-soil analyses but should be within the following ranges:

- Farmyard manure at 0-100 kg/ha
- Liming when soil pH is <6 at 2,000-10,000 kg/ha CaO
- 0-600 kg/ha P_2O_5
- 0-1,000 kg/ha K_2O
- 0-300 kg/ha MgO

In established vineyards, dry fertilizers should be applied to soil underneath the vine canopy in a 1-1.5 m (3-5 ft) wide band at least 0.5-0.6 m (18-24") away from the base of the vines[4]. Nitrogen is conventionally applied (0-40 kg/ha) as an overall dressing in late winter or early spring, according to IFA.

It is general practice for P (20-50 kg/ha P_2O_5) and K (100-150 kg/ha K_2O) to be top dressed together with N on light soils in wet climates or, alternatively, be worked into clay soils during the winter dormant period in dry climates.

A single N application prior to bud break is common in the wine producing areas of California and Europe, whereas a split application, half before bud break and half applied post-harvest, is sometimes recommended for table grape growing regions.

A nitrogen application rate of around 84 kg/ha is commonly suggested, but may range from 34-112 kg/ha in practice. Vines planted in the 'Geneva Double Curtain' system may require double the application rate of single trellis plantings. The application of an additional 45 kg/ha of N may be necessary where a cover crop such as grass is present[4].

Detailed fertilizer recommendations and agronomic advice for vineyards are available from leading suppliers such as Haifa Chemicals, Yara International, Tessenderlo Chemie and ICL. These all emphasise that application rates need to be tailored according to whether table grapes or wine grapes are being grown.

Tessenderlo, for example, advises that table grapes (25 t/ha yield) typically require a N application of 70-80 kg/ha, whereas 30-50 kg/ha of N is likely to be sufficient for wine grapes. The much higher nutrient requirements of table grapes in comparison to wine grapes is also revealed by Haifa's fertigation recommendations for Spanish growers (Table 4). This is also partly explained by the different target yields for table grapes (30 t/ha) and wine grapes (10 t/ha).

Demand for phosphorus is typically low in both wine and table grape production, according to Tessenderlo, and can be limited to 30 kg/ha annually. Adequate levels of P can generally be maintained by banding with single superphosphate (SSP) every two to three years, according to Haifa Chemicals. ■

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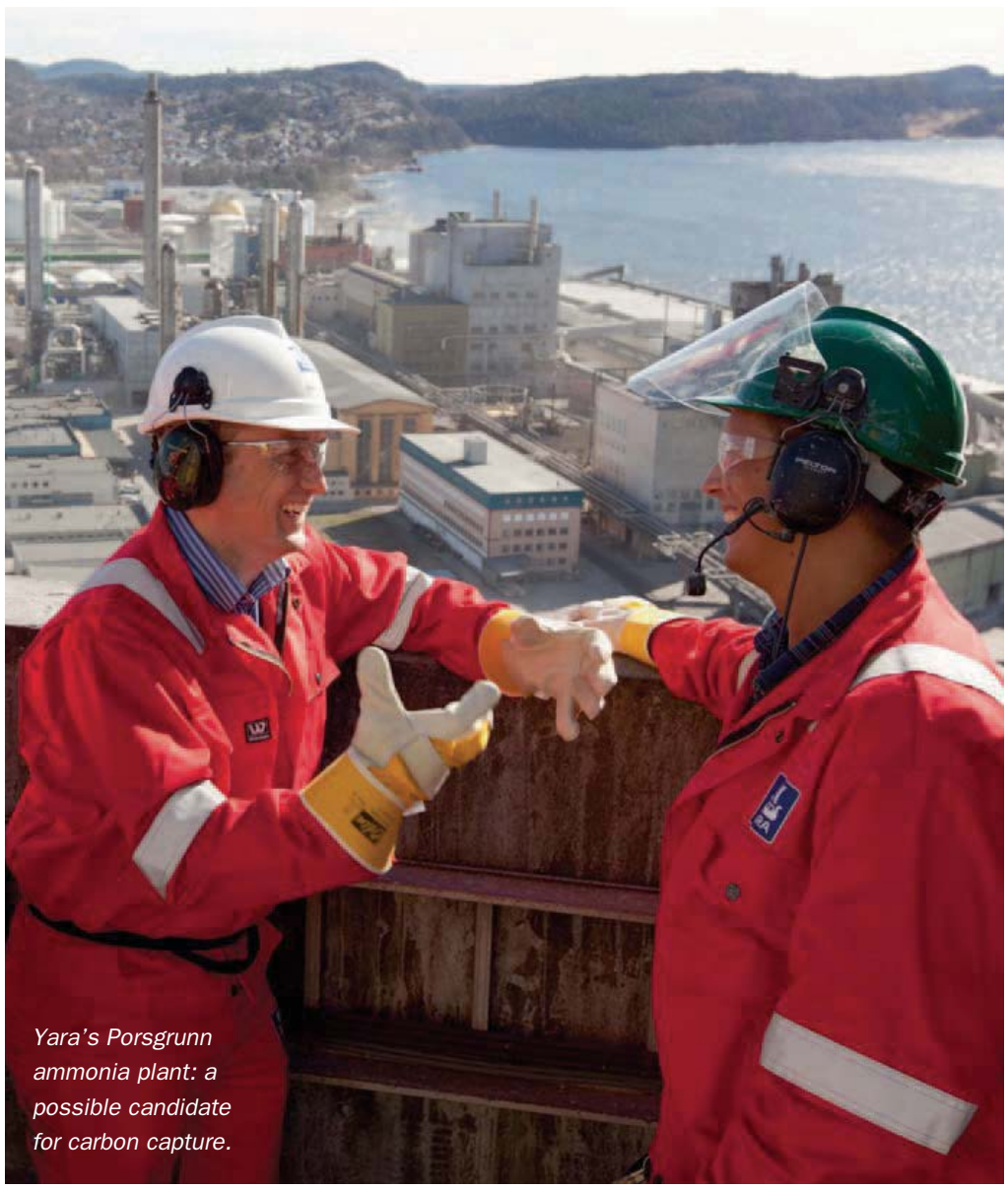
Cutting and capturing carbon emissions

Carbon abatement is firmly back on the fertilizer industry's agenda following last year's Paris climate change agreement. Ammonia production is coming under particular scrutiny because of its scale and energy intensity. However, for ammonia plants using the steam methane reforming process, only incremental and limited cuts to carbon emissions are likely to be possible in future. We assess the main technological options for more drastic carbon cutting at ammonia plants, including biomass gasification, electrolysis using renewable electricity and carbon capture and storage (CCS).



Yara's Porsgrunn ammonia plant: a possible candidate for carbon capture.

PHOTO: YARA

The fertilizer industry acted with diligence and foresight ahead of the global agreement on climate change that emerged from the UN's COP21/CMP11 conference in Paris last December.

In the weeks immediately prior to the deal being signed, climate change discussions were centre stage at the International Fertilizer Association's Strategic Forum in Paris in November. Phillip Townsend Associates presented the benchmarking results of IFA's latest ammonia industry CO_2 emissions survey[1]. CF Industries also gave a paper outlining options for reducing CO_2 emissions from nitrogen fertilizer production[2].

IFA is redoubling efforts to reduce greenhouse gas (GHG) emissions from fertilizers, partly by encouraging more research and development on ammonia production processes – and a higher level of ammonia industry participation in its energy efficiency and CO_2 emissions survey.

Responding to the Paris climate deal, IFA consultant John Drexhage argued for: "Robust carbon prices that will work to finance low GHG emissions solutions, including, of course, carbon capture and storage. It should also mean a strategic examination of how and which technologies will be required to supply the net carbon zero future."

Limits of current ammonia production technology

The possible adoption of game-changing low-carbon technologies by the ammonia industry was discussed in a report published late last year by consultants Ecofys[3]. Commissioned by trade association Fertilizers Europe, the report explores the climate impacts of fertilizer production and sets out a long-term 'roadmap' for reducing the industry's energy and GHG emissions intensity by 2050.

