

# US Agriculture and Soil Fertility Trends

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The past five years have been a turbulent time for the global economy, starting with the fallout from the financial crisis and now with the political struggle in many developed countries over the best way to deal with their fiscal deficits. While this economic turmoil has

affected many industries, agriculture has remained a sector of strength throughout this period. Nowhere has this been more evident than in the strong financial performance of US farmers. Net cash farm income has been a record in four of the last five years and farm

debt-to-equity levels are very low. Much of the economic gain has been driven by rising demand for agriculture commodities and higher crop commodity prices. However, farmers could not have taken advantage of this economic opportunity without making improvements in farm productivity over the course of many years.

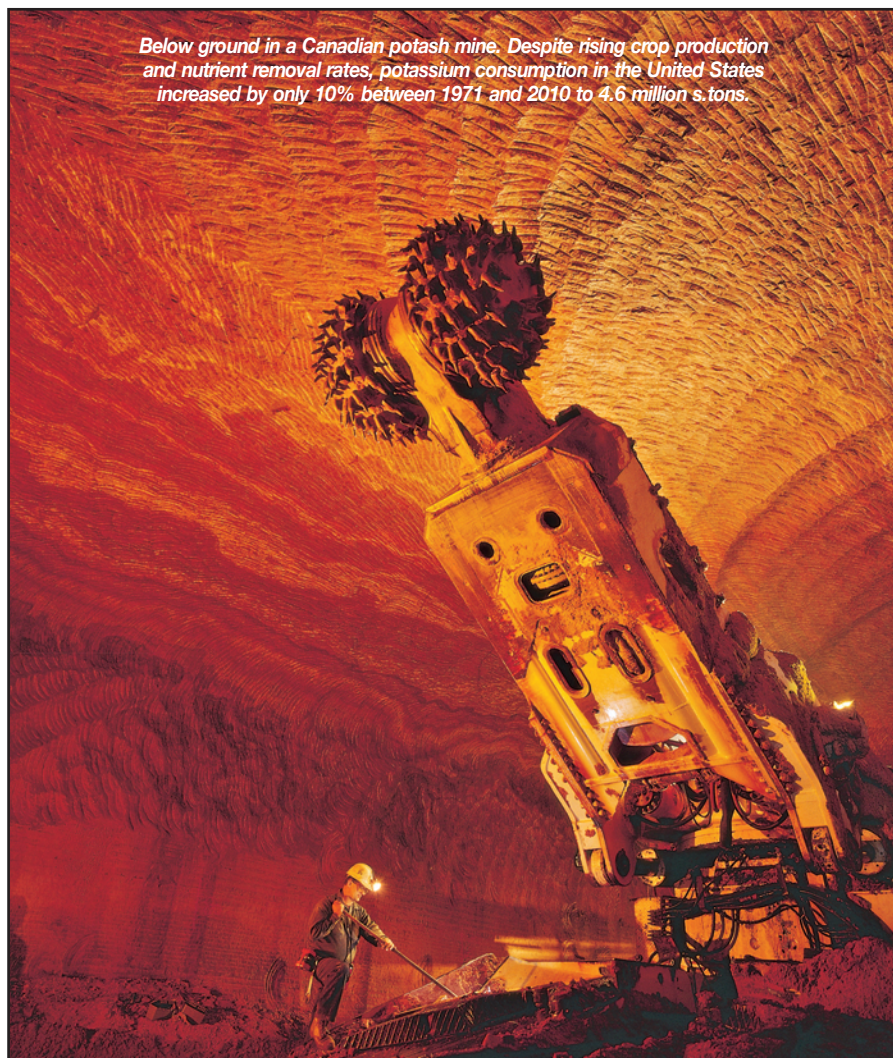
To highlight this point, one can look at the significant improvements in US corn yields over the past 40 years. Yields have essentially doubled over that time period and acreage has moved into regions of the US which historically were not considered suitable for corn production. These gains were made possible by the adoption of new technologies and best management practices, and by the maintenance of healthy fertile soils through the application of appropriate plant nutrients.

## Trends in US Nutrient Application and Crop Removal

The growth in US crop production over the past four decades has resulted in a significant increase in the uptake and removal of nutrients from the soil. For example, average nutrient removal rates for phosphorus jumped from 22 to 40 pounds of  $P_2O_5$  per acre in this period, and for potassium from 44 to 65 pounds of  $K_2O$  per acre. Removal rates have risen more in major row crop production areas such as the US Midwest that have achieved the greatest increase in yields.

