

field reports

SUMMER 2017

On the Ground With the PotashCorp Agronomy Team

One of the cornerstones of its commitment to feed a growing planet is PotashCorp's dedicated team of agronomists. This group's mission is to support the ag community in its quest to maximize yields. The team's contributions to the success of PotashCorp and its customers have proven immeasurable over the years as it provides research-based information that helps growers make sound fertilizer decisions.

Meet the PotashCorp Agronomy Team



Dr. Robert Mullen
Director of Agronomy

Dr. Robert Mullen leads the agronomy team of Dr. Cristie Edwards and Nicholas Scates. The team is busy year-round participating in industry organizations, traveling to work with farmers and agricultural retail customers, and working closely with the PotashCorp Sales and Marketing departments. Although they have come to the study of soil fertility via different paths, all members of the agronomy team operate under a similar vision – to provide PotashCorp customers with top-notch

service and the knowledge they need to grow their operations.

Dr. Mullen describes his path to agronomy as a rather circuitous journey. His undergraduate work was on the animal side of agriculture and he applied to study large animal reproductive physiology in graduate school at Oklahoma State. With no graduate assistantships available in this area, he turned to available positions in soil science. His passion for soil fertility has grown ever since.

In addition to a Bachelor of Science (B.S.) in Ag Business, Dr. Mullen obtained a Master of Science (M.S.) and Doctorate in Plant and Soil Science. His work has been published in a variety of books and trade journals. His writing focuses on taking the latest complex research and putting it in relatable terms for growers. Dr. Mullen joined the PotashCorp agronomy team in 2011 and plays a key role in developing and expanding the eKonomics program.

"I genuinely enjoy the personal interaction I am privileged to have on a daily basis," he says. "The sales professionals, marketing team, transportation and distribution group, and the credit folks at PCS are all first class. They have a passion for their jobs that makes it easy to be excited to come to work."

Dr. Mullen also notes how much he enjoys his regular interactions with agronomists working for PotashCorp's customers and being exposed to different agricultural systems. He has many inspiring stories to share, but one experience that stands out in his mind is a visit with a customer in Nicaragua. This customer was exceptionally grateful for the effort PotashCorp made to travel to him and provide personalized agronomic training to help him set his operation up for future growth with increased yields.

In this issue

Get to know members of the PotashCorp Agronomy Team and hear their passion for helping farmers and agricultural retailers.

After three years of record soybean production, more emphasis is being placed on K requirements. Dr. Cristie Edwards explains how K nutrition can be used to maximize soybean yields.

The fertilizer industry is undoubtedly a demand-driven market. Kelly Freeman explains what this means for the global market in coming years.

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Cristie Edwards, Ph.D.

Agronomy Manager
PotashCorp/PCS Sales

The Importance of Potassium in Soybean Production

In this article, we address reasons not to limit potassium in soybean production, which could limit return. It also covers issues you might face when potassium is limiting. For more details on the soil's buffering capabilities and levels needed to keep soil levels higher, please see our Winter 2016 edition. Archives and other articles can be found on our eKonomics website at www.potashcorp-ekonomics.com/news.

