The ALP program



The Agricultural Laboratory Proficiency (ALP) program provides soils, plants and water proficiency samples for the assessment of chemical analysis of Ag testing labs.

It is a service of Collaborative Testing Services (CTS), with 54 years providing professional proficiency test services across multiple testing discipline. Expertise in statistical analysis of laboratory measurement data.

Worldwide Interlaboratory Testing
Collaborative Testing Services

Accredited provider under ISO/IEC 17043:2023 [1], "*General requirements for the competence of proficiency testing providers*", assessed biennially by ANSI National Accreditation Board (ANAB).

ISO/IEC 17043:2023
Conformity assessment
General requirements for the competence of proficiency testing providers

International Organization for Standardization

[1] Newest revision of ISO/IEC 17043 conformity assessment.

ALP by the numbers

20 years - **60** PT cycles

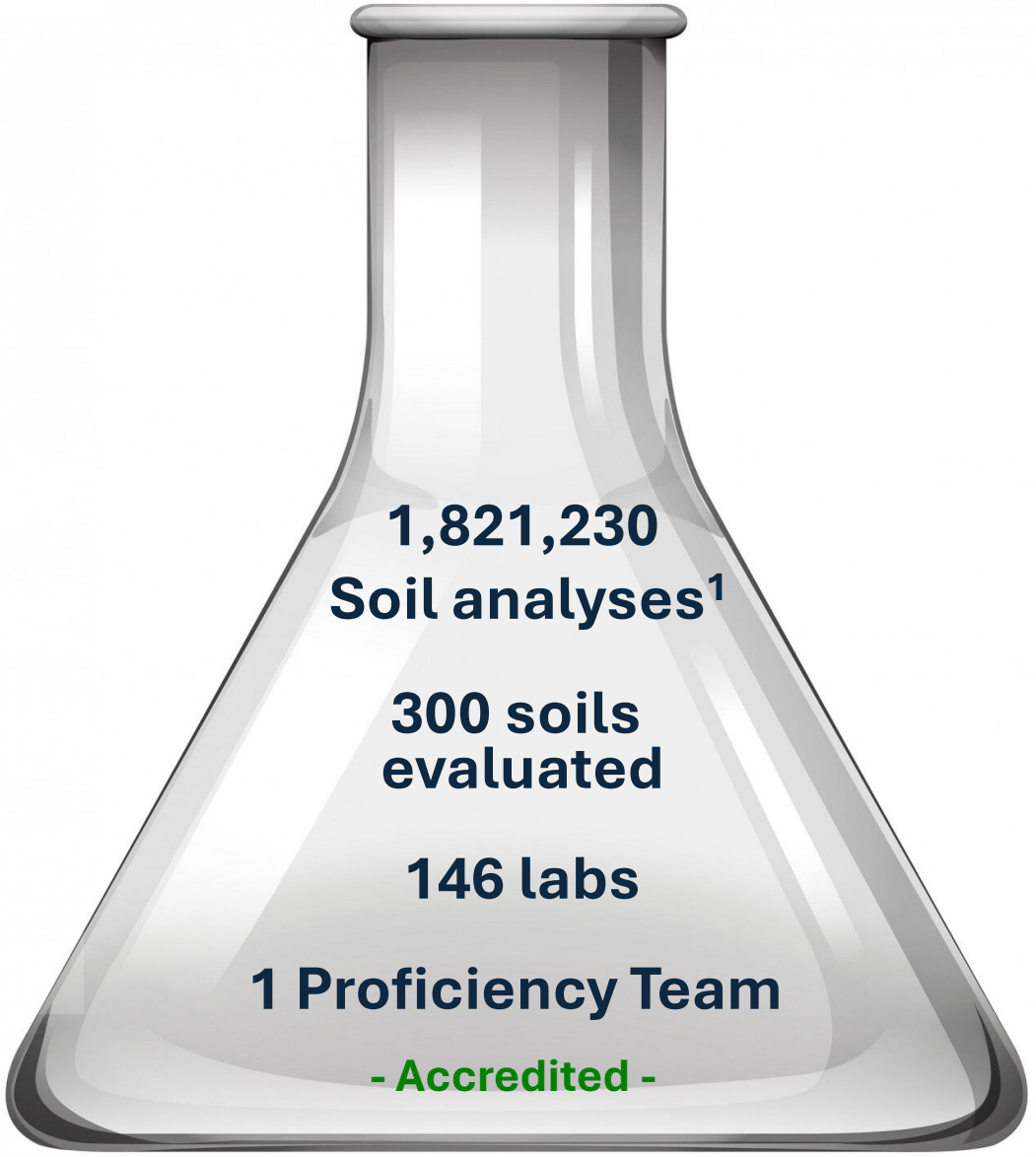
300 soils, **212** plants **192** water PT samples

Soils from **58** States / Canadian provinces

122,400 lbs of reference soil prepared

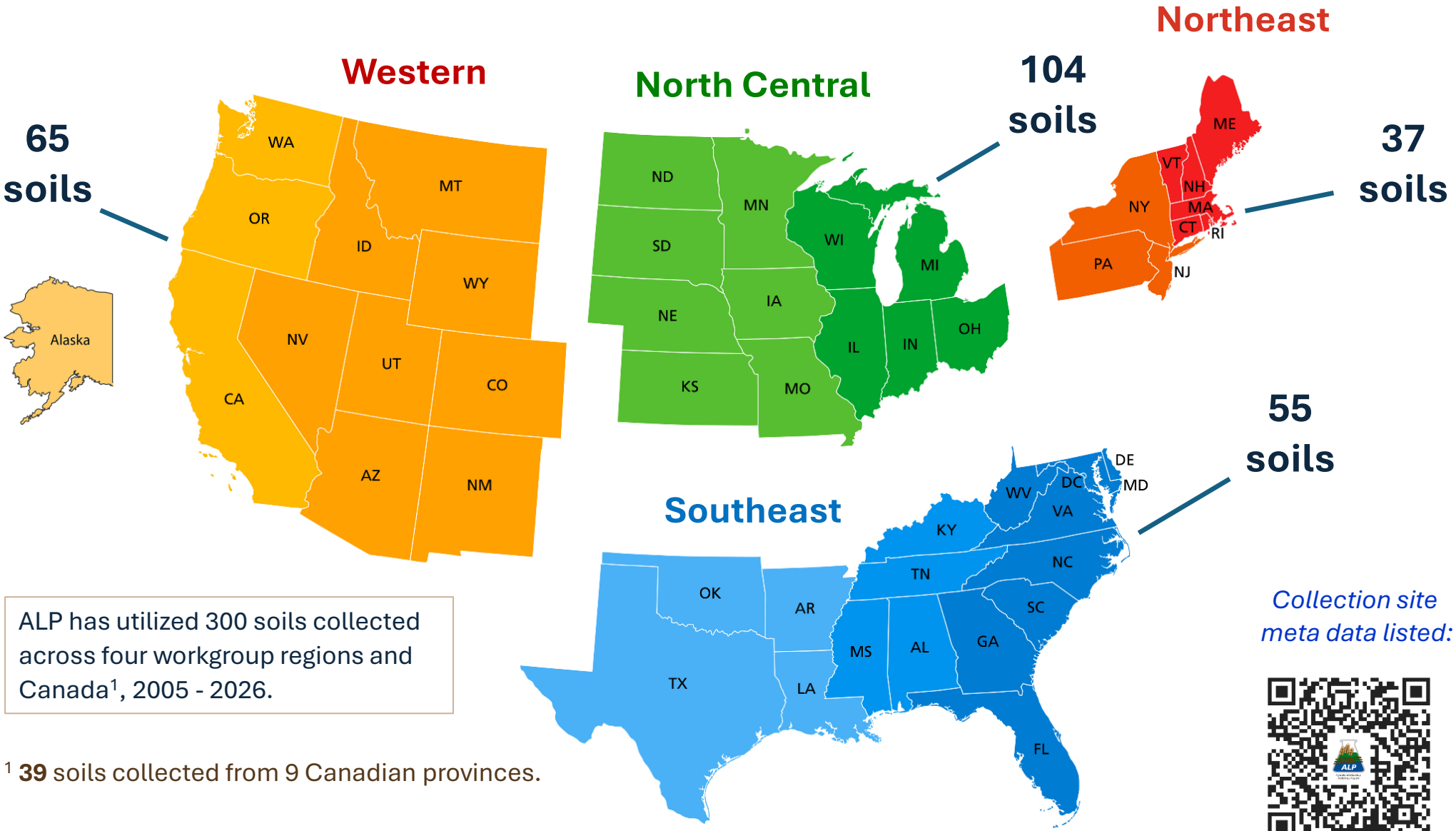
1858 proficiency reports on quality

22,420 lbs of standard reference soil



[1] Number of soils × parameters × labs × reps.

ALP soil collections



ALP has utilized 300 soils collected across four workgroup regions and Canada[1], 2005 - 2026.

