Economic Impact of Gypsum

A study of Midwestern crop growers completed January 12, 2014

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In this first-of-its-kind study, most farmers who applied gypsum as a soil amendment found that returns substantially exceeded the cost of the input. Yield, sulfur availability and long-term improvements in soil productivity topped the extensive list of benefits for gypsum users. The study revealed many other promising contributions gypsum offers to today's farming operations, from improved drainage and rooting depth to nutrient retention and reduced erosion.

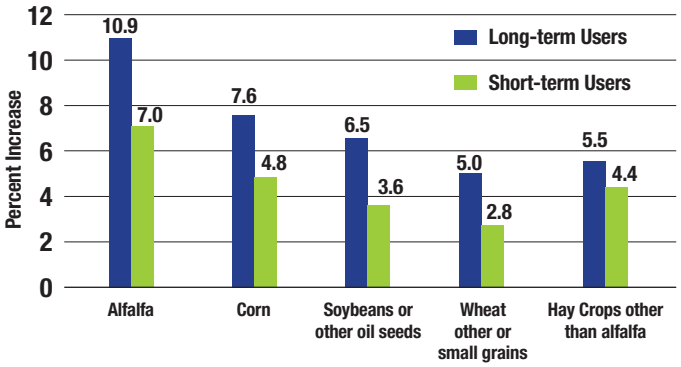
Increased yield and revenue

When asked why they used gypsum, the number one reason cited by 84% of users, was "helps improve crop yields". Seventy-seven percent of users rated yield improvement from gypsum moderately to extremely important.

When asked to quantify the yield increases, long-term users reported higher yield increases than short-term users (Fig. 1). The researchers hypothesized that either yield benefits accumulate over time, or perhaps longer-term users simply had more experience upon which to draw.

Yield increases were highest for alfalfa (nearly 11% for long-time users) and second highest for corn (nearly 8%). The yield response in alfalfa may in part be due to the fact that alfalfa has a high sulfur requirement, and gypsum provides sulfur in a plant-available form.

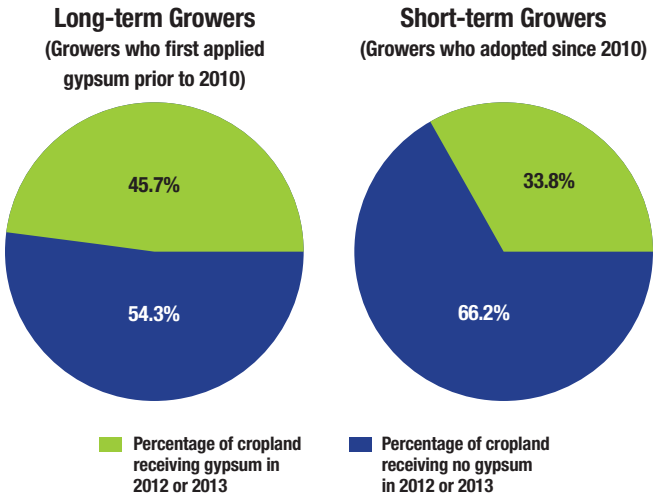
Figure 1 – Estimates of Yield Improvements by Crop for Long-term and Short-term Gypsum Users



Gypsum use increased with experience

Those producers that had used gypsum longest applied it to a higher percentage of their cropland than those who had more recently started using gypsum (Fig. 2). Nearly 46% of all cropland on operations with long-term gypsum use received applications in 2012 or 2013. Nearly 30% of long-term users applied it to all of their cropland.

Figure 2 – Percentage of Cropland Treated with Gypsum by Long- and Short-term Users



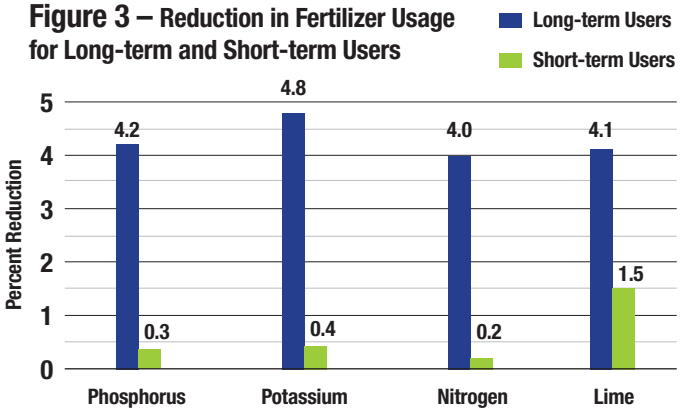
Essential sulfur, improved fertilizer effectiveness

In the survey conducted for the Economic Study, sulfur fertility ranked second in importance behind improved yields among gypsum users. Gypsum is calcium sulfate dihydrate, $CaSO_4 \cdot 2H_2O$. The sulfur is in sulfate form, which is readily available to crops. (Elemental sulfur applied to fields first must be converted to the sulfate form for plant uptake.) The value of sulfur in gypsum is more than $5 per acre for a 200-bushel corn crop, and more than $16 per acre for a 6-ton alfalfa yield.