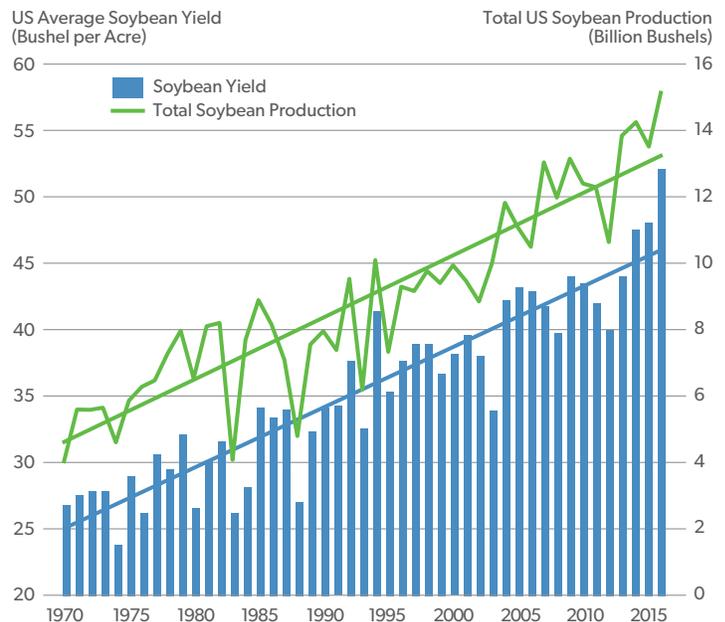
With three years of above-average soybean yields and record production (Figure 1), there is more emphasis on potassium (K) requirements for soybean production. Compared to corn, soybean seed removes six times the amount removed in corn grain (1.5 lb K₂O per bushel vs. 0.25 lb K₂O per bushel). With higher yields in the past three years, we need to ask if K levels are adequate for soybean production.

A record high 89 million soybean acres are projected to be planted in 2017 (USDA), up more than 6 million acres from 2016. This is made possible partly due to new herbicide-resistant varieties. Crop budgets, calculated by the University of Illinois, have estimated soybean following corn to be more profitable than corn following corn for the 2017 production season. But are farmers applying enough K to maximize these potential profits in 2017?

What practices am I using and are they maximizing profits?

Typically, farmers apply their K using potash as a bulk blend with phosphorus (P) fertilizer. Farmers apply this blend either before corn as a two-year application rate, or

Figure 1. US Average Soybean Yield and US Total Soybean Production



every year prior to corn and soybean planting. Since the greatest demand for K in most crops occurs in the early phase of rapid vegetative growth, K applications made prior to planting are ideal. Application rates for a two-year rotation (i.e. corn-soybean rotation) are generally calculated based on the nutrient removal rates and projected yields of those two crops. But, what happens when corn yield is higher than expected. Is there adequate K in the soil for the following soybean crop?

The short answer is: probably not. If soil test K is already below critical levels, then levels would be inadequate for soybean production. In the Midwest, soil test K levels usually range from 130-190 parts per million. Depending on beginning soil test levels, most farmers tend to focus on nitrogen fertilization first and foremost. This scenario, where K is limiting, could be true for any situation if a producer applies multiple-year recommended fertilizer rates as a one-time application and higher yields are achieved in the first crop.

The Importance of Potassium in Soybean Production

CONTINUED FROM PAGE 2

What happens when soybeans are stressed from lack of K?

The most noted potassium deficiency symptom in soybean is yellowing of leaf margins on older leaves. This usually begins at the leaf tip and extends down toward the leaf base. Inadequate acquisition of K can also result in:

- **Slow growth and weakened stems.**
- **Poor disease resistance.** The effect of low K on soybean has been found to increase the incidence of soybean cyst and other diseases caused by fungi. A field study evaluating the effects of K on moldy soybean seed by pod and stem blight showed that applying K limited fungal growth (Jeffers et al., 1982).
- **Poor drought resistance.**
- **Aphid population growth.** On K-deficient plants, aphid development showed a significantly greater intrinsic rate of population increase and net reproductive rate (Myers and Gratton, 2006). Potassium deficiency was found to increase nymph numbers as much as 39 percent compared to healthy plants grown with adequate K.
- **Poor utilization of other supplied nutrients.** Studies have shown how deficiency of K impairs utilization of P and N, even though adequate levels of N and P are available.

Considering that soybean grain removes 1.5 lb K₂O per bushel, there is concern for areas that are growing more soybean following soybean. Potassium deficiency in these areas could lead to more problems with diseases and pest infestations if removal rates of previous crops are high and K levels are not adequate.

Are we pushing new varieties to their potential?

New records for soybean yield were set in 2016 by state and national contest winners. Yield can be maximized when farmers utilize irrigation, insecticides, fungicide and proper genetics. High soybean yields were also attributed to intensive nutrient management programs.