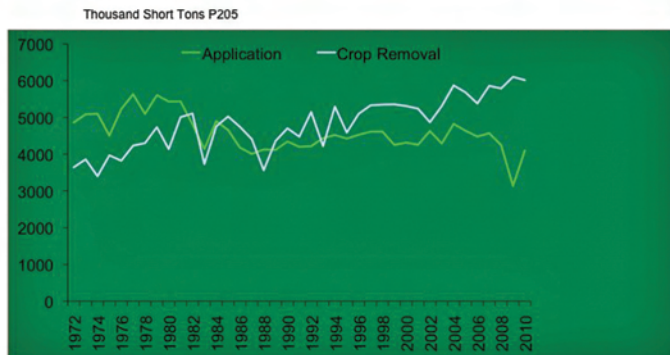
Despite the rising crop production and nutrient removal rates, US consumption of phosphorus and potassium has not changed dramatically since the 1970s (see Figures 1 & 2). In fact, phosphorus usage has trended down, from 4.8 million s. tons (available  $P_2O_5$ ) in 1971 to 4.1 million s. tons in 2010. Potassium usage has fared a bit better, increasing from 4.2 million s. tons (available

*Below ground in a Canadian potash mine. Despite rising crop production and nutrient removal rates, potassium consumption in the United States increased by only 10% between 1971 and 2010 to 4.6 million s. tons.*



**Figure 1: US Phosphate Application and Crop Removal**

Application Rates Have Not Kept Pace With Crop Removal



Source: AAPFCO, USDA-NASS, PotashCorp

K<sub>2</sub>O) to 4.6 million s. tons. Simultaneously, US animal numbers have been decreasing and animal production has become more concentrated. This means the volume and accessibility of manure as a fertilizer source has decreased. Combining the relatively flat commercial fertilizer usage statistics and declining nutrients available from manure translates into an overall reduction in the amount of phosphorus and potassium being supplied to US soils.

That raises a question: Have phosphorus and potassium become less important to the production of healthy crops? The answer is

unequivocally no. So the follow-up question is: How have US crop yields increased without a corresponding rise in application rates?

We believe the single biggest factor is that phosphorus and potassium application rates during the 1960s and 1970s exceeded crop removal rates in many regions of the US, which resulted in higher soil test levels for both nutrients. Unlike nitrogen, phosphorus and potassium can be stored in the soil when application rates exceed crop nutrient removal rates, which can increase the availability of these two nutrients for subsequent crops. The expanded use of soil testing also contributed to

a better understanding of the available nutrients resident in the soil. As a result, farmers started to draw from the soil nutrient bank in the late 1980s and the gap between nutrient removal and application has grown since that time.

The second factor that has likely contributed to this negative application balance is the significant increase in rented acres over the last 25 years. Short-term leases typically offer little incentive for maintaining higher levels of soil fertility and are leading to mining of soil nutrients. We believe it is only a matter of time before landowners become more aware of the long-term implications of this practice for the productivity of their primary asset, the soil.

### Trends in US Soil Test Levels

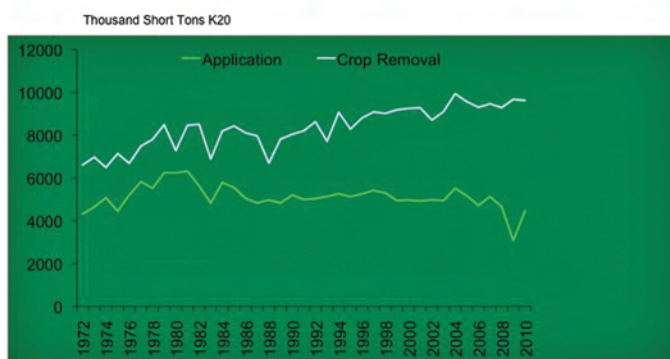
A recent report published by the International Plant Nutrition Institute (IPNI) provides a summary of soil test levels across North

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**Figure 2: US Potash Application and Crop Removal**

Application Rates Have Not Kept Pace With Crop Removal



Note: The application balance for potash was negative prior to the late 1980's because of the large application deficit in west-central US states. This is a region that has naturally potassium rich soils.



Source: AAPFCO, USDA-NASS, PotashCorp

America. The data compiled from more than 4.4 million soil samples illustrate two things very clearly – average soil test levels for phosphorus and potassium are decreasing, and the frequency of soil samples testing below established critical levels is increasing. Over the sample periods of 2005 and 2010, soil test levels for phosphorus and potassium declined on average by 6 ppm and 4 ppm, respectively. As illustrated in Figure 3, large declines were recorded in major US crop producing states in the Midwest and Southeast. This corroborates the discussion above that current fertilization practices are not keeping up with crop demand.