Reports in the scientific literature also indicate that sulfur may allow farmers to reduce nitrogen rates[1]. Researchers found evidence that the application of sulfur with nitrogen can promote uptake. As a result, the value of decreased nitrogen fertilizer rates can be substantial and far greater than sulfur's benefits alone.

Gypsum users interviewed as part of this Economic Study indicated that gypsum improved the efficiency of nutrients such as phosphorus and potassium, as well as the retention of these nutrients in the soil profile for plant use. One of the most experienced gypsum users interviewed for this report, who applies fertilizer based on rigorous soil testing, indicated that over time he had reduced phosphorous and potassium use by 50% because gypsum helped improve the availability of these nutrients in the soil. Survey respondents also indicated that, on average, they found they could reduce fertilizer application through gypsum use (Fig. 3).

Figure 3 – Reduction in Fertilizer Usage for Long-term and Short-term Users



Improvement in soil quality

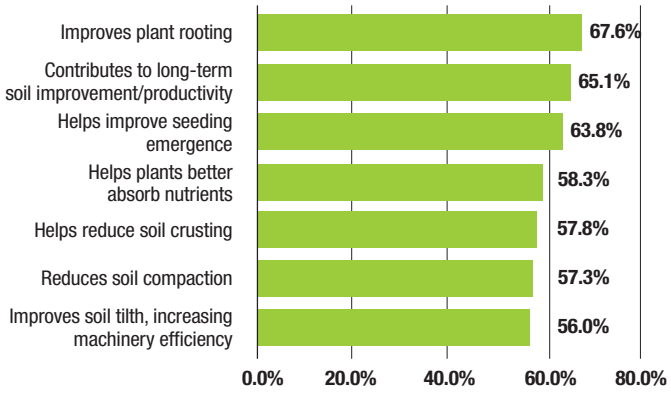
One of the most compelling reasons for gypsum use identified in the study was improvement in soil characteristics. Farmers in this study collectively ranked soil improvement among gypsum's top three attributes. Many long-term users ranked it as the most important benefit of gypsum.

What is soil improvement? Gypsum users indicated that gypsum application reduced compaction and improved soil tilth. In addition, after a rain there was less crusting, which improved seedling emergence. Looser, more permeable soils provided a deeper root zone for crops, which also increases plants' access to soil nutrients (Fig. 4).

Many of the farmers interviewed for this study pointed out that better soil tilth helped them get into the field more quickly after a rainfall event, and accomplish more fieldwork with less fuel and horsepower.

Gypsum also is known to decrease sodium and aluminum toxicity in soils. Although not a problem identified by most farmers surveyed in this study, in many parts of the country, aluminum barriers or sodic soils limit root penetration and crop growth. Gypsum also can help flush excess magnesium from soils.

Figure 4 – Percent of Users Who Rank Various Soil Improvement Benefits of Gypsum as Important

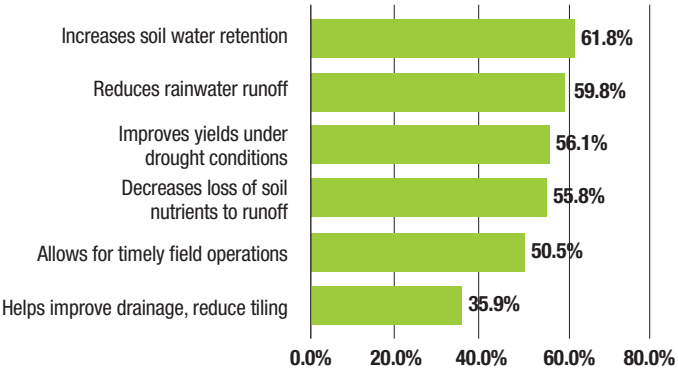


Better water management

The single most critical factor in crop production is water. Too much or too little severely limit yield. Moisture received at the wrong time or lost to runoff goes unused. Improving a farmer's ability to manage moisture was perhaps one of gypsum's most tangible benefits.