Not only is it important to know what nutrients to apply, successful management programs address the timing of nutrient applications and at what rate. Research has shown K deficiency symptoms can appear late in the season, especially under dry conditions and in compacted soils.

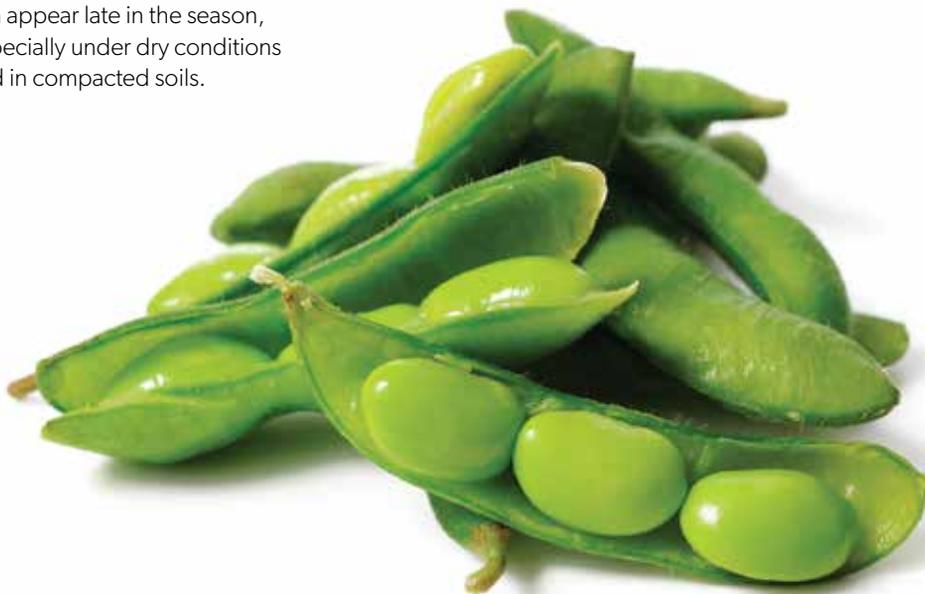
What can be done about this?

There is no guarantee that a late-season application will correct deficiency symptoms for the current crop or be economical. However, foliar applications made during the growing season can positively affect yields (Nelson et al., 2005; Nelson et al., 2010). Additionally, any application made will be available for future crops and without fear of excess K negatively affecting the environment.

With increasing soybean grain yields, potassium fertilization is becoming more important in crop rotations. By soil sampling regularly and understanding crop removal rates, producers can better manage adequate levels of K for soybean production. Maintaining potassium levels is as essential to crop production as providing adequate nitrogen and phosphorus, and failing to do so can limit yields.

References

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Kelly Freeman

Director, Strategy & Corporate Development
PotashCorp

A Demand-Driven Market

When market observers discuss the outlook for fertilizer markets, new capacity is often one of the first items noted. Certainly, there is little debate that new fertilizer supply will be available to meet future demand. And that is a good thing.

Yet bullish demand outlooks are usually viewed more critically. Unlike the supply side, where you can readily see global producers investing in new capacity, predicting demand has proven more difficult as it involves many moving drivers — from crop budgets to foreign policies to currency values — and these do not necessarily create an instant feedback loop.

After a volatile year, the fertilizer market found support toward the end of 2016 and carried momentum into early 2017. In fact, looking broadly across nitrogen, phosphate and potash, the first quarter of this year proved to be more robust than expected. A key factor has

been stronger-than-expected demand. Shipment data through the first few months in several key consuming countries tell part of this story, but reports of significant producer commitments extending well into the second quarter for certain products provide better anecdotal evidence of how the market has ‘demonstrated upside’ through early 2017.