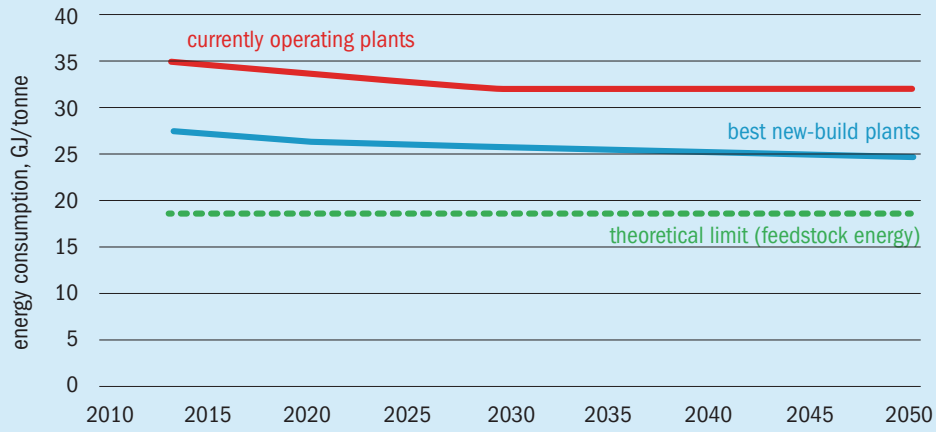
The report builds on a previous 2013 study commissioned by the European Chemical Industry Council (CEFIC)[4]. This set out a pathway for improving energy efficiency and lowering carbon emissions using best available technology (BAT).

The CEFIC study, which looked at production of ammonia from natural gas by steam methane reforming (SMR), concluded that there was potential for cutting the energy use of the current stock of European ammonia plants from the current average of 35 GJ/t to 32 GJ/t NH_3. This would require a number of modifications to existing SMR plants – including reformer section improvements, changes to CO_2 removal, low-pressure synthesis, better process control and process integration (*Fertilizer International*, 468, p31).

CEFIC's report also suggested that very latest SMR plants are capable of achieving an energy efficiency of 28 GJ/t NH_3. These more efficient plants also have a better carbon intensity, around 1.3 $tCO_2/t\ NH_3$, compared to the average 2 $tCO_2/t\ NH_3$ level of the current European plants.

Looking further ahead, greater integration of ammonia production with other industrial processes, or innovative heat recovery systems, could see ammonia plant energy use eventually drop to 26

Fig 1: **Future energy consumption of ammonia production using steam methane reforming**



Source: CEFIC (2013)

GJ/t NH_3 by 2050, forecasts CEFIC (*Fertilizer International*, 468, p31). The latest report from Ecofys goes further, suggesting that future types of SMR plants could ultimately operate at an energy efficiency of 24-25 GJ/t NH_3 by 2050 (Figure 1).

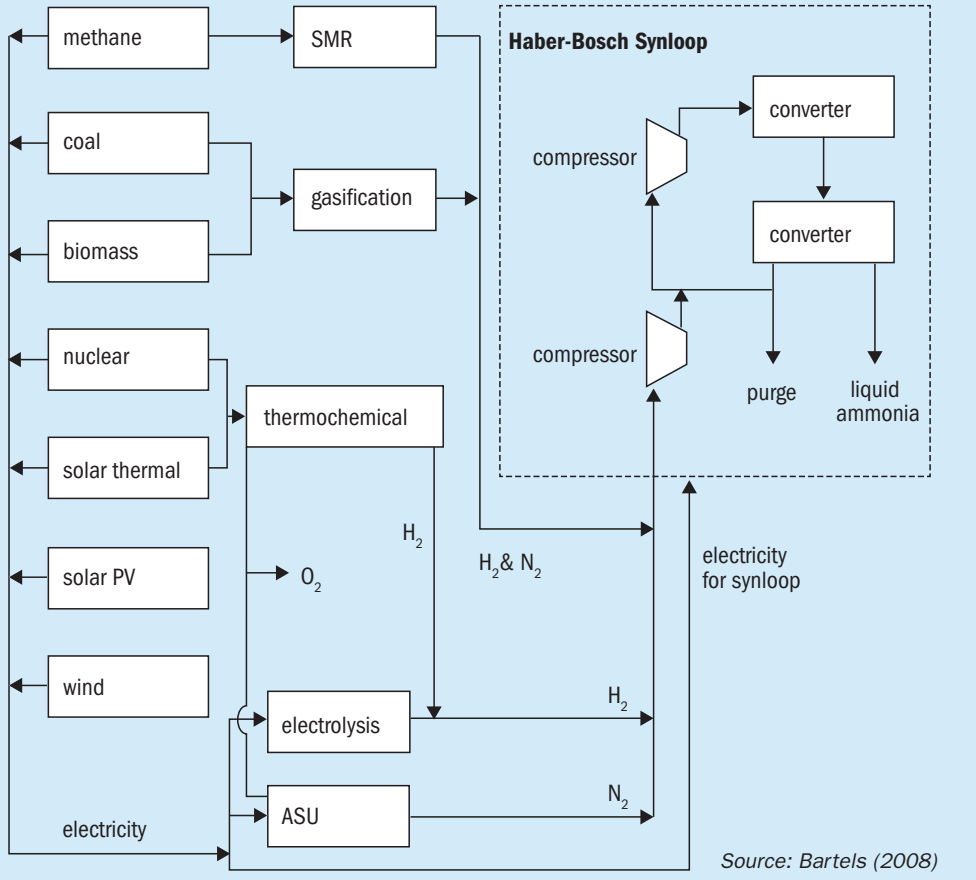
A fall in energy consumption to this level would bring ammonia production closer to the theoretical limits of efficiency for the SMR process. The consumption of natural gas as a feedstock by SMR plants is associated with 18.6 GJ/t NH_3 of energy use, a limit that could never be achieved in practice (Figure 1).

Potential low-carbon game-changers

In the absence of carbon capture and storage (CCS), further abatement of carbon emissions would require ammonia producers to replace SMR with another process for hydrogen/syngas generation (Figure 2). The four main candidates identified in the latest Ecofys study are:

- Biomass syngas production
- Hydrogen from electrolysis using renewable electricity
- Hydrogen from nuclear high temperature electrolysis
- Solid state ammonia synthesis

Fig 2: **Ammonia production flowsheet for different technologies**



Source: Bartels (2008)

Table 1: **Low-carbon ammonia production: main technology options for replacing steam methane reforming (SMR)**

Technology	Large-scale adoption by 2050	Reasons
Biomass syngas production	Unlikely	● Not economically viable as energy use higher than SMR ● Requires the grid supply of competitively-priced biomethane of consistent quality ● Questions over the availability of sufficient biomass and its sustainability
Hydrogen from electrolysis using renewable electricity	Unlikely	● Energy use comparable to SMR ● But not economically viable due to power costs
Hydrogen from nuclear high temperature electrolysis	Unlikely	● Energy use comparable to SMR ● But not economically viable due to power costs
Solid state ammonia synthesis (SSAS)	Unlikely	● Energy use comparable to SMR ● But not economically viable due to power costs

Source: Stork & Bourgault (2015)

Table 2: **Estimated cost of ammonia production using nuclear, solar, wind and biomass energy sources**

Study	Energy source	Process	Ammonia production cost ($/t)
Petri et al., 2006	Nuclear	Electrolysis	1,894-2,462
Glatzmaier et al., 1998	Solar	Electrolysis	2,262,-5951
Levene et al., 2006	Wind	Electrolysis	660-2,432
Padro & Putsche, 1999	Biomass	Gasification	488-1,519

Source: Iowa State University review, Bartels (2008)

For a number of reasons, Ecofys concludes that steam methane reforming will remain the dominant technology for ammonia production up until 2050 (Table 1). This picture could change, however, if a 'hydrogen economy' was to emerge and competitively-priced hydrogen became available. Furthermore, electrolysis and solid state ammonia synthesis could potentially become attractive, Ecofys admits, if renewable power becomes abundant and cheap in future.

Others are more optimistic about the potential for innovation. Johnson Matthey is developing a number of new technologies able to generate syngas from 'clean energy' sources such as biomass gasification and electrolysis using solar and wind power.

It concludes that the prospects for increased syngas production from renewables sources looks promising, as the technologies are becoming less expensive and will also be needed to help meet the European Union's 2050 climate policy goals (*Nitrogen+Syngas*, 328 p 22).

Other research has also concluded that biomass gasification for ammonia production is economically competitive with SMR at current biomass feedstock and ammonia prices – and can deliver GHG reductions of 65%[5]. But, as Ecofys suggests, the amounts of biomass required remains a major practical hurdle to implementation at scale.

A biomass plant producing a relatively modest 410,000 t/a of ammonia, for example, would require 1.2 million t/a of feedstock – more than the world's largest biomass power plant. The viability of biomass gasification is also highly sensitive to ammonia pricing, and uncertainties over capital costs means that investing in this technology currently carries very high risks[5].