[1] **39** soils collected from 9 Canadian provinces.

Collection site meta data listed:

PK Blender update

Patterson Kelly V shell blender, used for soil processing is being refurbished after 26 years of service and processing > 110 tons of soil. Service replacement of intensifier bar and flails.



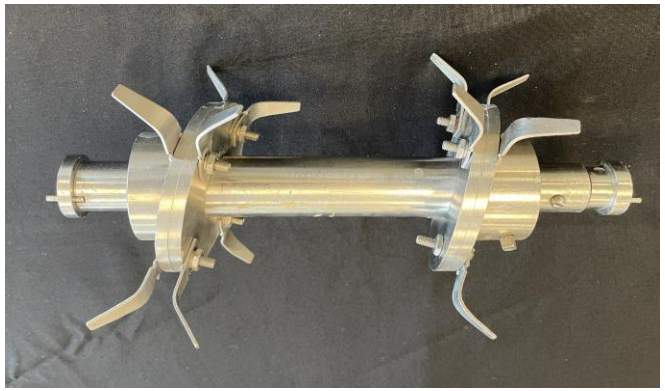
Worn intensifier bar

Soil carbon program

The ALP soil carbon proficiency program has 14 labs enrolled. Cycle 61 samples ship September 18, 2026.

Projects

ALP is collaborating with Spectro in Germany, to evaluate the use of XRF for the analysis if metals on ALP archived plant reference samples.



Replacement intensifier bar

Soil Health Methods



https://i.ytimg.com/vi/szAhuU60TE4/sddefault.jpg

ALP is launching a PT Soil Health Method program, in September for lab testing with regard to NRCS CEMA 217 requirements. An assessment study of methods will be conducted in ALP Cycle 61 to evaluate sample integrity, stability and method performance. Methods:

- pH (H_2O / 0.01 M $CaCl_2$)
- Soil Organic Carbon (SOC)
- Soil respiration
- Aggregate stability
- POX-C
- Ace Protein

Soil proficiency materials will require special processing to maintain soil aggregate integrity during processing and shipping. Further details available September 1, 2026.

ALP
Agricultural Laboratory Proficiency Program

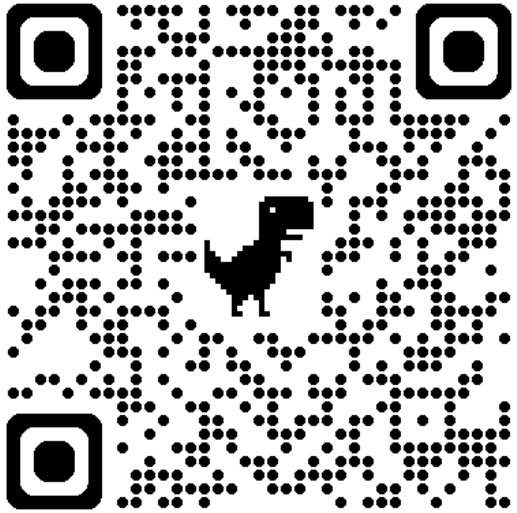
Building a National Resource for Soil Fertility Decisions: The FRST Approach

Contact FRST

The Fertilizer Recommendation Support Team (FRST) welcomes questions, ideas, and collaboration from researchers, Extension professionals, laboratories, producers, industry partners, and all stakeholders engaged in advancing soil fertility science.
For general inquiries, information about joining FRST, or project-wide information, please reach out to our primary contacts:

Dr. Nathan A. Slaton (University of Arkansas)
Title: Associate Vice President for Agriculture and Assistant Director of the Arkansas Agricultural Experiment Station (AAES)

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Northeast Region Lead

Dr. John T. Spargo (Pennsylvania State University)
Title: Research Professor & Director, Agricultural Analytical Services Laboratory, Department of Plant Science

Email: jts29@psu.edu

Southern Region Lead

Dr. Luke Gatiboni (North Carolina State University)
Title: Extension Soil Fertility Specialist and Professor, Department of Crop & Soil Sciences

Email: luke_gatiboni@ncsu.edu

North Central Region Lead

Dr. Daniel Kaiser (University of Minnesota)
Title: Professor and Extension Soil Fertility Specialist, Department of Soil, Water, & Climate

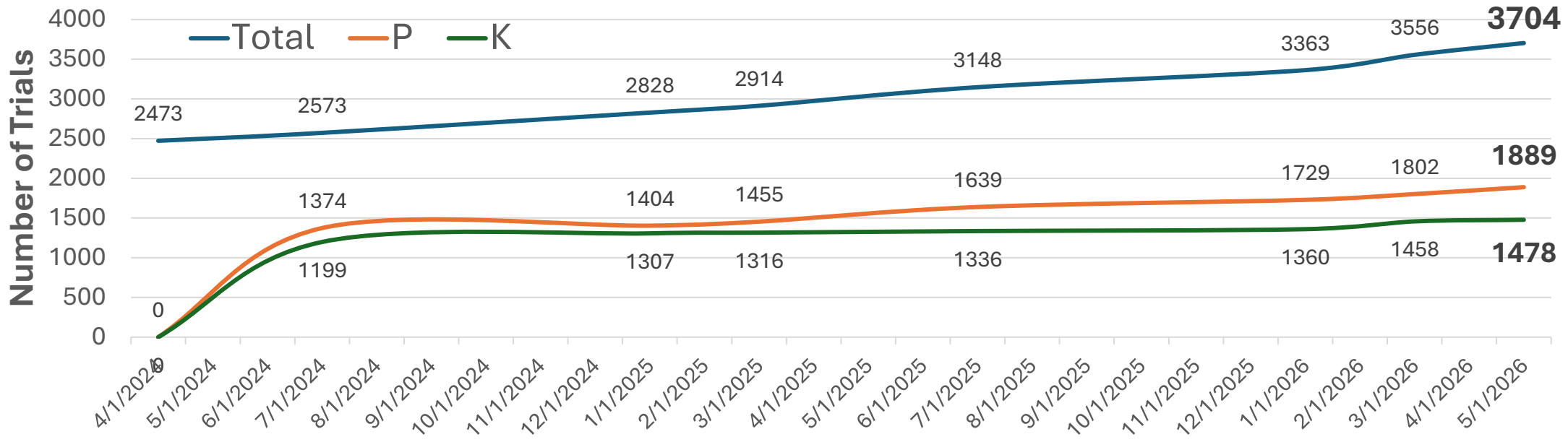
Email: dekaiser@umn.edu

Western Region Lead

Dr. Matt Yost (Utah State University)
Title: Assistant Professor, Department of Plants, Soils, & Climate

Email: matt.yost@usu.edu

The FRST National Database Growth



P Database

- **1,889** observations
- 77% of data from corn & soybean
- 41 states represented

K Database

- **1,478** observations
- ~74% of data from corn & soybean
- 34 states

S Database

- **338** observations
- 90% from corn, soybean & winter wheat
- 14 states

Database information from 05.31.2026

Fertilizer Calibration Modeling Activity

- **Committee**
  - *Luke Gatiboni, Chair*
  - *John Filippi, Research Lead*
  - Greg Buol
  - John Spargo
  - Carl Bolster
  - Megan Bourns
  - Adrian Correndo
  - Huijie Gan
  - Daniel Kaiser
  - Emma Matcham
  - Kelly Nelson
  - Nathan Nelson
  - Deanna Osmond
  - Rasel Parvej
  - Vaughn Reed
  - Amy Shober
  - Rajveer Singh
  - Jared Spackman
  - Matt Yost
  - Nathan Slaton

Project Overview

- Comparison of modeling approaches for fertilizer-P & K rate calibration
  - Quantile regression
  - Alternative to equation-based rates
  - Groundwork for modeling ROI calibration
  - Paper is in peer-review process with *Soil Science Society of America Journal*
  - Seeking volunteers for beta testing

Lime Calibration Activity

- **Committee**
  - *Amy Shober, Chair*
  - *Rajveer Singh, Research Lead*
  - Bob Miller
  - Shannon Alford
  - Luke Gatiboni
  - Brad Joern
  - John Jones
  - Daniel Kaiser
  - David Kissel
  - Amber Moore
  - Stephanie Murphy
  - Deanna Osmond
  - Manbir Rakkar
  - Kurt Schroeder
  - John Spargo
  - Matt Yost

Project Overview

- 116 soil-lime lab incubations
- 9 BpH methods
- Complete suite of soil characterization data
- Post-lime incubation soil properties
- Soil scoop density analysis