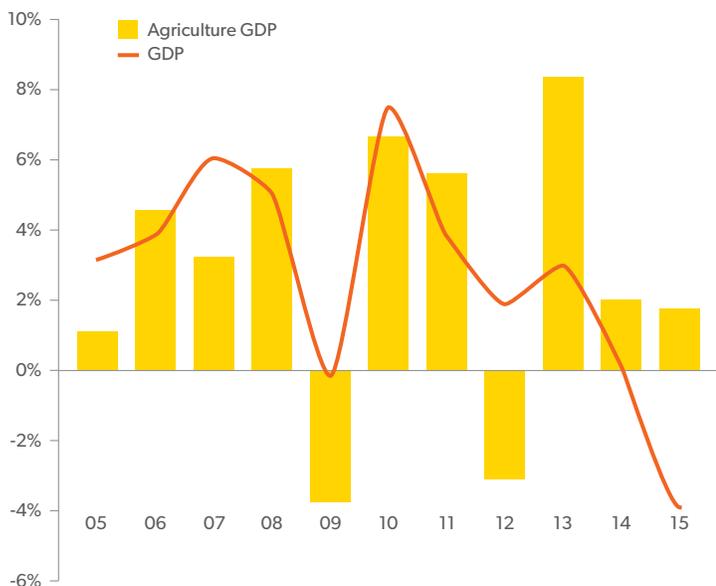
Global Market Insights

Watching the trade data only paints a partial picture of the factors that influence global markets. What is not as readily recognized in the numbers are some of the interesting underlying themes

and developments occurring in many regions. This became clear when we recently spent time in two of the world’s largest fertilizer markets — Brazil and China.

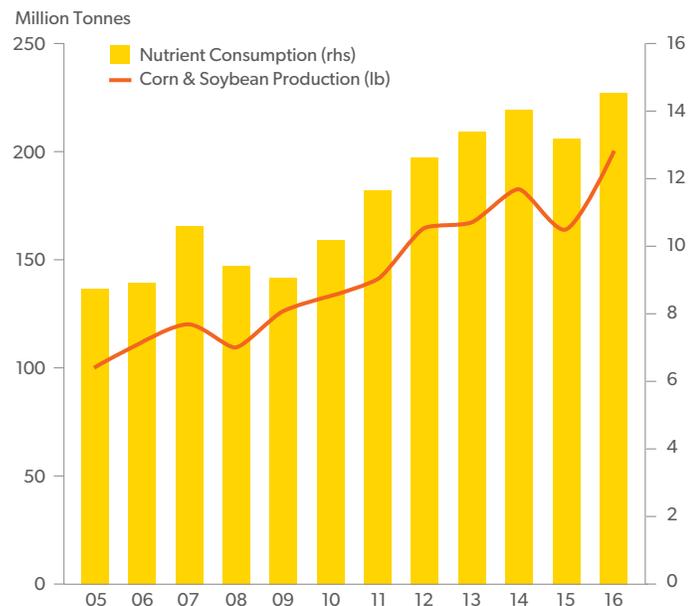
Brazil has long been a source of optimism in the fertilizer space. Even as the country works through political and fiscal uncertainties, the agricultural sector has consistently been a strong contributor to the country’s economic growth (Figure 1). Crop acreage and production have grown at a robust compound annual growth rate of 6 percent over the past 10 years with this year’s soybean crop expected to hit a record 108 million tonnes.

Figure 1: Brazil’s GDP Growth Comparison
Agricultural Growth Has Typically Outpaced the Broader Economy



Source: World Bank

Figure 2: Brazil’s Crop Production vs. Nutrient Consumption
Fertilizer Consumption Has Grown In Line With Crop Production



Source: CRU, IFA, USDA

Brazil's fertilizer consumption has closely mirrored this growth over the same period, with total usage reaching a record 34 million tonnes of product (or 14.5 million tonnes of nutrients) in 2016 (Figure 2).