The cost hurdle

The energy consumption of many low-carbon ammonia production options, with the exception of biomass syngas production, is broadly similar to that of SMR (Figure 3). Doubts about the economic viability of these technologies – as highlighted by Ecofys –are instead due to their prohibitively high power costs relative to SMR[3].

The electrolytic synthesis of ammonia combines the use of electrolysers and air separation units (ASUs) with Haber-Bosch synthesis (Figure 2). Typical energy costs for this production route, based on hydroelectric generation, have been estimated at around $600/t, for example, compared to a fuel cost of $30-40/t for ammonia synthesis using natural gas.

The total costs of ammonia production by conventional SMR are somewhere in the region of $200-400/t, according to Bloomberg New Energy Finance, and could rise as high as $500 by 2025 under some scenarios. Estimates of ammonia production costs using nuclear, solar, wind and biomass energy sources vary widely, but are generally far in excess of SMR. (Table 2)

Recent studies put the cost of ammonia production from renewable hydrogen at between $660-1,320/t compared to a cost of $180-260/t for current SMR production, roughly 4-5 times more expensive[7]. Capital costs for a centralized 20,000 t/a hydrogen plant for methanol or ammonia production are thought to be around $60 million currently with annual operational expenditure of $3.3 million also likely.

Solar PV and wind turbine electricity generating costs have undoubtedly fallen drastically in recent years. Yet doubts over their viability and suitability for ammonia production remain.

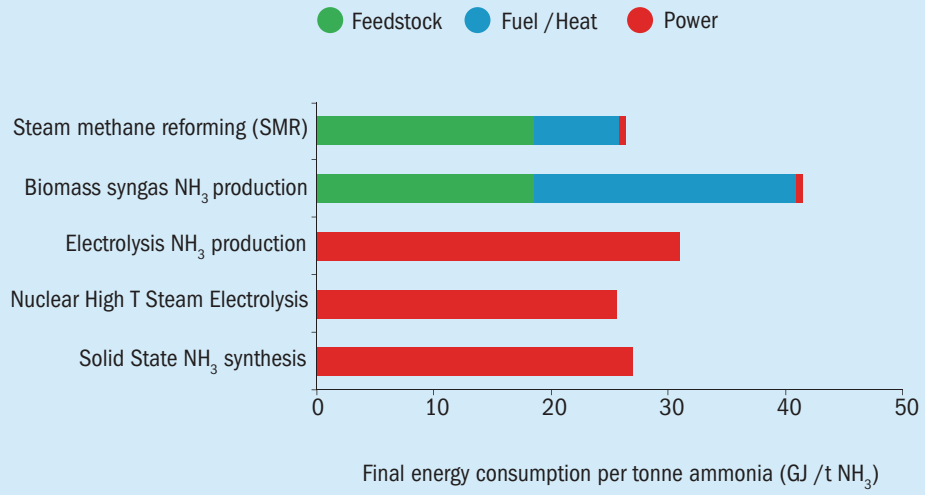
Even very high levels of carbon taxation may fail to make ammonia derived from wind power commercially attractive, according to

a 2015 economic evaluation of a small-scale ammonia plant (26 t/a) powered by a wind turbine (1.65 megawatt) in Morris, Minnesota[8]. This is because energy costs only represent a small fraction of overall plant costs. Around two-thirds of costs are attributable to capital costs and interest charges instead.

"The overwhelming effects of capital costs and interest charges cannot be overcome by considering other costs, like cheaper energy, which is just 11% at baseline," says the report. "Carbon taxes could make ammonia derived from wind power more attractive, but rates would have to be very high to make much difference."

The Minnesota wind energy plant required an investment cost of $98,714/t and would need to be scaled-up by around 1,000-10,000 times to bring the cost of ammonia production down to $727/t[8]. Wind-based ammonia production on this scale (26,000-260,000 t/a) would still require a capital outlay of $4,724-10,101/t, making ammonia production by the wind power route roughly 5-10 times more expensive than the typical investment cost for a European SMR ammonia plant (around $1000/t)[3].

Fig 3: **Final energy consumption of steam methane reforming compared to potential substitute technologies**



Source: CEFIC (2013)

The promise of carbon capture and storage (CCS)

Given the current cost hurdles for ammonia production from renewable energy, some in the fertilizer industry are instead placing their faith in carbon capture and storage (CCS) as the most viable long-term option for carbon abatement.

"CCS could be a very useful tool to reduce emissions. In the future, I think we could get fertilizer production down to practically a zero-emissions footprint," Antoine Hoxha, Fertilizers Europe's technical director, commented last August.

Ecofys broadly agrees and says that CCS holds the most promise for delivering large GHG emission reductions between now and 2050[3].

"In the future, if cost-efficient CCS and logistics systems become available, nearly all CO_2 generated in ammonia plants could be dealt with," concludes Ecofys. "In practice, if the CO_2 from combustion processes could be cleaned in a cost-efficient manner, the European Fertilizer industry has the potential to come close to zero emissions."

Mitsubishi Heavy Industries (MHI) has been a major player in the commercial development of CCS technology. The firm's proprietary *KMCDRProcess* (Kansai Mitsubishi Carbon Dioxide Recovery) technology has been licensed to GPIC, Bahrain, and several Indian fertilizer companies (*Fertilizer International*, 452, p27). MHI's carbon capture technology uses a trademark amine solvent (*KS-1*) to recover up to 200-450 t/d of CO_2 from reformer flue gases at ammonia plants. The captured CO_2 is typically recycled as a feedstock for urea production.

In Europe, Norway has set itself the goal of bringing a CCS demonstration project to fruition by 2020. State-owned company Gassnova is leading Norway's efforts on carbon capture and submitted a pre-feasibility report on full-scale CCS to the Norwegian government last spring.

"There is a broad political support for the fact that CCS technologies will form a vital part of the solution to tackle climate change," says Tore Amundsen, Gassnova's former chief executive. "Reaching our climate goals will be much more expensive without CCS."

Gassnova is currently negotiating a contract with Yara for a full-scale CCS feasibility study at its 520,000 t/a Porsgrunn ammonia plant. The plant's total CO_2 emissions are around one million t/a. The capture of 210,000 t/a of CO_2 at Porsgrunn is feasible using existing technology, according to Yara.

Advantageously, Yara already possesses extensive expertise in liquid CO_2 handling, storage and logistics. As Europe's largest liquid CO_2 producer, Yara has access to port facilities and a fleet of tankers able to transport the CO_2 generated at its Porsgrunn and Sluiskil ammonia production sites. ■

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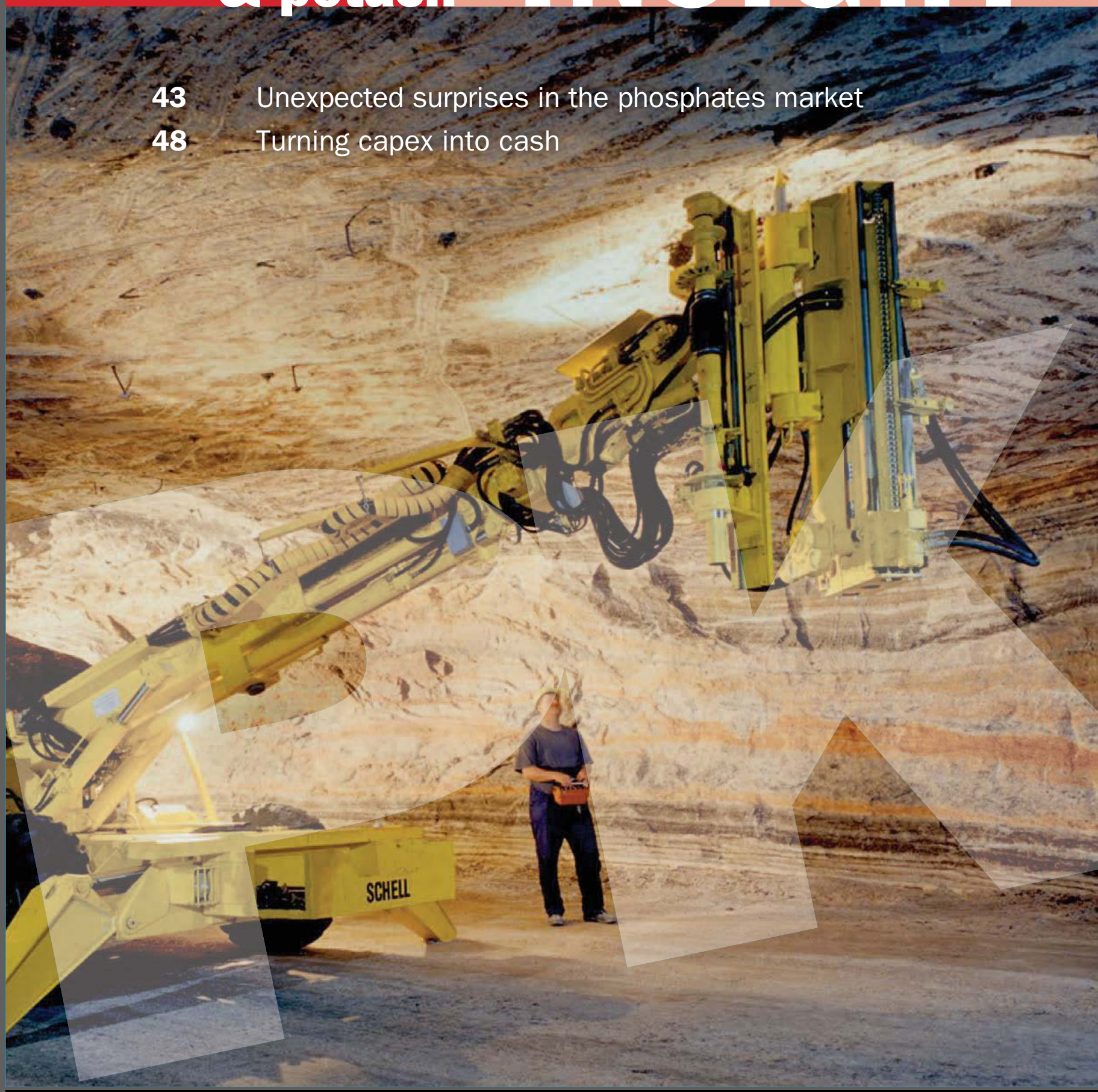