Farmers interviewed for this study indicated that gypsum reduced runoff and that resulted in less loss of valuable water and nutrients (Fig. 5). In fields treated with gypsum there was also less ponding after a rainfall event. Water infiltrates faster, which means that the soil surface dries faster, creating a wider window for fieldwork. Gypsum also improved the water-holding capacity of the soil, so crops are more drought-tolerant.

Figure 5 – Percent of Users Who Rank Various Water Management Benefits of Gypsum as Important

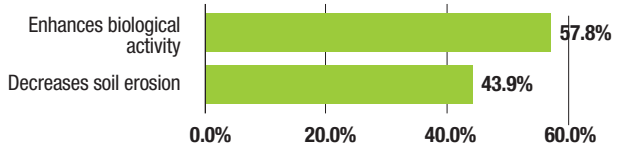


More sustainable production

Sustainability is an important factor in a world with finite land resources and a rapidly growing population. World population is expected to increase 50% in the next 35 years. That part of the population classified as middle class, which will demand the greatest improvement in diet, is expected to triple, from 1.8 billion to 4.8 billion by 2050[2].

Improved yields, more efficient fertilizer utilization and more effective conservation of water from gypsum use could help meet the need for additional food production from each acre. There are other benefits from gypsum that can contribute directly to the sustainability of farming, including improved biological activity in the soil, and decreased soil erosion. Both were highly valued by gypsum users interviewed for this study (Fig. 6).

Figure 6 – Percent of Users Who Rated Improved Sustainability as Important



While it is difficult to attach a specific dollar value to improved soil tilth, better water-holding capacity and improved sustainability, it was clear in this study that these were some of the most highly valued benefits among gypsum users, especially among those with the most experience.

Improved environmental stewardship

Groundwater pollution with phosphorus and other fertilizers can have significant negative impacts on water quality in streams, lakes and oceans downstream. In particular, phosphorus runoff from upstream crop and livestock production has been blamed for eutrophication of streams, lakes and coastal waters.

Soil-applied gypsum may serve as a means to stabilize phosphorus in the soil and reduce downstream effects of phosphorus movement. In fact, research has been conducted with the use of gypsum filters in ditches and waterways to intercept the flow of runoff, including phosphorous[3].

Poor water quality diminishes recreational values of streams and reservoirs and consequently the value of nearby properties. It also increases the costs of municipal water treatment and dredging of eroded soils from rivers and water storage reservoirs. To analyze gypsum's value in improved water quality, the researchers generated models based on an extensive review of literature. In one example, they estimated the value of gypsum in improving water quality for a 15,616-acre watershed. If gypsum were applied on all crop acres, annual value of improved water quality was $106 per household, or about $6 per cropland acre in the watershed.

Studies are currently underway in several major areas on the use of gypsum on farms to decrease nutrient pollution in major waterways, including Lake Erie.

Measuring the combined benefits of gypsum

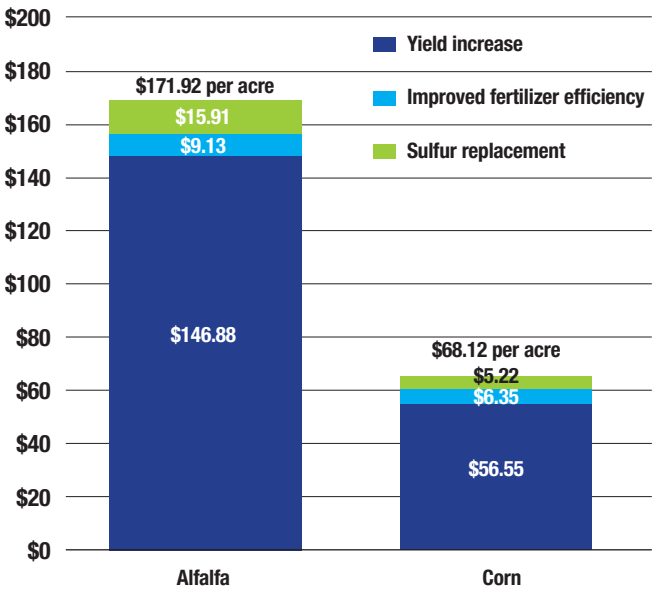
In summary, there are many ways that gypsum benefits farmers and improves profitability. Some benefits, such as improving soil, better drought resistance and increased sustainability are critical, but more difficult to measure economically.

Many benefits were quantified in the course of this study – both through review of peer-reviewed research, as well as through surveys of current gypsum users. Those include yield increases, sulfur fertility, and more efficient use of nitrogen, phosphorous and potassium.