FRST Lime Calibration Project

Rajveer Singh | Robert Miller | Nathan Slayton

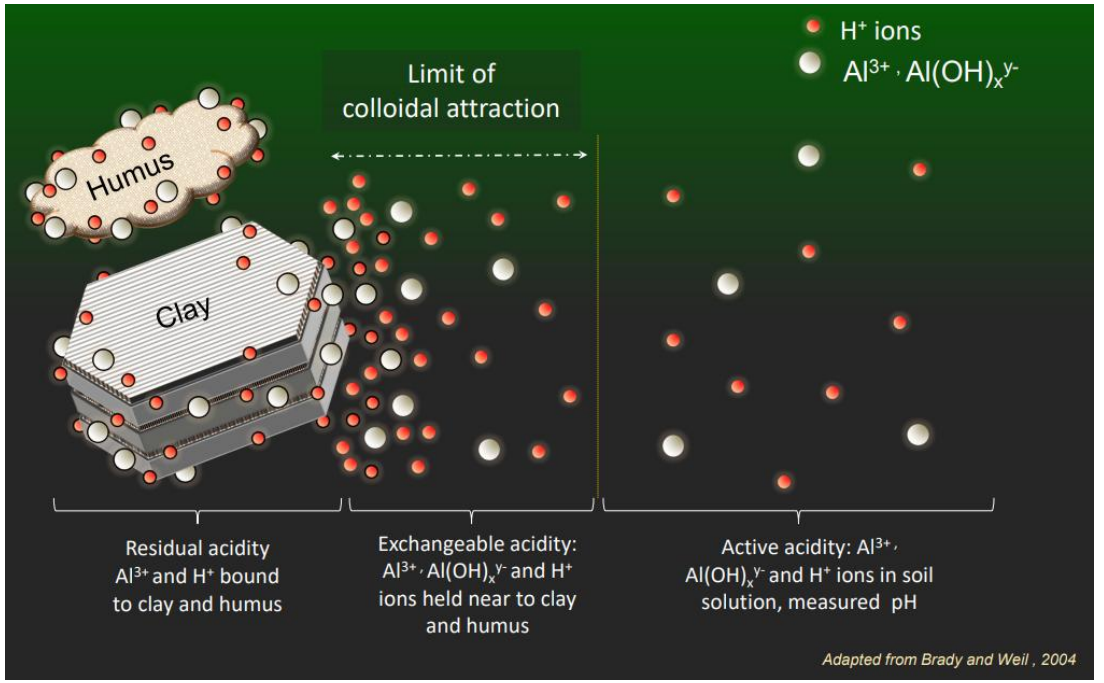


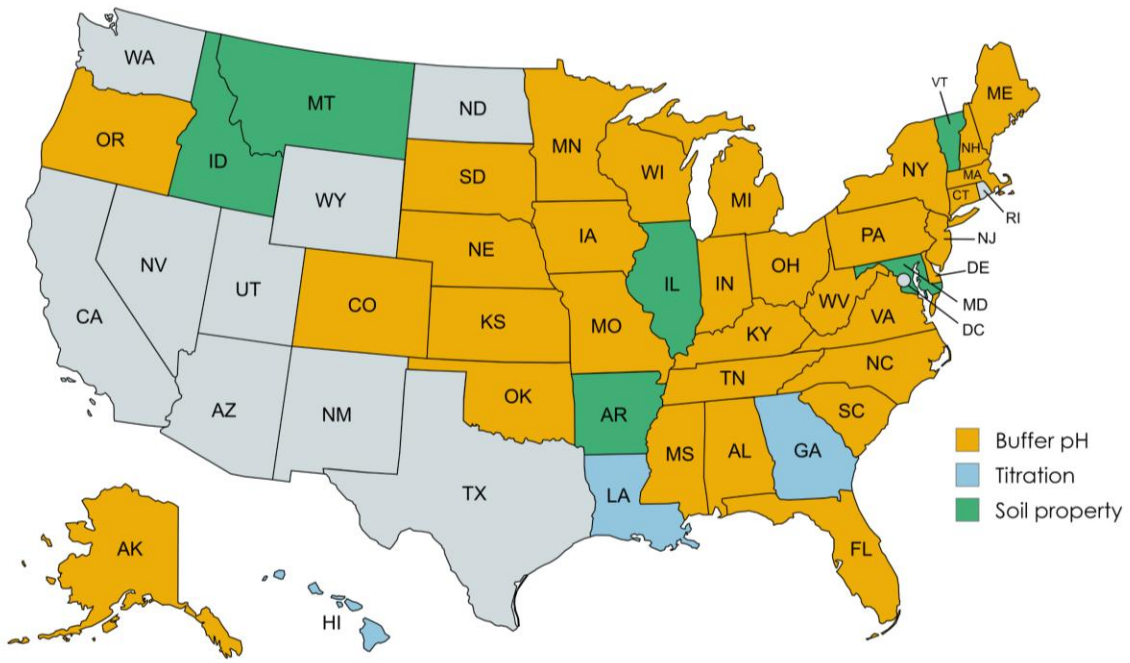
Introduction

- **Soil acidity** is a major constraint to crop production.
- Liming is the primary practice used to increase soil pH.
- Effective liming neutralizes active, exchangeable, and reserve acidity.

How much lime should be applied?







Buffer solutions: Woodruff, SMP, Adams–Evans, Mehlich, Mod. Woodruff, Mod. Adams–Evans, Sikora, Moore–Sikora, Sikora 2, and Mod. Mehlich

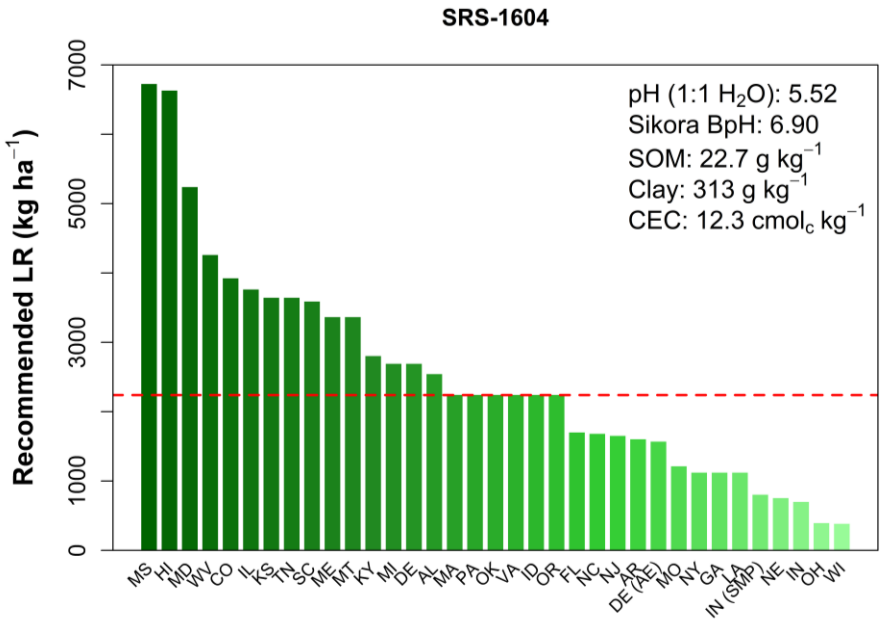
19 different methods are used by LGUs to make lime recommendations.

- **Buffer pH methods**: Most widely used approach
- **$Ca(OH)_2$ titration**
- **Soil property-based estimates**

These methods were developed and calibrated for specific states or regions.

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Variation in lime recommendations across the United States



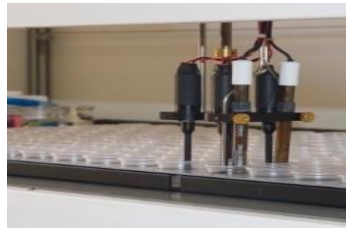
Assessment of soil pH and lime requirement methods and recommended lime rates for six reference soils across US land grant institutions

John D. Jones, Robert O. Miller, John T. Spargo, Frank J. Sikora, Manbir K. Rakkar, Nathan A. Slaton, Deanna L. Osmond

First published: 05 September 2025 | https://doi.org/10.1002/saj2.70116

- A 2022 survey evaluated lime recommendations from 34 land-grant universities using six reference soils.
- Recommended lime rates varied substantially among institutions.
- Results highlighted the need for **a national lime calibration effort**.

FRST Lime Project



Phase I

Webinars, review of basis of soil acidity, soil pH and BpH methods.
Survey LGU soil pH, BpH methods and lime recommendations used in North America. Manuscript on survey results in progress.