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BCInsight

Unexpected surprises in the phosphates market

A host of negative drivers conspired to drive down the phosphates market in the latter part of 2015. We discuss changes in the supply, consumption and trade in phosphate products over the last 12 months with **Mike Rahm** of the Mosaic Company. Fortunately, disappointing Brazilian phosphate demand last year was largely countered by a strong resurgence in Indian buying. Chinese exports also reached new heights, making up shortfalls from other producers.

Mike Rahm.

Global phosphate product shipments reached 65.2 million tonnes in 2014, based on the latest estimates from the Mosaic Company and analysts CRU (Figure 1), and are projected to rise by just over 250,000 tonnes to 65.5 million tonnes in 2015. Prospects for 2016 also remain reasonably positive, with phosphate shipments in the region of 66-68 million tonnes anticipated.

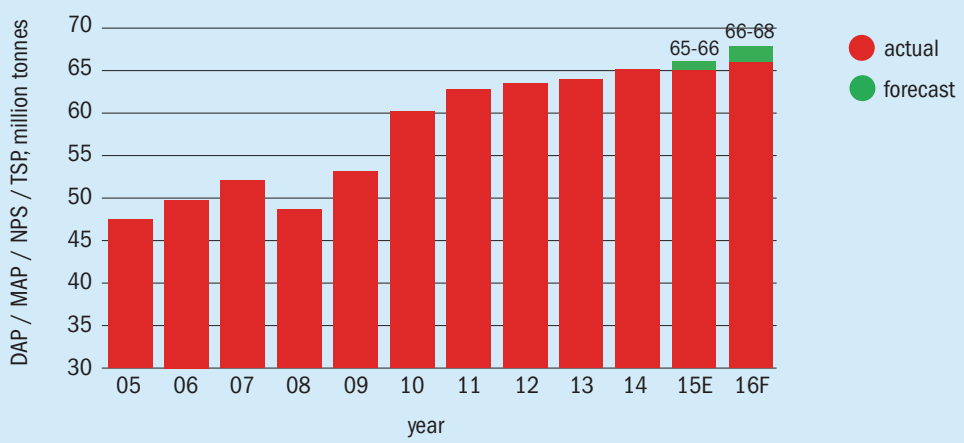
2014 sets the scene

Looking back, 2014 saw a marked shift in phosphate trade patterns. Chinese exports reached record levels and made significant inroads into increasingly distant markets. Global trade volumes (circa 24 million tonnes) also leapt by 7% (1.7 million tonnes) in 2014, driven by record US imports, growth in Brazil and a moderate rebound in the Indian market.

Extra demand in 2014 was mainly met by increased exports from China, Morocco and Saudi Arabia. Chinese phosphate exports grew particularly strongly to 6.3 million tonnes in 2014, up from 5.3 million tonnes in 2013 and topping the country's previous 2011 export peak of 6.0 million tonnes. Lower-than-expected demand from India saw China export almost as much phosphate to Brazil in 2014 (1.02 million tonnes) as it did to the subcontinent (1.08 million tonnes).

The behaviour of four countries, India, Brazil, China and the US, has strongly influenced the phosphate market in recent years, particularly as they collectively account for over half of global phosphate consumption. Developments in these four pivotal countries continued to shape the phosphates market in 2015, as discussed below.

Fig 1: **Global phosphate shipments**



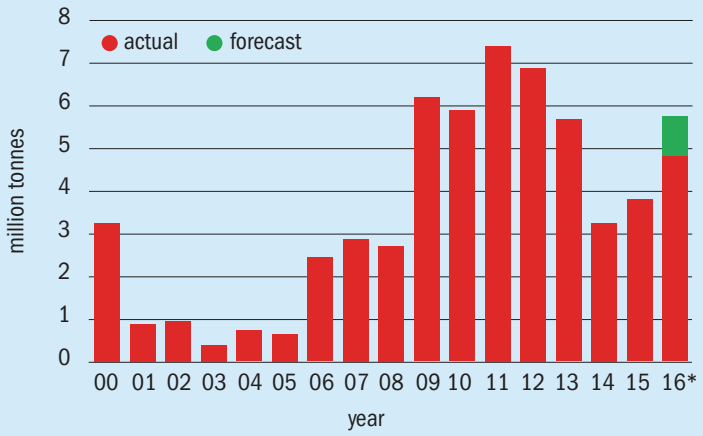
Source: CRU / Mosaic

Banking on India

Going back a year, analysts predicted that growing Indian demand, stalling Chinese production and the dollar's strength were likely to have the most impact on the phosphates market in 2015. Indian DAP imports, which peaked at over seven million tonnes in 2011, languished at just over three million tonnes in 2014. Yet expectations of a revival in Indian phosphate imports during 2015 were particularly high.

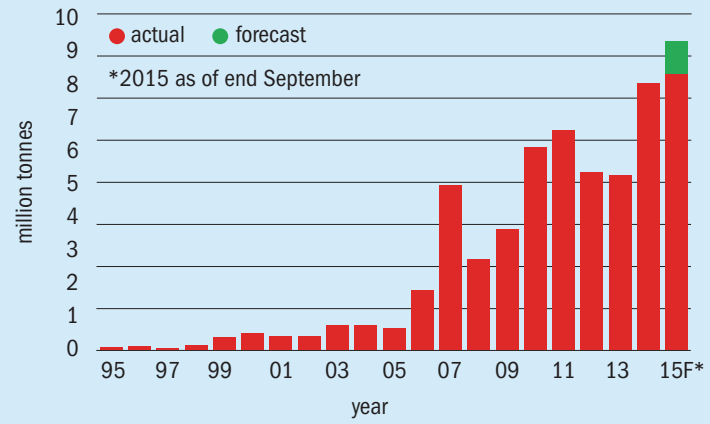
CRU, for example, anticipated imports of 4.5-5.0 million tonnes to help meet 8.0-8.5 million tonnes of Indian demand in 2015. A combined annual DAP/MAP

Fig 2: **Indian DAP imports, by year ending 31 March**



**2015/16 as of end September 2015*

Fig 3: **Chinese DAP / MAP / TSP exports**



Source: China Customs / Fertecon / Mosaic

requirements for Brazil and India of "close to 8.5 or even 9 million tonnes" was expected, barring unforeseen weather or currency issues, with much of this required for shipment between April and September 2015.

Widespread confidence in the likelihood of a rebound in Indian demand was due to a host of factors, including profitable farm economics, empty distribution channels and the relatively stable rupee. The 8% increase in India's P&K subsidy to INR 225 billion announced in February 2015 also helped.