The charts below show the benefits of gypsum use on alfalfa and corn (Fig. 7) when gypsum is applied at average rates and typical costs. Calculations were derived from mean yield increases for all users; added yield increases from longer-term users; improvement in fertilizer efficiency and the value of maintaining sulfur in the soil based on amount removed by the crop.

With an average cost for gypsum and application of $30/A, gypsum applied to alfalfa generated an average benefit to cost ratio of **5.73:1** and in corn **2.27:1**. This is without attaching a value to soil improvement. Other factors that improved the benefit to cost ratio include using gypsum in combination with no-till or conservation tillage, cover crops, and/or livestock manure.

Figure 7 – Gross Economic Benefits Per Acre to Longer-term Users of Gypsum on Alfalfa and Corn



Individual experience will vary, depending on soil types, management practices, gypsum cost and application, and other factors. In sum, as this Economic Study demonstrates, gypsum can be a valuable asset to crop production, offering an excellent return on investment.

Turn the page to read about the objectives and methodology for the Economic Study, plus demographics and gypsum usage history for the respondents.

About the Study

The Economic Impact of Gypsum study (Economic Study) was conducted by Marvin T. Batte, PhD and D. Lynn Forster, PhD. Both are agricultural economists who recently retired from The Ohio State University. The study was sponsored by the GYPSOIL Division of Beneficial Reuse Management, in cooperation with *No-Till Farmer* magazine.

Objectives

1. To determine the value of nutrients supplied through gypsum application.
2. To measure the impact on crop performance and enterprise profitability associated with gypsum use.
3. Review and quantify potential environmental benefits.

Methodology

The study involved three phases:

1. An extensive review of gypsum research in peer-reviewed journals;
2. In-depth interviews with five producers – case study farmers – that had extensive experience with gypsum; and
3. A survey of 362 farmers who were either readers of *No-Till Farmer* magazine or who had recently purchased gypsum. (A total of 294 respondents completed all aspects of the survey.)

A profile of survey respondents appears in Figure 8. It demonstrates that gypsum users were typical of Midwestern farmers. There were no substantial demographic differences between gypsum users and non-users.

Figure 8 – Demographics and Business Characteristics of Gypsum Users and Non-users

Measure	Full Sample	Gypsum Users	Non-users
Number	294	102	192
Mean age in years	54.1	52.0	55.3
Percent with a college degree	50.7%	52.9%	49.5%
Total acres farmed	1,266	1,237	1,281
Percent of land share lease	11.0%	8.9%	12.1%
Percent of land cash lease	37.8%	34.6%	39.5%
Farm gross sales	$986,088	$1,181,152	$882,461
Percent of income from livestock	16.2%	20.5%	13.9%

Ninety percent of survey respondents were from IL, IN, WI (44% from those three states) plus IA, KS, KY, MI, MN, MO, NE, NY, PA.

Gypsum use

The most common soil types found on surveyed farms were clay-clay/loam and loam-silty/loam. The most important soil problems identified by respondents included compaction and poor drainage or water infiltration, cited as moderate to serious by a third of producers.

Farmers using gypsum typically applied it at the rate of 1,000 or 2,000 pounds per acre. The most common rate was 2,000 pounds per acre. The mean rate ranged from 1,121 to 1,397 pounds per acre depending on crop.

At mean application rates, total costs for gypsum and application were as follows:

Alfalfa	$30/A	**Soybeans**	$31/A
Corn	$30/A	**Wheat**	$33/A

For more information about the use of gypsum and an extensive Research Library with peer-reviewed journals and other bulletins, visit **www.gypsoil.com.**

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[1]Chen, Liming, David Kost, and Warren A. Dick. 2008. "Flue Gas Desulfurization Products as Sulfur Sources for Corn." Soil Science Society of America Journal 72:1464-1470.

[2]Food & Agriculture Organization (FAO) "How to Feed the World in 2050" Rome. 12-13 October 2009, pp. 1-6; and Kharas, Homi. "The Emerging Middle Class in Developing Countries.: Global Development Outlook. OECD Development Center. Working Paper No. 285. Jan. 2010. http://www.oecd.org/dev/44457738.pdf

[3]Bryant Ray B., Anthony R. Buda, Peter J.A. Kleinman, Clinton D. Church, Louis S. Saporito, Gordon J. Folmar, Salil Bose and Arthur L. Allen. "Using Flue Gas Desulfurization Gypsum to Remove Dissolved Phosphorus from Agricultural Drainage Waters." Journal of Environmental Quality 41(3): 664-671.