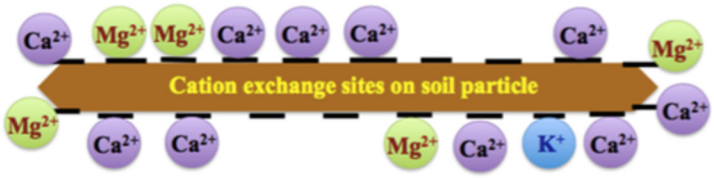
A Primer on Soil Balancing and its Application

The Ohio State University Soil Balancing Team

What is Soil Balancing?

For most farmers and scientists, soil balancing generally refers to the theory and practice of attaining an optimum ratio of the plant nutrients, calcium (Ca), magnesium (Mg), and potassium (K), in the soil. For many soils, achieving balance requires relatively large inputs of calcium-rich minerals (limestone and/or gypsum) in order to raise Ca to the desired level. A balanced soil is rarely achieved quickly and often requires an investment of resources.



Graphic courtesy of Chaganti, VJ and Culman, SW (2016)

Figure 1 Cation Exchange Soil particles contain sites that can hold positively charged ions (e.g., Ca, Mg, and K). Soil balancing calls for specific percentages of these sites to be occupied by these three ions. Thus, at its core, soil balancing is about managing soil chemistry.

Soil balancing is based on Base Cation Saturation Ratio (BCSR) theory that calls for approximately 65, 10, and 5 percent of a soil's cation exchange sites (Cation Exchange Capacity or CEC) to be occupied by Ca, Mg, and K, respectively. (See figures 1 and 2) CEC refers to a soil's innate ability to retain nutrients and make those nutrients available to crops. Soils high in CEC hold more nutrients and thus can release more than soils low in CEC.

Brief History: Who, Where, When

Soil balancing concepts were first proposed in the late 1800s by German scientist, Oscar Loew, and then built upon by others starting in the mid-1900s (Figure 2). However, the main concepts are commonly associated with William A. Albrecht (Figure 3), a Professor at the University of Missouri during the 1930s–1960s. Albrecht believed that crops responded to limestone or gypsum primarily because of increasing Ca levels, rather than changes in soil pH.

	% Ca	% Mg	% K
Bear (1945)	65	10	5
Graham (1959)	60-85	6-12	2-5
Albrecht (1975)	60-75	10-20	2-5

Figure 2 Percent saturations of base cations suggested by different researchers.

Figure 3
Dr. William A. Albrecht.
Courtesy of Acres USA. acresusa.com/history/

How does Soil Balancing Compare with Other Approaches to Nutrient/Soil Management?

Soil balancing is practiced in a variety of ways throughout the United States. As a management practice, it is more common among organic growers. With regard to soil fertility management, land grant universities have historically advocated for considering each nutrient individually and determining a sufficient level for nutrients in the soil. This approach is sometimes called Sufficiency Level of Available Nutrients (SLAN) and it disregards ratios of one element to another. Agricultural researchers have evaluated SLAN approaches for decades, but BCSR approaches have been studied and reported on far less.

Many soil balancing practitioners closely follow the core principles outlined by Albrecht, with a primary focus on the use of limestone and gypsum to manage the soil. For others, however, "soil balance" refers to a wider range of considerations. This broader view strives for a 'balanced soil biology,' which may involve applying micro-nutrient blends and microbial formulations thought to help accelerate the balancing process and contribute to overall soil health.

"The soil balancing concept fits well with the orientation of organic farmers towards feeding the soil rather than the crop. Soil balancing is considered to be a long-term approach that may not have observable benefits in the short-term."
– A farmer practicing soil balancing

Photo Stephanie Short

Above, researchers explain an on-farm experiment to members of the project's stakeholder advisory committee, other farmers, and extension educators.

Different Experiences Result in Different Perspectives Regarding Soil Balancing

Numerous row-crop and vegetable farmers have reported improved soil tilth, better crop yields and quality, and greater ease in managing weeds as the 'balance' of their soils improved.

Yet, scientists conducting controlled experiments to evaluate BCSR have found little evidence of its advantages beyond what can be achieved by focusing on individual nutrients and general soil health. Research to date has indicated that when directly comparing management using the BCSR and SLAN approaches, there was no evidence of an increase in yield that would justify increased costs associated with BCSR amendments. As a result, most scientists and advisers discourage the use of BCSR-based approaches.

Meanwhile, many farmers and farm-advisors remain convinced that soil balancing can improve their soil and crops. Their positive experiences with a diversity of soil balancing practices have led to questions about whether soil balancing research to date has adequately tested their approaches, including the fact that there are a relatively small number of studies and that most of those were too short-term, focused on too narrow a conception of soil balancing, or measured too few of the outcomes farmers consider to be important (other than yield). Proponents recommend more research before drawing firm conclusions.

Grower-Consultant-University Collaborations Look to Move the Soil Balancing Discussion Forward.

Soil balancing is valued by some growers and an important curiosity for others. Scientists have not been able to support claims that targeting high Ca saturation ratios alone can generate consistent benefits in controlled studies. However, there remains room to expand scientific study to the more complex soil management systems used by many organic (and conventional) soil balancing practitioners. Combining rigorous scientific methods and the practical field experiential knowledge of farmers and consultants is likely to generate new insights about the complex interactions between soil balancing management practices and agroecosystems.

With support from the USDA and others, farmers, farm-consultants, and scientists at The Ohio State University are working to build bridges between the knowledge base held by farmers and practitioners (on the one hand) and the agricultural research community at land grant universities (on the other). We continue to invite farmers, consultants, and scientists to join us in our work. For more information, please contact members of the Ohio State soil balancing project team.

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