After meeting with people across the agricultural and fertilizer sector in Brazil, a person better appreciates the significant growth potential that still lies ahead. One can summarize the outlook as: 'Optimism trumps caution.' In nearly every discussion – from the port operator to the farmer – you gain an appreciation of how people are preparing for what they believe will be inevitable growth in the years ahead. From new investment in logistic infrastructure, construction of new blending plants, or the purchase of new land to be brought into production by ever-expanding megafarms, Brazil is investing to remain an agricultural superpower. We

believe these trends support a long-term growth thesis.

Not surprisingly, China is a very different market than Brazil. We met with players at different points along the supply chain and heard about some of the opportunities and challenges they face.

Unlike Brazil, where new land is being put into production each year, China's story is about retaining existing acres and promoting improved agronomic practices that enhance productivity. It's particularly interesting to see firsthand how farm consolidation in China is occurring and making an impact on this front.

A new land transfer policy published in China in 2008, which aimed to secure farmers' rights to use their land fully as collateral and allow consolidation of farm operations, has been a big driver. This policy has helped

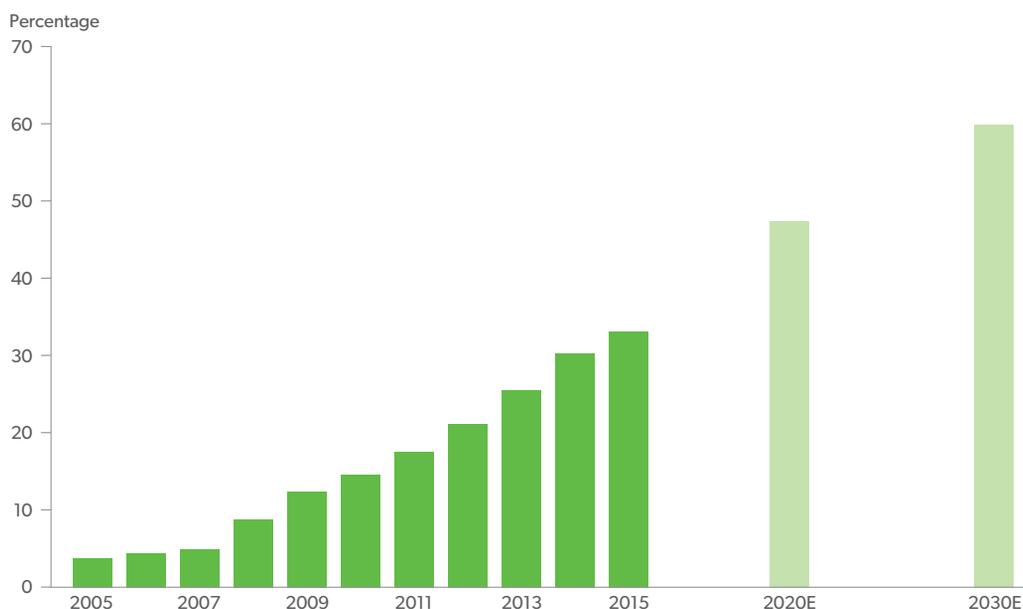
facilitate the move to larger farms that are better able to adopt agronomic best practices that can enhance yield and nutrient efficiency. We visited two partners in Shandong province who had recently consolidated approximately 600 Mu (or around 100 acres). This may seem insignificant in comparison to geographies where farm operators are responsible for thousands of acres, but that perspective changes when you consider this land base was previously farmed by approximately 300 individual farmers!

This type of consolidation is happening across the country and is expected to remain a broad-based theme in the years ahead (Figure 3). This trend is one of many that we believe will support greater adoption of mechanization and balanced fertilization, as well as shifts in crop selection toward higher-value, more nutrient-intensive crops.

Other changes are also evident in China. On the demand side, there is targeted investment into new ag superstores and online tools designed to improve access to agronomic information and support. Both the industry and the government are undertaking initiatives to promote specialty fertilizers to address specific nutrient deficiencies in soils.

While these items are creating new opportunities, domestic fertilizer producers also face certain challenges that could reshape domestic supply. The removal of certain subsidies, additional value-added taxes and stricter enforcement of environmental regulation have reduced the competitiveness of many producers. Given China's significant capacity in nitrogen and phosphate, we expect meeting its future domestic needs will not be an issue, although its presence – and competitiveness – in the global export market is likely to be reduced from levels witnessed in recent years.