"On Indian demand we have high expectations," Dr Michael Rahm, vice president, market and strategic analysis at Mosaic commented last spring. "Everyone is forecasting Indian imports of 5-5.5 million tonnes. Internally, we're saying we wouldn't be surprised if that tops six million tonnes in 2015."

Rahm's bullish prediction proved to be remarkably prescient. In the event, a 97% rise in Indian DAP/NPK/NP imports to 5.7 million tonnes was subsequently recorded between April and October 2015. DAP accounted for five million tonnes of this volume (Figure 2) with imports now expected to reach 6.3 million tonnes by the year's end.

China continues to be India's biggest DAP biggest supplier, shipping 3.8 million tonnes in the first 10 months of 2015, an import share of 65%. Saudi Arabia was India's next largest DAP supplier with a 20% import share over this period, equivalent to 1.1 million tonnes.

> **"Brazil's performance was one of the year's surprises... we had greater expectations there.**

India bought early, finished early

India came to the market early in 2015, as Rahm explains.

"A combination of a low pipeline coupled with decent import economics translated into a 2-2.5 million tonne increase in imports into India last year. India bought early and finished early, as opposed to a year ago [2014] when their buying continued at very high levels through the fourth quarter."

He continues: "In India, if you look at their imports and phosphate shipments, they had declined in the previous couple of years to low levels. Our assessment was that the pipeline, especially at the retail level of the distribution chain, had been pulled down to very low levels and as a consequence there was a need for restocking.

"Even with erosion of the rupee, and thankfully the rupee didn't erode as much as some of the other currencies, import economics worked. A moderation in DAP prices and the new subsidy regime established on 1 April also made the economics work."

Brazil disappoints

Brazil, as an agricultural commodity exporter, was expected to be a beneficiary of the dollar's strength. Analysts were predicting that the dollar's appreciation, although likely to affect affordability in India, would have an upside for Brazilian farmers in 2015. "They're exporters of crop products and will get dollars in – which for farmers means they will have more money to spend on inputs," CRU's Juan von Gernet commented last spring.

The very clear weakening in Brazilian demand by the middle of 2015 therefore came as a surprise. "Demand from Brazil remains a disappointment to global phosphate exporters," CRU noted in August. "Brazil imports of all phosphate-based fertilizers between January and July were down by 21% against last year with imports of DAP and MAP seeing the biggest falls."

This disappointing performance continued as 2015 progressed with combined Brazilian MAP/DAP/TSP/SSP imports down a fifth year-on-year to 3.9 million tonnes between January and October.

Brazil's performance was one of the year's surprises, admits Mike Rahm, as "we had greater expectations there". Currency volatility and credit availability appear to be partly to blame, as Rahm explains.

"The confusing macroeconomic environment, political uncertainties, the depreciation of the reais, and how that played out in terms of lack of credit and competition for credit in Brazil, had a greater impact on demand than we initially thought. It's not only the depreciation of the reais but some of the volatility of the reais that caused Brazilian importers to say 'do I wait a little bit longer or not?'."

The build-up of inventories in Brazil during 2014 was another complicating factor. The "pretty ample pipeline inventories" at the start of the year were very likely to have been partly responsible for the "decline or stagnation in imports" seen in 2015, according to Rahm.

However, Brazilian demand should re-emerge at some point, if past experience

is anything to go by. “A weak reais has always been associated with a very strong performance of their agricultural sector,” comments Rahm.

He added: “Nine dollar soybeans and a four reais to the dollar exchange rate will result in very attractive farm economics eventually. The fact that it didn’t take hold as quickly as we expected was one of the year’s surprises.”

Chinese exports scale new heights

The start of a long-predicted slowdown and shakeout in the Chinese phosphate industry had been thought likely in 2015. Timing is always problematic, but CRU expected Chinese phosphate production to “catch a cold” in 2015 due to a combination of lower exports and a decline in domestic consumption, the latter linked to excess application of phosphate and agricultural and environmental policy changes.

In fact, quite the opposite has happened with China’s combined DAP and MAP exports surging to 8.6 million tonnes between January and October 2015, a two-thirds year-on-year rise (Figure 3). Chinese DAP exports, totalling 7.2 million tonnes between January and November 2015, were also up nearly three-quarters on the preceding year, with 3.6 million tonnes of this going to the Indian market.

Full-year Chinese DAP exports are now expected to reach at least 7.5 million tonnes, a 2.6 million tonne increase on last year’s record DAP export volumes. Chinese producers exported 834,000 tonnes of DAP in November alone, 200,000 tonnes more than in November 2014, including 387,000 tonnes to India and 117,000 tonnes to Bangladesh.

Mike Rahm expects 2015 to go down as a record year for Chinese phosphate exports, which could even reach 11 million tonnes by the year’s end.

“China exported a little over 8 million tonnes of phosphate products, DAP, MAP and TSP, in 2014, and through to November [2015] the figure is 10.5 million tonnes,” says Rahm. “If they have a decent December, they could export 11-11.5 million tonnes of product this year – that would obviously be an all time record.”

China makes up the shortfall

The inter-linked nature of Chinese supply and Indian demand are partly responsible for this export surge.

“India’s imports are up about 2.4-2.5 million tonnes and China’s exports could be up about 2.5-3 million tonnes as well,” Rahm notes. “So there’s a little bit of symbiotic relationship there, as India’s adsorbed a lot of that increase.”

Meeting global requirements for phosphate in 2015 has been a challenge. US plant closures and production hiccups in South Africa, Jordan and Mexico have hit supply. Some of OCP’s capacity has also been offline whilst their Jorf Lasfar phosphoric acid plants have undergone conversion from dry rock to slurry.

Because of this, China ended up supplying much of the growth in phosphate demand in 2015, by making up the shortfall from other producers.

“The world needed more tonnes from China to balance supply and demand,” explains Rahm. “Going around the globe, there have been some production challenges.”

Tunisia continued to run at about 50% of capacity last year because of the political unrest there. South Africa and Jordan

also had production problems, and the first phase of Ma'aden continues to run at about two-thirds of capacity.

So why does China continue to confound expectations when it comes to restructuring? China has stopped building phosphate plants and changes to the country's phosphate industry are starting to happen, although the pace of restructuring remains uncertain. "You have some efficient, integrated plants that are well-located to serve export markets and you have some non-integrated plants that are higher-cost and not very well-situated to serve any market," comments Rahm.

"The supply coming from China will stabilise at some point, probably at levels that are less than we've seen in 2015," he adds. "But China is always a wild card and a lot depends on the overall supply and demand balance and on price levels as to how far and quickly restructuring takes place."

Shift in US exports

US exports have contracted from 6.1 million tonnes in 2009/10 to 4.6 million tonnes in 2013/14 with volumes shipped to India down from 2.41 million tonnes to 0.5 million tonnes over this period. The Americas have replaced India as the main end destination, accounting for 2.98 million tonnes (65%) of US exports in 2013/14.

"US phosphate producers used to supply two million plus tonnes to India a few years ago. Obviously, with the emergence of China and Saudi Arabia, we're supplying India with fewer tonnes," says Rahm. "Mosaic will move around 400,000 tonnes of phosphate product into India, either through our own distribution system or to third parties."

The Mosaic Company made a strategic decision several years ago to re-orient exports to the Americas and focus more on its *MicroEssentials* line of premium products.

"There's been an increase in capacity in parts of the world that have freight advantages to India," explains Rahm. "So our focus has been more on the Americas, particularly our home market in North America, as well as key growth markets like Brazil. That's where we have focussed our attention."

North American producers have continued to benefit from the relative strength of US phosphate prices and margins. The DAP 'stripping margin', for example, the difference between the DAP f.o.b. price and sulphur and ammonia raw material costs, has remained stable at $265-275 per short ton, compared to the fall in MOP prices and the recent decline in urea margins (Figure 4). DAP margins have held up comparatively well, as declines in raw material costs have largely offset any product price falls.

Fig 4: **DAP stripping margin for a typical central Florida plant**

Source: Fertecon / Green Markets / Mosaic

Producers in North America remain broadly positive about their position in the market due to confidence in their ability to find efficiency improvements, innovate and adapt to changing conditions. The Mosaic Company, for example, expects the industry to benefit from a positive demand outlook for phosphates over the longer-term, the end of China's massive expansion and a general paucity of phosphate projects in the pipeline, with the exception of those of OCP and Ma'aden.

Negative drivers causing havoc?