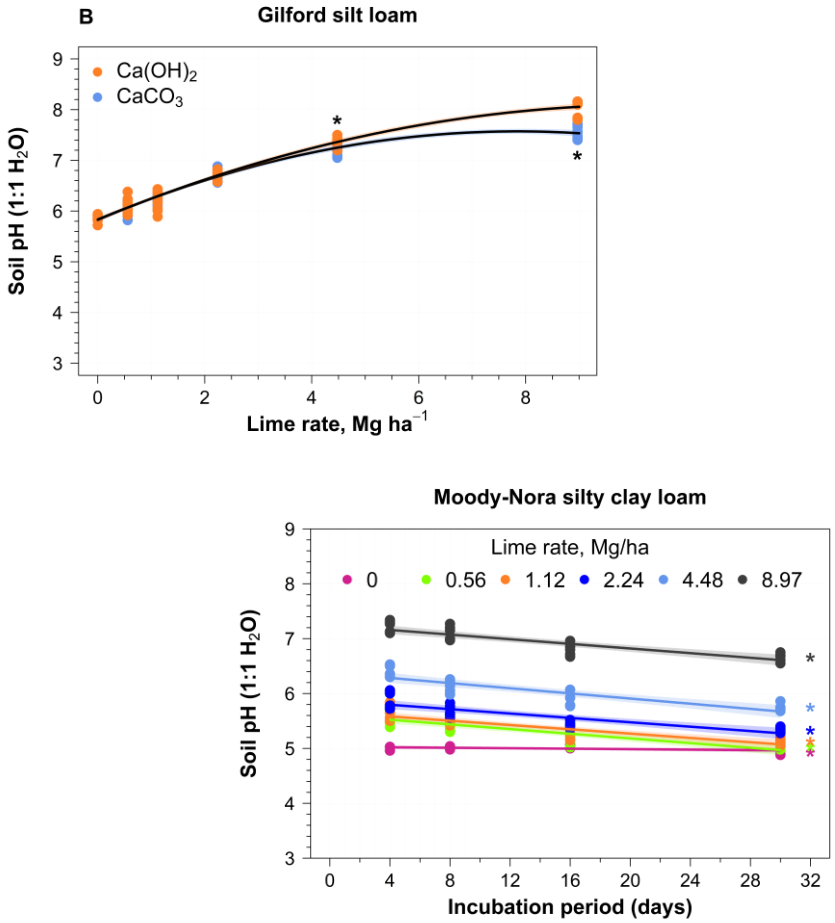
Phase II

Initiate a national project to generate new lime calibration data.

- Collect: 120 acid soils across US, compile soil analysis data.
- Conduct: lime incubation study to assess neutralization of acidity.
- Develop: new lime calibration recommendations.

A National Lime Calibration Effort

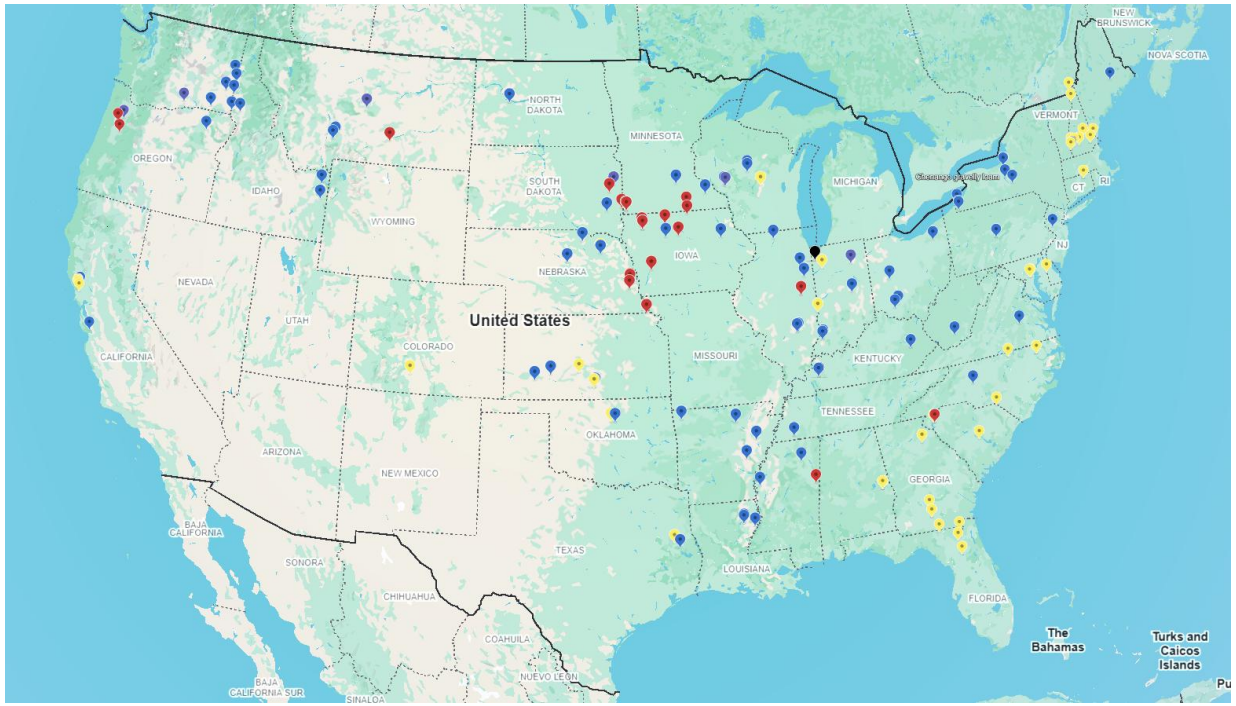
The project aims to calibrate multiple LR methods using diverse U.S. soils



- A standardized protocol was needed for conducting soil incubations.
- A **pilot study** evaluated the effects of lime source [$CaCO_3$ and $Ca(OH)_2$] and incubation period (0–30 d).
- 4–8 d incubations with either $CaCO_3$ or $Ca(OH)_2$ were sufficient to characterize soil pH response to lime rate.

Materials & Methods

A total of **148 soils** were collected across the US



- pH (1:1 H_2O): 4.0–7.7
- Clay content (g kg^{-1}): 30–520
- Organic matter (g kg^{-1}): 2–190
- Mehlich-3 Ca (mg kg^{-1}): 100–5090

- **32 soils** with pH > 6.2 were excluded

Soils were characterized for different **buffer pH methods:**

- Adams-Evans: 5.71 – 7.82 (7.32, Median)
- Modified Adams-Evans: 6.84 – 7.96 (7.70)
- Moore-Sikora: 6.64 – 7.83 (7.58)
- Modified Mehlich: 4.93 – 6.34 (6.06)
- Modified Woodruff: 5.14 – 6.88 (6.52)
- SMP & Sikora: *Pending*
- Lime buffer capacity, mg kg^{-1} : 278 – 11498 (1316)

PennState

AUBURN UNIVERSITY

CLEMSON UNIVERSITY

UNIVERSITY OF GEORGIA

RUTGERS

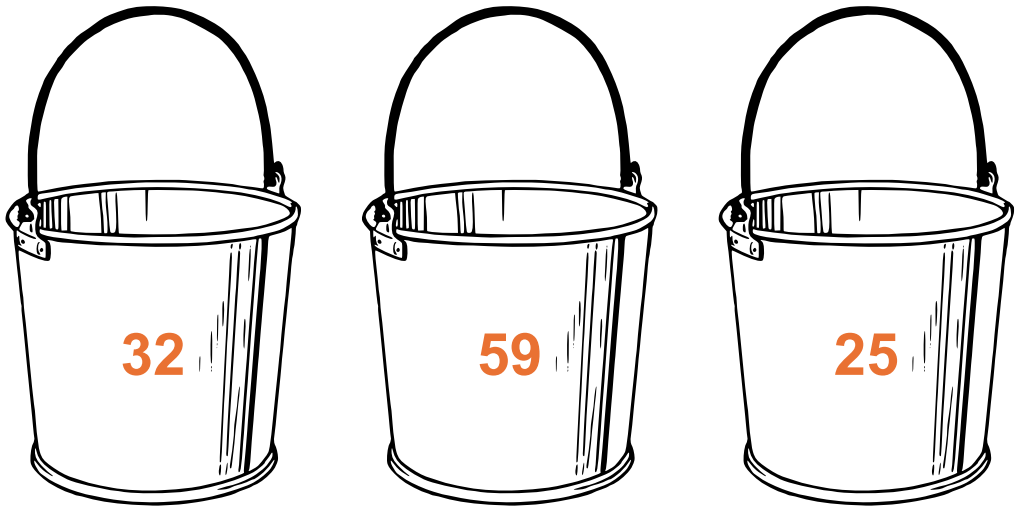
Mizzou
University of Missouri

LSU

ROCK RIVER LABORATORY, INC.
AGRICULTURAL ANALYSIS

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Soils grouped by lime requirement (target pH 6.5) using the Modified Mehlich BpH



Six lime rates (Mg ha^{-1}) applied:

- Group 1: 0, 1.12, 2.24, 3.36, 4.48, 6.73
- Group 2: 0, 1.12, 2.24, 4.48, 8.97, 13.45
- Group 3: 0, 2.24, 4.48, 8.97, 13.45, 17.93

Incubation setup

Sample size: 100 g per soil

Lime source: Reagent-grade $CaCO_3$

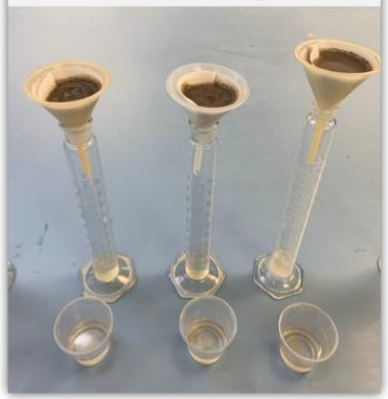
Soil moisture: 50 – 80% MWHC

Incubation period: 8 – 21 days

Temperature: 23 ± 2°C

Design: CRD (triplicate)

Soil water holding capacity



Lime application



Lime mixing



Soil–lime mixture



Moisture addition



Experimental setup



- **Post-incubation processing:**

  Oven-dried at 55°C for 48 h & ground to pass a 2-mm sieve.