Many universities have developed crop response models to determine critical soil test levels for both phosphorus and potassium. A farmer whose soil falls below the established critical level risks a substantial decline in productivity if that land goes unfertilized. Just how much yield loss depends upon a number



of factors such as soil test level, growing conditions (rainfall amount and frequency) and pest pressure. The probability and magnitude of a potential yield loss rises when soils are testing below the critical level and the crop is facing adverse growing conditions such as drought. With more US soils falling below the established critical level we believe the risk of yield loss is increasing.

One can use these university models to determine yield loss and economic return scenarios for crops grown on soils testing below the established critical level. For instance, using average response curves from across the US Midwest, a farmer growing corn with the target of a 200 bushel per acre yield could lose 16 bushels per acre on average when soil test phosphorus levels are between 10 and 15 ppm phosphorus. Similarly, a farmer growing corn with the same yield target could lose on average 24 bushels per acre if soil test



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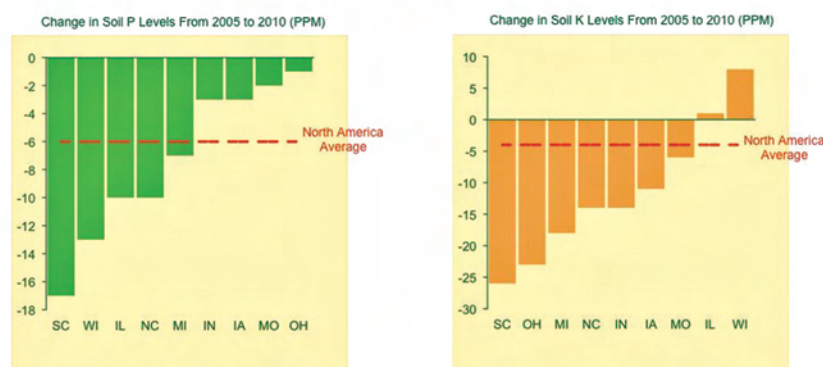
potassium levels are between 75 and 100 ppm. Without the application of additional nutrients, this represents an opportunity lost by a farmer to capture additional yield and profit.

## What Lies Ahead

As populations increase and diets improve in developing countries, the world faces an unprecedented challenge to keep pace with the rising demand for food. The ability of farmers to meet this demand is closely linked to the health of their soils. Farmers in the US have been blessed with highly productive soils that have enabled them to be major suppliers of crops for food, feed, fibre and fuel uses. However, maintaining this advantage over the long term will require a change in the way soil fertility programs are managed.

This starts with an awareness of the implications of continuing to draw down soil phosphorus and potassium levels. While

**Figure 3: US Phosphorus and Potassium Soil Test Levels**  
IPNI Study Indicates Soil Test Levels are Declining



Source: IPNI

increased crop productivity has been achieved by drawing down nutrients banked in the soil, a point has been reached in many regions of the US at which crops are likely not achieving their full potential due to soil fertility issues. We expect the push for higher yields will ultimately lead to greater utilization of these two nutrients in the US.

The need to increase fertilizer application rates will have to be managed alongside environmental considerations. In the case of phosphorus, application rates will have to be increased in a way that maximizes its availability to a growing crop and minimizes its potential

impact on the environment. This will be accomplished through the continued use of soil testing and application approaches that address nutrient loss. We support the efforts of IPNI, The Fertilizer Institute and the Canadian Fertilizer Institute who have been heavily promoting the use of 4R Nutrient Stewardship as an approach to address the societal need for more food and the desire for less environmental impact.

Feeding the world is a noble calling, and no one said it was going to be easy. Developing sustainable fertilization approaches will go a long way to ensuring that global nutritional needs are met moving forward. ■

**Table 1: Corn Yield Response to Phosphate and Potash Application at Selected Soil Test Levels**

Soil Test P Level (PPM)	Average Yield Response to P Application (bu/acre)
5-10	30
10-15	16
Soil Test K Level (PPM)	Average Yield Response to K Application (bu/acre)
50-75	46
75-100	24
100-130	8

Based on yield response models available from across the Midwest. Assumes a yield target of 200 bushels per acre.



Source: University of Illinois, Purdue University, Ohio State University, Iowa State University, PotashCorp