Demand fundamentals in the phosphate market have remained positive for the last two years. Global phosphate use is projected to increase by 1.1% in 2015, equivalent to almost one million tonnes of DAP, having risen by 2.5% in 2014, equal to a 2.2 million tonne rise in DAP use.

Fortunately, disappointing Brazilian demand last year was countered by a strong resurgence in Indian demand, until a buyers market emerged in September. A number of negative drivers then combined to cause a deterioration in the phosphates market towards the end of 2015.

Sarah Marlow, CRU's senior phosphate consultant, commented in September that: "A combination of weak currencies, El Niño, low crop prices, credit and tax issues is causing havoc in key regions, namely India, Brazil and China."

The scale of the current El Niño has been a growing concern, as is further economic bad news from Brazil. New oil price lows and the massive restructuring and lay-offs at Anglo American also deepened commodity woes as 2015 ended.

However, "tarring plant nutrients with the same brush used on many other energy and hard commodities" is unfair in Mosaic's view.

"If you look at commodity prices in general, oil prices, copper prices, iron ore prices, they're all down +60%, whereas if you look at crop prices they're not off nearly as much," comments Rahm. "That's simply reflects the fact that the fundamentals are better in ag commodities."

He continues: "You have to go back to ag commodity prices and the longer-term outlook for ag commodities: I still think it remains very positive and underpins a decent demand prospect – whether that comes from India, other Asian countries or Africa."

The phosphates market may well rebound in the first quarter of 2016, if it adheres to the pattern of previous years.

"Things turned out pretty much as planned in 2015 with stable prices and margins at decent levels through the first ten months of the year, and then a seasonal adjustment that was probably a little more pronounced than expected," concludes Rahm. "In light of all the macroeconomic turbulence, that's not terribly surprising – and hopefully we will be set for a seasonal rebound in the first quarter of 2016, like we've seen in the last couple of years." ■

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Turning capex into cash

The independence of German producer K+S KALI GmbH, the oldest player in the potash market, was threatened by a takeover bid from Canada's PotashCorp in 2015. The future success of K+S as a standalone business hinges on turning massive capital expenditure on its Canadian greenfield mining venture, the Legacy project, into cashflow. We profile K+S as it seeks to strengthen its competitive position and attempts to become a producer in both North America and Europe.

K+S KALI GmbH holds a sizable 8% share of the 68 million tonne world potash market, making it one the largest players globally after the Canpotex producers (PotashCorp, Mosaic and Agrium), Uralkali and Belaruskali (Fig. 1).

The long history and independent status of K+S means it is respected and valued by its customers, suggests Dr Andreas Radmacher, head of potash and magnesium products at K+S: "Potash is a small world and K+S has a good niche position as an independent player. K+S is the oldest player in the potash world which means a lot, especially for our customers."

Diversifying and adding value

K+S is insulating itself from commodity market volatility by moving away from straight muriate of potash (MOP) production and

Table 1: **K+S potash and magnesium business unit performance**

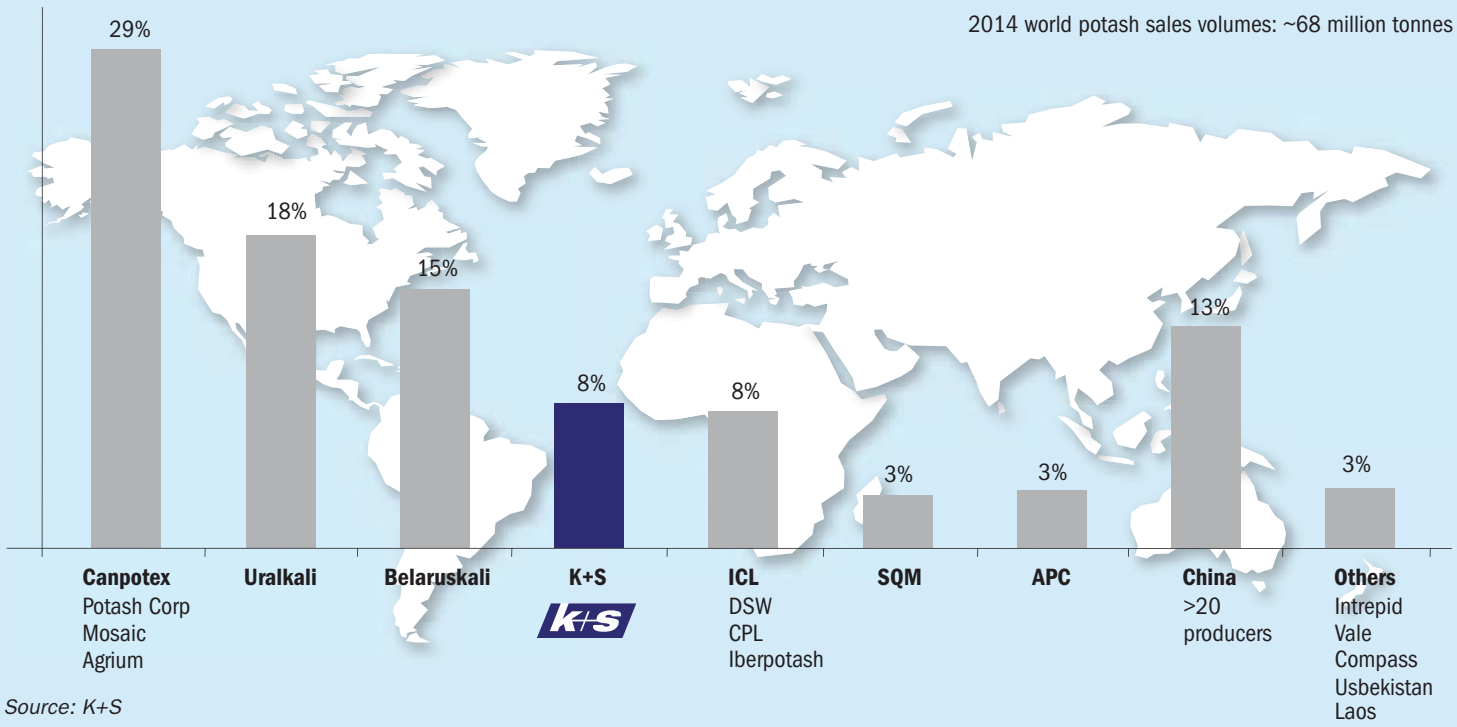
	2015 3rd Quarter	2014 3rd Quarter	Year-on-year change
Revenues	€471 million	€451 million	+4%
Earnings, EBIT*	€127 million	€134 million	-5%
Earnings, EBITDA**	€93 million	€111 million	-16%
Average selling price	€310/tonne	€279/tonne	+11%
Sales volumes	1.52 million tonnes	1.62 million tonnes	-6%
	2015 3rd Quarter	**2014**	**Last 12 months**
Costs† excl. Legacy project	€239/tonne	€203/tonne	€223/tonne
Costs incl. Legacy project	€249/tonne	€208/tonne	€232/tonne

**Earnings before interest and taxes.*

***Earnings before interest, taxes, depreciation and amortisation.*

†Costs = (Revenues-EBIT)/Sales volumes. Source: K+S third quarter results, 11 November 2015

Fig 1: **Main world potash market suppliers**



Source: K+S

selling a broader range of higher-value speciality products for both the industrial and fertilizer markets instead. In recent years, the company has established itself as a leading supplier of sulphate of potash (SOP) and has diversified into food and animal feed products, high purity pharmaceutical salts, pulp and paper detergents and oil drilling mud additives.

The company's range of speciality potash and magnesium products includes *60erKali*, *KaliSOP*, *Magnesia-Kainit*, *Korn-Kali*, *ESTAKieserit, Patentkali* and *EPSOTop*. K+S produced 5.6 million tonnes of potash products and 1.2 million tonnes of non-potash products in 2014. This 6.8 million tonne volume was divided between speciality fertilizers (3.06 million tonnes), MOP (3.05 million tonnes) and industrial products (0.75 million tonnes).

Robust performance in tough times

A significant €139-189 million increase in year-on-year earnings is expected in 2015, according to the firm's latest guidance, helped by positive factors such as salt pricing, business cost savings and the EUR/USD foreign exchange rate. On the downside, earnings were negatively affected over the course of 2015 by a €36 million insurance payment, rising operational expenditure on the Legacy project, costs incurred by PotashCorp's unsolicited takeover bid and lower potash sales volumes.

Third quarter revenues from potash and magnesium products rose by 4% year-on-year to €471 million in 2015, although earnings fell back (Table 1). K+S described this performance as "robust" despite the tough market environment. Higher average selling price for the quarter helped offset lower sales volumes.