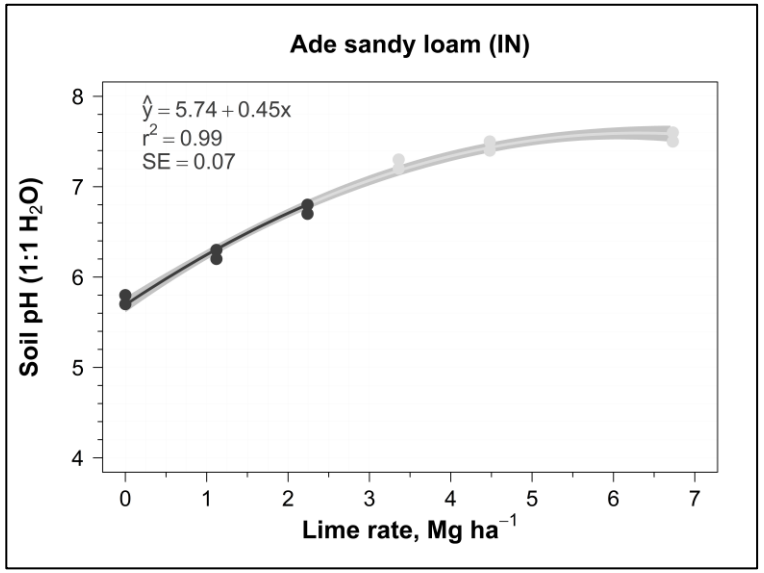
- **Post-incubation analyses:**
  - pH (1:1 & 1:2 H_2O)
  - pH (1:1 0.01 mol L^{-1} $CaCl_2$)
  - Mehlich-3 extraction

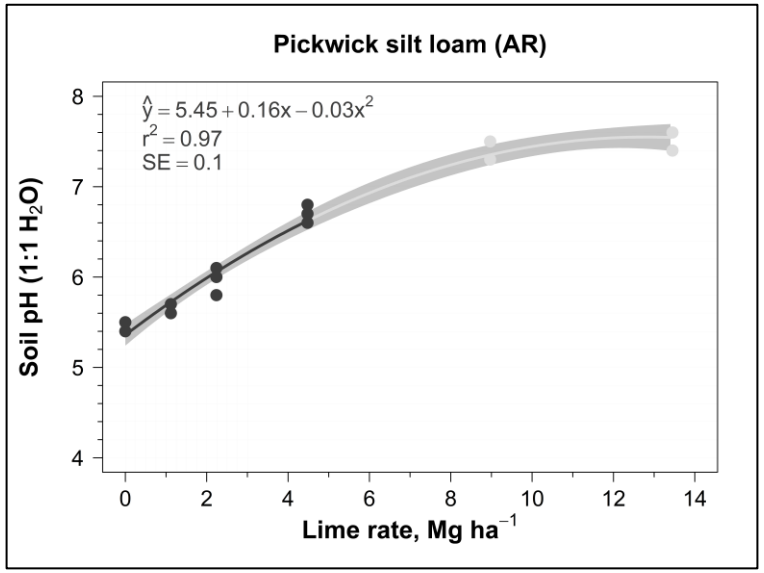
- **Data analyses:**
  - Soil pH response: Linear & quadratic regressions
  - Buffer pH methods evaluated against predicted LR
  - Forward stepwise regression

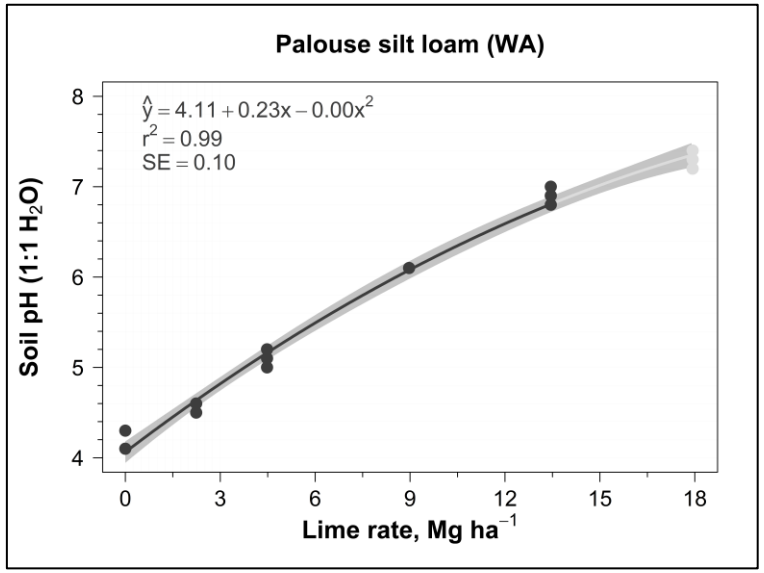


Results & Discussion

Soil pH response to increasing $CaCO_3$ application rate





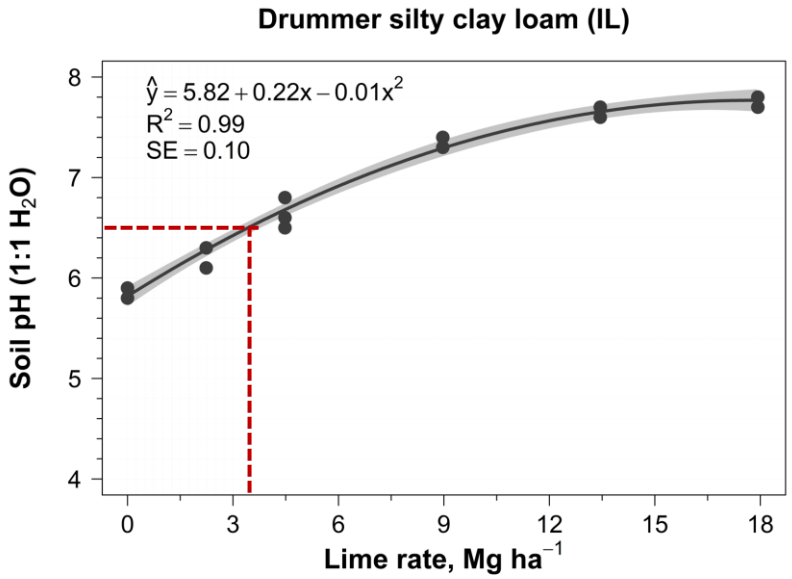


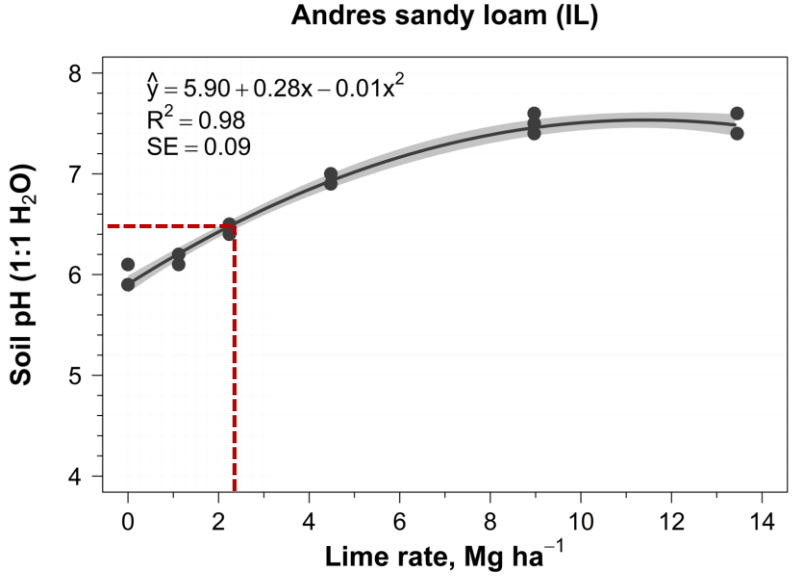
- Soil pH response modeled to a target pH of 6.8
- r^2 = 0.87–1.00

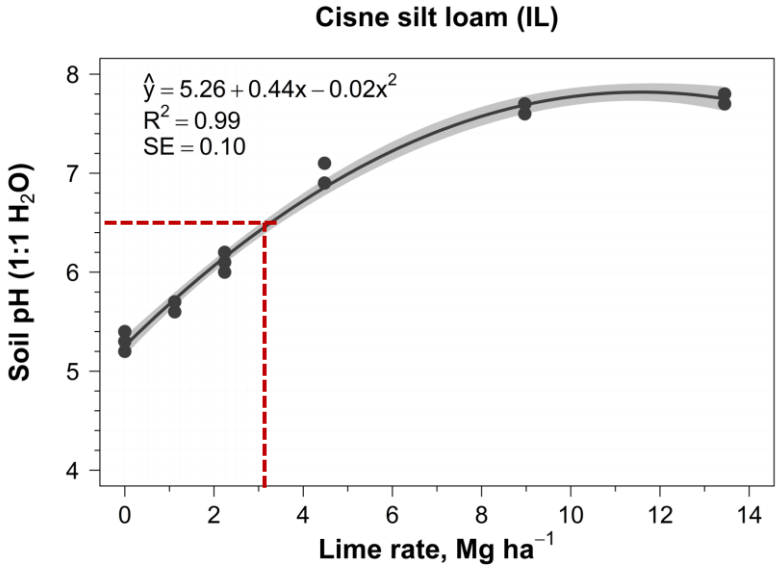
FRST Lime incubation results for 4 Midwest soils.

