

National Lime Rate Survey

Soil testing and fertilizer nutrient management are at the core of modern agriculture. The majority of soil test correlation and calibration trials and development of fertilizer recommendations occurred from the 1950s to 1970s. Despite many changes and advancements in agronomy and increases in crop yields, research on key soil fertility topics has not been conducted in many states. Today, the imperative of upgrading fertilizer and soil amendment recommendations is highlighted by volatile on-farm economic conditions and concerns over the fate of fertilizer nutrients in the environment.

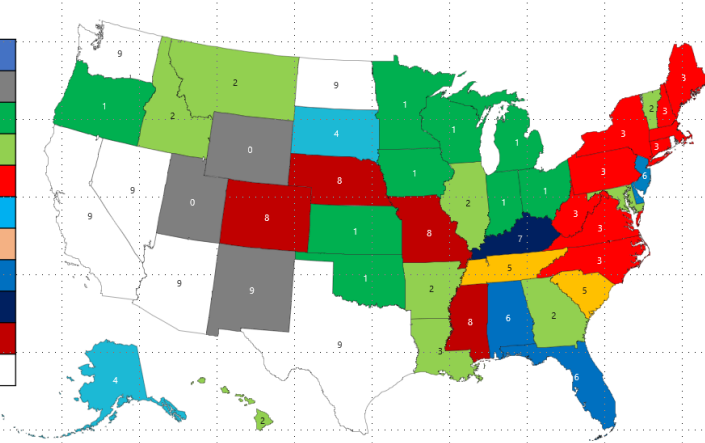
The Fertilizer Recommendation Support Tool, or “FRST”, is a national initiative to modernize fertilizer recommendations by pooling expertise and soil test correlation and calibration data from across the country into an accessible decision support tool. Researchers working as a national team rather than within individual states and institutions will reduce ambiguity while optimizing soil amendment and nutrient use across state lines through the development of the FRST. FRST activities encompass other endeavors including the improvement of soil pH management and liming recommendations. The FRST tool and data generated by FRST activities are expected to augment existing recommendations with the potential to enhance soil and natural resource management, increase the return on soil amendment investment by growers, and reduce excess nutrient losses to the environment.

Soil pH influences soil and fertilizer nutrient availability which determines plant growth and productivity. Ensuring soil pH is maintained within the optimal range for plant production is the most fundamental soil nutrient management practice and is key to maintaining healthy soil. Laboratory practices to measure soil pH and estimate a liming rate have evolved across time and geographic regions in the USA. We surveyed land grant institution scientists in the 50 US states and Puerto Rico to determine the methods used to measure soil pH and lime requirement. Methods in current use were compared to the method documented for each state nearly 40 years ago. Participating institutions were also asked to provide a lime rate recommendation for six acidic soils using a suite of soil chemical and physical properties. The recommended lime rates were standardized by expressing the lime rate for the amount of 100% calcium carbonate equivalent lime needed to adjust soil pH in a 15 cm depth (6 inches) to a target pH of 6.5.

This investigation documented soil pH methods for 48 states and lime requirement methods for 41 states. A 1:1 soil-water ratio is used for pH determination by 34 states (71%), 1:2 soil-water ratio pH in 7 states (15%), and four other methods accounted for the other 7 states. Forty-one states had 51 total liming recommendations with some institutions having guidelines for two or more methods. Nine different buffer methods accounted for 40 of the lime requirement recommendations from 31 states with the Sikora (10), Mehlich

Fig. 1. Buffer pH solution or method used to provide liming recommendations for each U.S. state and Puerto Rico based on the 2022 survey.

| # Legend | Method |
|----------|---------------|
| 0 | Not offered |
| 1 | Sikora (+SMP) |
| 2 | Other |
| 3 | Mehlich |
| 4 | SMP (Only) |
| 5 | Moore-Sikora |
| 6 | Adams Evans |
| 7 | Sikora-2 |
| 8 | Woodruff |
| 9 | No response |



The implications of large lime rate recommendation variations across agricultural laboratories are important for regions of the U.S. where similar soils exist across state boundaries, or soil-testing laboratories serve clients across many states. There is a need to determine why large differences in lime rate recommendations exist

or modified Mehlich (10), and SMP (9) buffer methods used most frequently. In the 10 states not using a buffer solution, the lime requirement was determined by titration, pH alone, extractable aluminum, or combining soil pH with other soil properties. Compared to 1980, the lime requirement method has changed in 34 of the 41 states. Twenty-eight of the 34 states adopted new lime requirement determination methods in the last 20 years mainly to replace buffer methods that contain hazardous chemicals with more laboratory-friendly buffer methods.

The median rates of 100% calcium carbonate equivalent lime recommended to adjust pH in the top 6 inches ranged from 2000 to 8100 lb acre⁻¹ (2242 to 9079 kg ha⁻¹) with standard deviations of 1072 to 3372 lb acre⁻¹ (1202 to 3779 kg ha⁻¹) for the six survey soils. The coefficient of variation for the six mean lime rates ranged from 41 to 73%, showing that state-specific lime rate calibrations are quite variable. Despite the high variability, the state recommendations conceptually agreed with the relative amounts of lime recommended for each soil.

and to harmonize recommendations among agricultural laboratories to ensure accurate, consistent, and transparent guidance is provided to farmers.

For more detailed information on the national lime survey, please see:
TBD – *paper is in review*

Special thanks to the individuals providing state lime rate recommendations for this survey and our funders, USDA-NRCS (grants 69-3A75-17-45 & NR233A750011G016), USDA-ARS (grant 58-8070-8-016), and agInnovation (State Agricultural Experiment Stations) via Hatch Funds provided by the National Institute of Food and Agriculture, U.S. Department of Agriculture.

For more information visit soiltestfrst.org.

*Authors: Authors: J. Jones (Univ of Illinois), B. Miller (Agricultural Laboratory Proficiency Program), J. Spargo (Penn State Univ.), F. Sikora (Univ of Kentucky), M. Rakkar (Ohio State Univ.), N.A. Slaton (Univ. of Arkansas Division of Agriculture), & D. Osmond (NC State Univ.)
January 2025*