Production costs in the potash and magnesium business, however, continue to rise and are expected to average €223/t for 2015 as a whole. Average costs per tonne have mainly been affected by lower sales volumes, higher depreciation costs and maintenance, according to K+S.

Mission not completed (yet)

K+S brought a turbulent 2015 to a close by holding a Capital Markets Day at the end of November, its first such event in five years. The day provided K+S CEO Norbert Steiner with an opportunity to reflect on the year and PotashCorp's failed takeover attempt (*Fertilizer International*, 469 p9).

Steiner revealed that the main reasons K+S felt unable to accept PotashCorp's offer was because it did not reflect the "fundamental value" of the company – or properly take account of the Legacy project. Neither was adequately met or considered, in his view.

Yet Steiner was equally clear that K+S was only part-way through a period of major strategic change – a mission that has yet to be completed. Progress on this is being closely watched by shareholders and investors.

"We are clearly aware of the fact that K+S has to deliver on its promises," accepted Steiner. "We will – but we will do that in the continuation of our strategic path that we have started years ago."

Steiner remains convinced that the group's 'two-pillar' strategy remains the right one for K+S and part of what makes it unique as a business.

"We think we have made the right decision to concentrate on our two pillars – potash and magnesium products on the one hand and salt on the other," said Steiner. "We are rather unique, if you take out… Compass in the United States."

Dr Burkhard Lohr, chief financial officer, sums up third quarter earnings

How was business development in the first nine months of 2015?
The K+S Group continued to grow in the first nine months of 2015. We increased operating earnings by more than 20% during the period.

The performance of our salt business was especially pleasing. EBIT almost doubled mainly due to the increased price of de-icing salt in North America.

The potash and magnesium products business unit also performed strongly during the first three-quarters of the current year. High average prices led to an increase in operating earning of around 4%.

And last but not least, Fit for the Future, as well as a stronger US dollar compared to the euro, delivered positive contributions.

> Soon our Legacy project in Canada will become the main driver of growth for our potash business.

How is the Legacy Project going?
The third quarter once again saw good progress with the construction of our potash blend in Canada, the Legacy project. Work was focused on steelwork, the installation of main components and earthwork for the railroad connection.

In addition, two more pads were commissioned for the cavern development and the brinefield. Piling and initial foundation work were carried out at our handling and storage facility at the Port of Vancouver. As planned, Legacy will be commissioned in the summer of next year and achieve an annual capacity of two million tonnes by the end of 2017.

In our opinion, the tremendous value of the Legacy project is still only partially reflected in our share price. However, we are convinced the capital markets will begin to appreciate the potential of the Legacy project more and more as we draw closer to the start of production.

What is the outlook for 2015
We can again confirm our recent forecast of a significant increase in operating earnings for this year. The earnings strength of our salt business unit is anticipated to balance the lower volume availability and the current weakening in the market for potassium chloride.

In terms of concrete figures, we expect the K+S Group to have an EBIT of between €780-830 million for this year. Our group earnings are also expected to significantly exceed those of the previous year.

This should be reflected in a higher dividend for 2015, which is of course subject to the approval of the AGM.

What are the mid- to long-term prospects of K+S as an independent company?
Soon our Legacy project in Canada will become the main driver of growth for our potash business. Our salt business is performing extremely well and is on the way to achieving the target of a generating a sustainable annual EBIT in excess of €250 million by 2020.

We will also continue to ensure that cost discipline also remains high beyond 2016. We seek to continue growing in both business units as well as to strengthen our activities in attractive growth markets.

Despite the current slowdown in the potash market, there has been no change in medium-term growth trends. We are therefore continuing to anticipate an increase of the EBITDA up to €1.6 billion until 2020. ■

Steiner named Compass as their "one big competitor and salt producer" and also a "relatively smaller producer of SOP".

The diverse range of speciality products offered by K+S is a key business strength, in Steiner's view: "We don't only have MOP, in standard and granulated quality, we have this very, very broad range of specialities that help us... to be on a more stable area when MOP prices are going down."

Steiner also emphasised that this year's results (see box) are amongst the best ever recorded by K+S, with earnings before interest and tax (EBIT) on track to hit €780-830 million in 2015, up from €641 million in 2014 (Table 2). He also predicted earnings of €1.6bn EBITDA (earnings before interest, taxes, depreciation and amortisation) by 2020. "Despite the current situation of the market we think that it is achievable... it is one of our targets we will deliver," insisted Steiner.

Summing up, Steiner ended the Capital Markets Day by saying that "K+S is on a good track" and that two-pillar strategy remained "the right strategy" for the business.

"We have a lot of challenges in the marketplace in bringing up Legacy and caring for the environmental issues here in Germany – but we trust our experience and our intelligence. That enabled us in the past to also overcome critical situations and to stay as a competitor and as a supplier," concluded Steiner.

From Capex to Cash

Chief financial officer, Dr Burkhard Lohr, says that the fundamental business transformation currently underway at K+S has its roots in the purchase of Potash One in 2010, the junior mining venture that later became the Legacy project.

"We had a lot of good reasons, strategic reasons, to make that move... into a new mine. From a pure financial perspective, I would like to call that journey from 'Capex to Cash'," he explained.

Lohr is confident that this 'Capex to Cash' strategy – although it involves a high level of capital investment in the Legacy project (C$4.1bn) and a rise in net debt – will ultimately generate unprecedented cashflows for K+S. Despite the short-term pain, Lohr predicted "huge positive free cashflows by 2020" and net debt returning to normal levels (Table 3).

In fact, capital expenditure on the Legacy project has already peaked and is

Table 2: **Latest K+S financial performance guidance for 2015 compared to previous guidance and 2014 results**

	FY 2015e	Previous guidance	FY 2014
Potash and magnesium products unit			
Global sales volumes[1]	Moderate decline	Moderate decline	~68 million tonnes
K+S sales volumes	Slight decline	~7 million tonnes	6.9 million tonnes
Average selling price	Tangible increase	Tangible increase	€274/t
Salt business unit			
K+S sales volumes	On last year's level	On last year's level	24 million tonnes
t/o de-icing	~14 million tonnes	~14 million tonnes	14 million tonnes
K+S Group			
Revenues	€4.3-4.5 billion	€4.35-4.55	€3.8 billion
EBITDA	€1.06-1.11	€1.06-1.14	€869 million
EBIT 1	€780-830 million	€780-860 million	€641 million
Financial results	Significant improvement	Significant improvement	-126 million
Capex	~€1.3 billion	~€1.3 billion	€1.2 billion
Average forex rate (€/$)	1.11	1.11	1.33
Dividend policy	40-50% payout ratio		

[1] Incl. approx. 4 million tonnes of lower miner content MOP and SOP.
[2] Incl. €36 million insurance gain.

Source: K+S

starting to fall, Lohr confirmed, with a corresponding tail-off in associated project risks.

"As of September we have spent 70% of the total capex programme," said Lohr "The peak of the construction and the capex programme is already behind us."

He continued: "The peak years were 2014 and 2015 and very importantly… almost 100% of the procurement is done – that is very crucial [as]… that means the project is significantly de-risked."

Having made the necessary investment, suggested Lohr, K+S should start to benefit from a positive cashflow in two years times – and that will be just the start of the extra revenues Legacy will bring into the business.

"We will be cashflow positive in 2017… and we are growing our cashflows on a level that the company has never seen before… In 2020, we expect €1.6bn EBITDA – and remember that Legacy is not even fully ramped up by 2020 so we have three more years with growing volumes from Canada," said Lohr.

He was also unequivocal about the share value of Legacy project: "We want to take the opportunity here at the Capital Markets Day to confirm our view that the value of the Legacy project is between €11 and €21 per share."

Compensating for closures

The Legacy project will also compensate for German mine closures when its starts production in 2017, according to Norbert Steiner.

"We will have [the loss from] the shutdown of our Sigmundshall mine of about 600,000 tonnes by 2020, 2021. When you compare that with… the first phase

[of Legacy] in 2018 this is not that very far away from that… Mines that we intentionally shut down are something that we can compensate with Legacy."

Although mine depletion was an issue, new investment will mean that production capacity in Germany should increase slightly in the near future, advised Steiner.

"We are facing the issue that the mines get more and more depleted although we will still run for the next decades, but the ore content is getting less – very slightly but it's getting less.

A minor increase in German production to seven million t/a is even expected in the next few years, confirmed Steiner, due to new investment in the so-called kainite crystallisation facility (KKF).