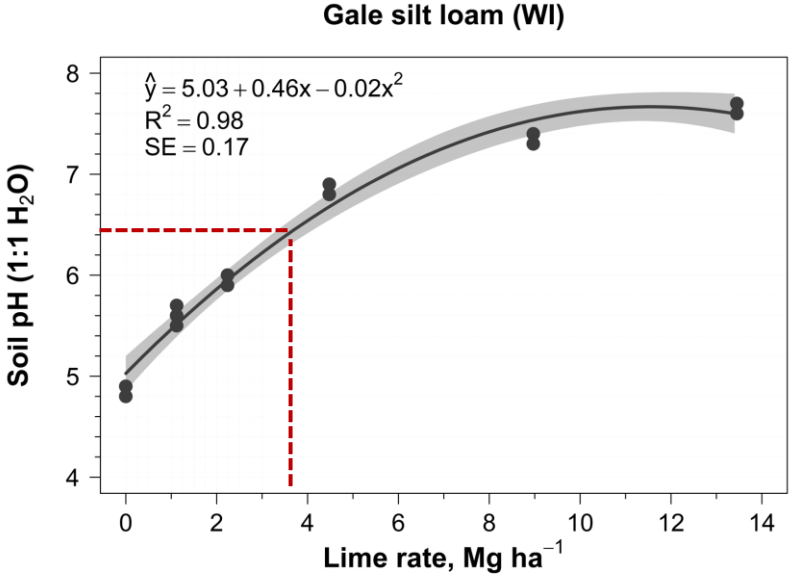
Base pH 1:1 shown with zero rate of lime.

Lime Rate is a function of initial pH and soil texture.



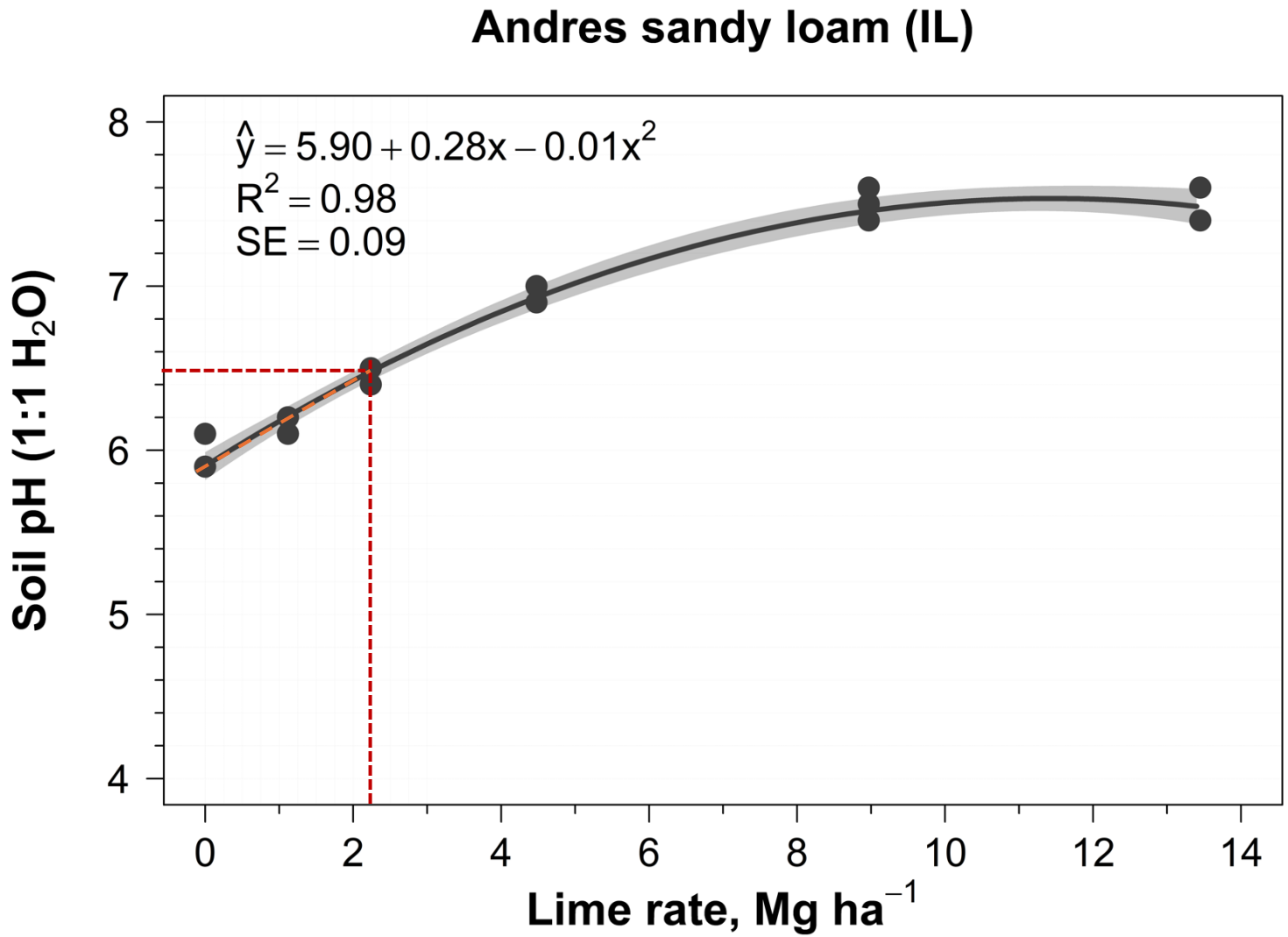






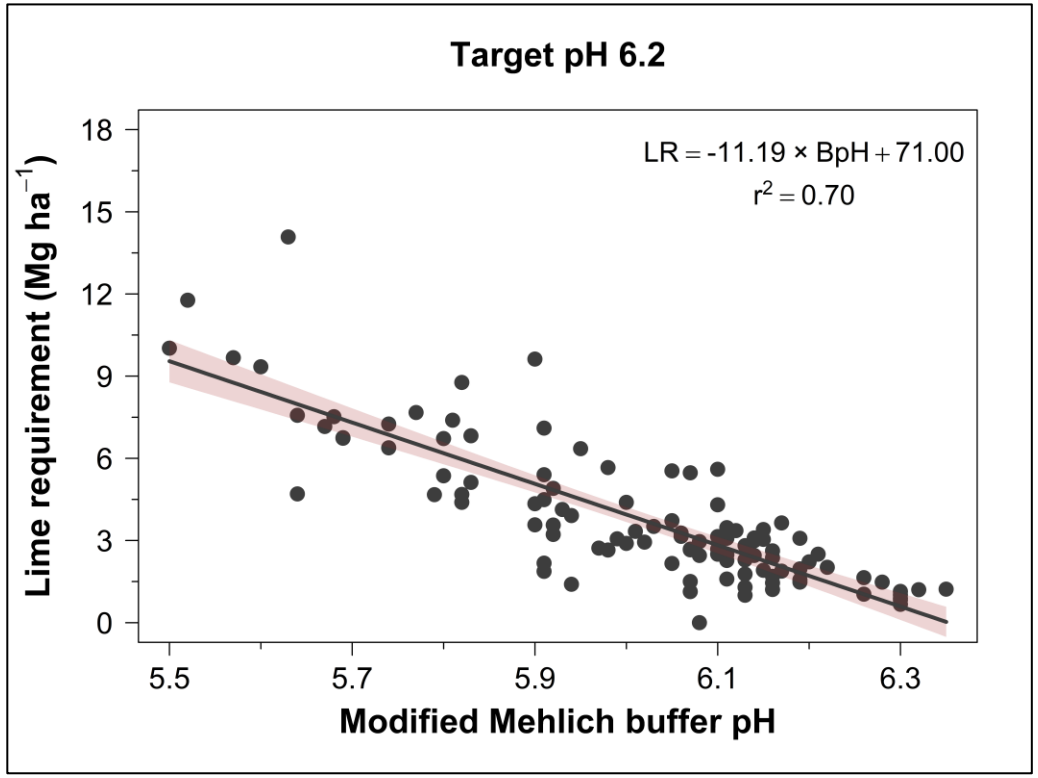
Linear equations were used to Define the slope of ΔpH / Lime Rate.