Figure 3: China's Farmland Rented
Consolidation Paves the Future for Improved Farming Practices



Source: Ministry of Agriculture, BOABC

Summing It Up

In any market, reconciling long-term trends with short-term market conditions is always a challenge. The supply side of the equation will continue to play a big role in shaping the near-term direction of the market, but we believe the "demand-driven market" cannot be ignored, especially in the long term.

On the Ground With the PotashCorp Agronomy Team

CONTINUED FROM PAGE 1

“Providing information that impacts someone’s livelihood is so incredibly humbling,” Dr. Mullen says. “It certainly keeps one motivated to continue to work harder.”



Dr. Cristie Edwards
Agronomy Manager

Dr. Edwards, the newest member of the team, grew up in southwest Virginia. Throughout high school, she planned to make her career in large animal veterinary medicine. Once she began college, she chose animal science as her field of study. However, she switched to soil science after her bachelor’s degree and partly attributes her decision to an influential professor who told her, “You can’t understand animals until you understand what they eat.”

She received a B.S. in Animal Science and an M.S. in Crop and Soil Environmental Science from Virginia Tech, and a Ph.D. in Agronomy, focusing on soil fertility, from Kansas State University. While completing her advanced degrees, Dr. Edwards conducted more than six years of field and lab research. Her laboratory research measured volatility loss from urea-based fertilizers. Her field research focused on phosphorus availability and the interactions with tillage and placement. She also has extensive experience in working with large data sets and analysis.

At PotashCorp, Dr. Edwards’ priorities include understanding yield-limiting factors and how growers can fix those issues as cost efficiently as possible.

“I strive to understand the science behind what is going on in their field, but also to effectively communicate with them about their options,” she says.

She looks forward to sharing her knowledge of previous research and continuing to learn about new products and management practices utilized by others.

“When I am finished with my career, the one thing I hope people can say about me is that I provided good information that was scientifically sound and helped someone grow more food.”

Dr. Robert Mullen



Nicholas Scates
Agronomy Marketing Specialist

Nick Scates, PotashCorp’s Agronomy Marketing Specialist, grew up on a farm in southern Illinois. He graduated from the University of Illinois, Urbana-Champaign with a Bachelor of Science in Agricultural and Consumer Economics as well as a Master of Business Administration.

“What thrills me most is listening to the stories of farmers and the agronomists that work with them,” he says. “Each farm is unique, so it’s great to hear folks share their knowledge and recipes for success.”

As part of his position, Scates interacts with farmers and agricultural retailers at a number of industry meetings. This part of the job allows him to show his passion and excitement for the agricultural industry and for helping others. One event Scates speaks at is an agricultural retailers’ annual meeting with more than 100 customers.

“They ask the hard questions and express their concerns,” he says. “This is a great opportunity to exchange new ideas, approaches, challenges and opportunities.”

The PotashCorp agronomy team is focused on helping its customers make scientific decisions to feed a growing planet. For more information on the history of the PotashCorp agronomy team, visit the PotashCorp Nourish site at www.potashcorp.com/nourish.

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These risks and uncertainties are discussed in more detail under the headings “Risk Factors” and “Management’s Discussion and Analysis of Results and Operations and Financial Condition” in our Annual Report on Form 10-K for the fiscal year ended December 31, 2016, the joint information circular of the company and Agrium, filed as Exhibit 99.1 to the company’s Current Report on Form 8-K dated October 6, 2016 and with Canadian provincial securities commissions, in connection with the proposed merger of equals with Agrium and in other documents and reports subsequently filed by us with the US Securities and Exchange Commission and the Canadian provincial securities commissions. Forward-looking statements are given only as of the date hereof and we disclaim any obligation to update or revise any forward-looking statements in this release, whether as a result of new information, future events or otherwise, except as required by law.