Cost reductions – Fit for the Future

Strengthening the group's product range and continuing with cost reduction efforts, through the 'Fit for the Future' programme, will continue to be a priority for K+S.

"We want to strengthen more than in the past our speciality, higher yielding products… and of course cost discipline beyond 2016," said Steiner. "Fit for the Future, it's something that should not end its impact on K+S at the end of 2016."

The cost savings from the programme have gone beyond those originally anticipated.

Table 3: **The 'Capex to Cash' journey: reaping the rewards of Legacy project investment by 2020**

	Capex phase	Cash phase by 2020
Net debt	€2.2 billion	<€2 billion
Leverage*	2.1x	1.0-1.5x
CapEx	€1.3 billion	Maintenance
Free Cash Flow (FCF)	Negative	Positive
EBITDA	€1.06-1.11 billion	~€1.6 billion

**Ratio of net debt to EBITDA*

"When we started this programme our aspiration was… to save €500m in the period between 2014 and 2016… In the first year, we have already achieved a higher number and… seen a very important positive side effect – improved cost discipline within the entire group," commented Lohr.

Tough in rough times

Whilst acknowledging short-term market difficulties, Dr Andreas Radmacher, head of potash and magnesium products at K+S, also saw a silver lining.

"This kind of boom and bust cycle is normal in… the potash market. We know it, we can live with it, we understand the dynamics, and there are some good messages: there is no incentive for any new entrants in the next years, and we have also seen how low prices spur demand."

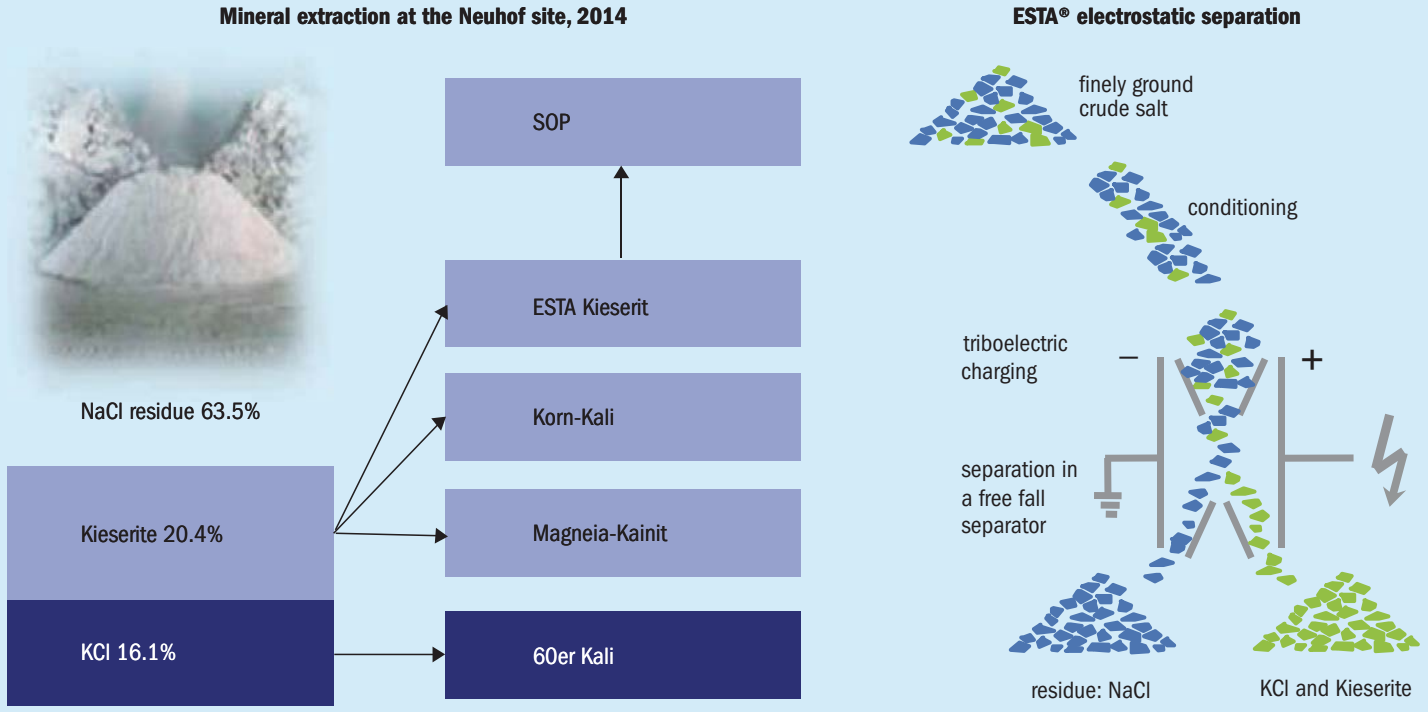
Long-term thinking was also necessary in Radmacher's view.

"We have got a bumpy road ahead of us – this is especially true for the short term. But the potash industry… is a capital intensive industry with a focus on very long-term developments," he said.

Radmacher acknowledged that the industry was facing short-term overcapacity over the next couple of years, but pointed out that barriers for new entrants would also remain "very high" in the current environment – to the benefit of incumbent producers such as K+S.

According to Radmacher, operating to the "the highest environmental and safety standards" and "keeping the costs in the world's oldest mines under control" was important to K+S. He was also pleased to

Fig 2: **Processing of potash ore and products obtained by K+S**



Source: K+S

report that the potash business unit had contributed to half the cost savings of the Fit for the Future programme.

Complex deposits, lower grades

Mining German potash has both advantages and disadvantages, argued Radmacher: "K+S is operating on complex deposits with, yes, lower K_2O grades compared to our competitors." But the company was also able to get the best from its mined assets by "making more out of it" and "utilising the entire range of minerals in our deposits", he said (Fig. 2).

The continued expansion of the speciality products portfolio also helped on pricing, in Radmacher's view: "The minority of our current product portfolio is pure MOP – this makes us more independent from the pure commodity cost play."

The use of state-of-the-art potash processing methods by K+S, such as its proprietary *ESTA* electrostatic separation method, also conferred advantages.

"We have a natural advantage, for example, in SOP," explained Radmacher. "Our unique production process allows us cost-efficient production of a high quality product."

He added: "The process is less energy intense, it's faster and cheaper than, for example the Mannheim process. And again we find the necessary nutrients in our deposits."

Production on two continents

According to Radmacher, the Legacy mine will place K+S in a unique position when it opens.

"K+S will be the only supplier with production on two continents. With Legacy, we'll have a competitive cost-base and customer proximity. Distribution will be done via existing channels or new partnerships, for example with Koch in the US."

The capacity to produce potash for lucrative industrial markets will also rise once Legacy starts to ramp-up, as Radmacher makes clear.

"After getting the first tonne at the end of 2016, we will steadily increase production up to 2.9 million tonnes of products in 2023. Starting in 2018, we will be able to produce about 20-30% of the total output [as] industrial potash," he said.

Radmacher also attached figures to the two main elements of Legacy's operational expenditure.

"Our production cost per tonne by 2023 will be around C$90 a tonne – and half of that [is] roughly energy and gas costs. Our logistic cost per tonne will be around C$65 – that includes transport from the mine to Vancouver and to the various destinations into the markets."

Apart from Legacy, growth efforts at K+S will focus on adding value to its product range and expanding its presence in the industrial products market.

"On the production side of our business, our focus will be on safety, efficiency and cost management," said Radmacher. "On the sales and marketing side, we are working on increasing our exposure to value added segments such as fertigation products, but also increasing our industrial footprint, for example in the farmer market."

Radmacher also singled-out a K+S project in Uganda "that educates farmers

PHOTO: K+S AKTIENGESELLSCHAFT

there how valuable the use of fertiliser is" (*Fertilizer International*, 469 p38). Although the project was set up to champion food security and farm livelihoods, K+S also wants to help develop Africa as a fertilizer market of the future. Radmacher compared Uganda to the Brazil of 20-30 years ago, in terms of its soil, climate and fertility. He said the country offered "huge potential" for fertilizers.

The year ahead

Radmacher remains positive about the year ahead, despite current "tough and rough times", and is confident about the position K+S occupies in the potash marketplace – emphasising the fact that "more than half of our product portfolio is not commodity MOP".

"It's indeed a bumpy road for the next 12 months but I'm convinced that the fundamentals of this market – fertiliser, world population etc – are really intact, and I think the demand side will play a significant role in establishing price," summed up Radmacher. ■

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