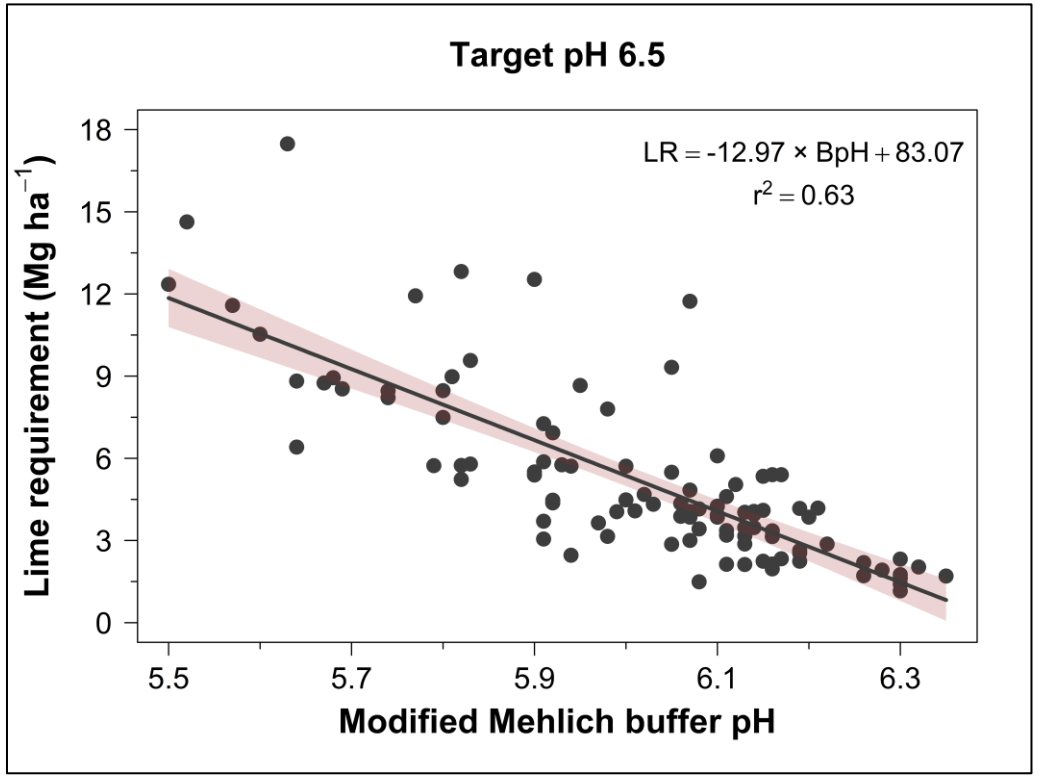
Equations were based on two target final pH values 6.2 and 6.5 for all 116 soils used in the incubation study, and developed for multiple buffer pH methods.



LR method evaluation

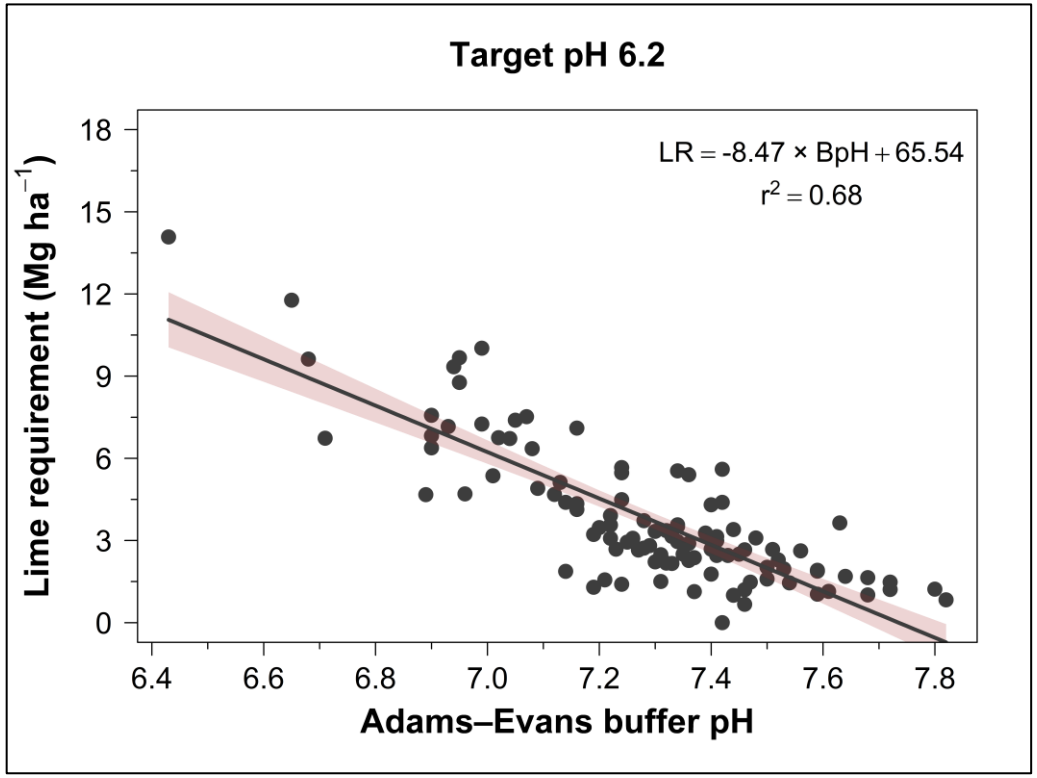
Modified Mehlich buffer pH

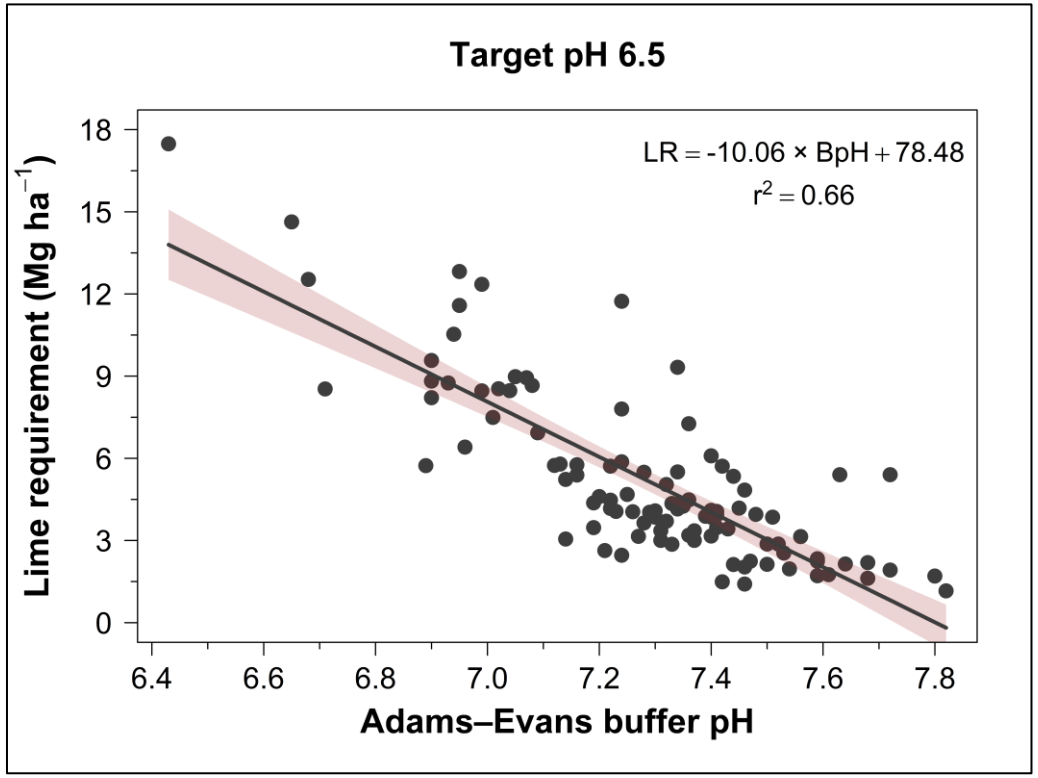




LR method evaluation

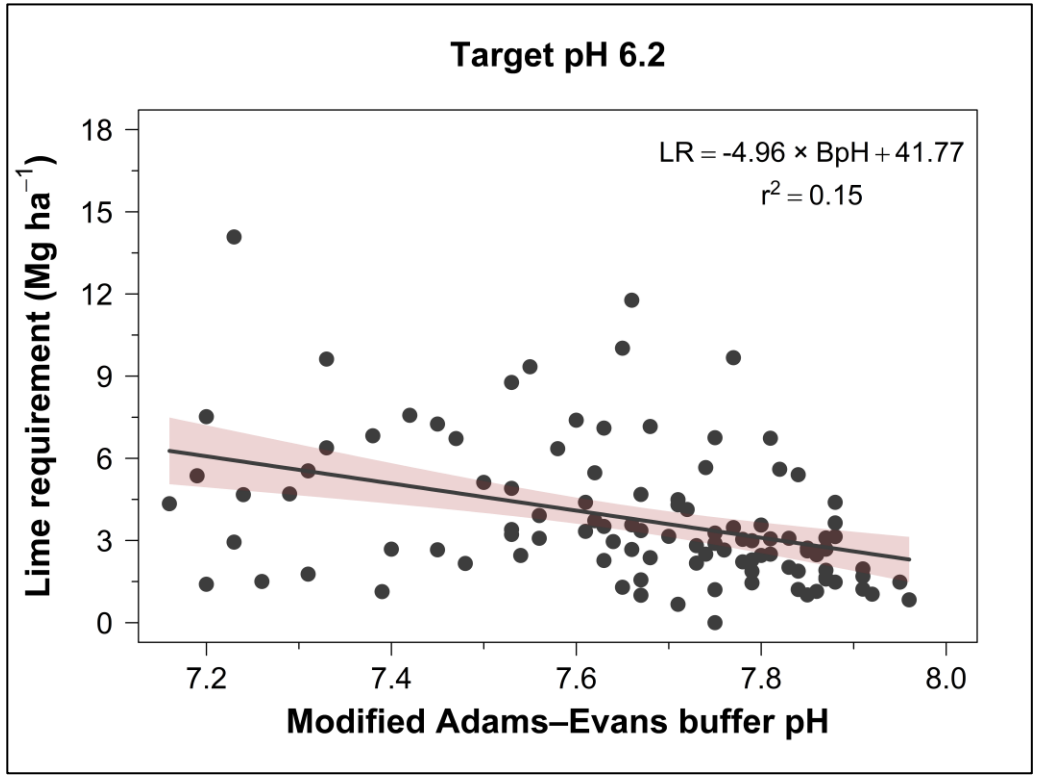
Adams–Evans buffer pH

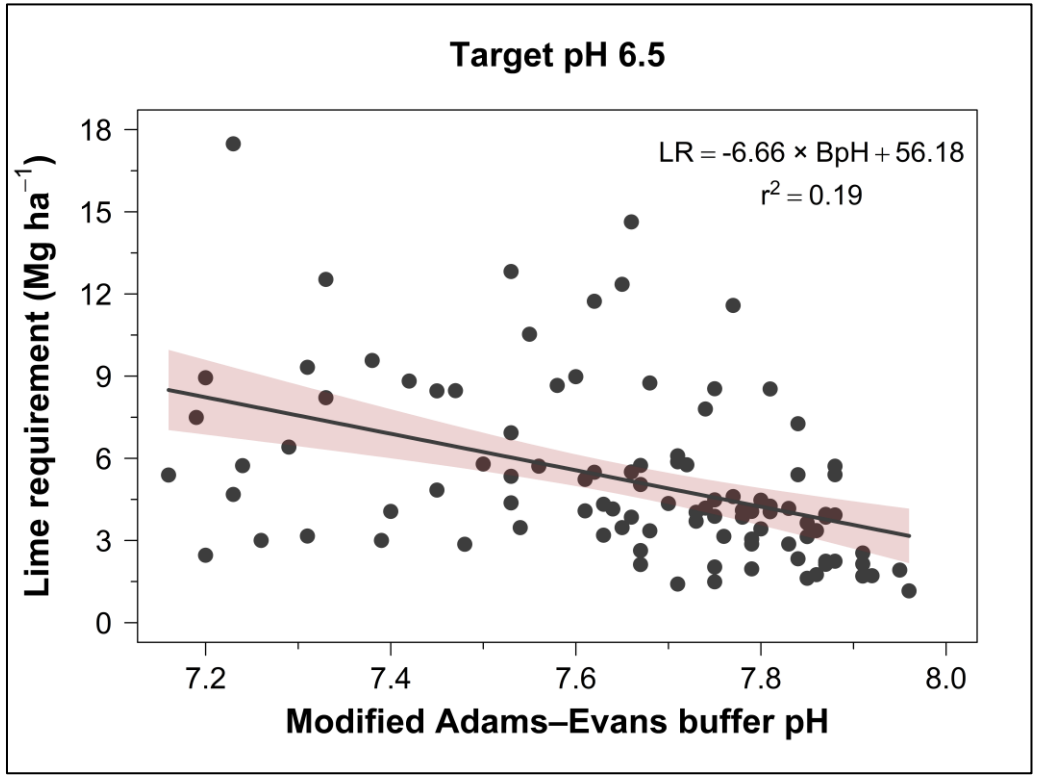




LR method evaluation

Modified Adams–Evans buffer pH





LR method evaluation

Routine soil test properties

Target pH	Multiparameter linear models for estimating LR (Mg ha^{-1})	r^2
6.2	LR = 21.29 – 3.41[**pH**] + 0.0003[**Ca**]	0.32
	LR = 15.89 – 3.12[**pH**] + 0.094[**OM**] + 0.016[**Al**] + 0.0036[**P**] + 0.0018[**Silt**] – 0.0013[**Mg**]	0.78
6.5	LR = 22.71 – 3.48[**pH**] + 0.0006[**Ca**]	0.22
	LR = 16.45 – 3.22[**pH**] + 0.126[**OM**] + 0.017[**Al**] + 0.0050[**P**] + 0.0023[**Silt**] – 0.0015[**Mg**]	0.75

Note: Soil test properties evaluated included pH (1:1 H_2O); Mehlich-3 extractable nutrients (mg kg^{-1}); EC (dS m^{-1}); KCl-extractable Al (mg kg^{-1}); organic matter by LOI (g kg^{-1}); and sand, silt and clay content (g kg^{-1}).

Wider adoption may be limited because **KCl-extractable Al** and **silt content** are not routinely measured.

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Conclusions

- Modified Mehlich, Modified Woodruff, and Adams–Evans were the best-performing buffer methods (r^2 = 0.63–0.74).
- Modified Adams–Evans was the weakest predictor of LR (r^2 = 0.15–0.19).
- Soil test properties predicted LR with similar accuracy to the best buffer methods (r^2 = 0.75–0.78).
- Field validation is needed to confirm the laboratory-based LR relationships developed in this study.

Acknowledgement

FRST Lime Calibration Team

Amy Shober — University of Delaware
Robert Miller — ALP Program
Nathan Slaton — University of Arkansas
John Spargo — Penn State University
Luke Gatiboni — NC State University
David Kissel — University of Georgia (Retired)
Amber Moore — Oregon State University
Stephanie Murphy — Rutgers University
John Jones — University of Illinois
Deanna Osmond — NC State University
Shannon Alford — Clemson University
Manbir Rakkar — Ohio State University
Kurtis Schroeder — University of Idaho
Matt Yost — Utah State University
Daniel Kaiser — University of Minnesota

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Ted Gauthier — LSU AgCenter
Shannon Alford — Clemson University
Jason Thomas Lessl — University of Georgia
John Spargo — Penn State University
Rasel Parvej — University of Missouri
Caleb Stevens — Rock River Laboratory
Stephen Jones — Best-Test Analytical Services

UADA Soil Testing Program

Marianna Soil Testing Laboratory
Fayetteville Agricultural Diagnostic Laboratory

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FERTILIZER RECOMMENDATION SUPPORT TEAM

Mehlich 3 Survey

Premise

Reports were received in June questioning the formulation of Mehlich 3 extract (M3) as prepared in the laboratory vs a contracted vendor. Observations noted with low recovery of soil P on M3 reagent purchased from a specific vendor.

A survey was conducted in July of 25 soil testing laboratories that provided soil M3 analysis results for ALP cycle 59. Survey was limited to five questions regarding preparation of M3, vendor source, batch size prepared, storage life and extraction reagent QC verification testing.

Eighteen labs provided responses.

Survey Results

Twelve of 18 responding labs prepared the M3 extractant using standard chemical reagents HNO_3, NH_4NO_3, NH_4F, CH_3COOH, EDTA and distilled water.

Six labs purchased pre-mixed M3 extraction reagent from one of four vendors (GFS, Columbus Chemical, Texas Scientific, or Aqua Chemical).

Laboratory M3 extraction reagent volumes varied from 4L to 160, with 40 - 50 L the most common reagent batch size.

Reagent shelf life before discarding varied from 14 days to one year. Several labs listed shelf life at 80 to 90 days.



https://fieldreport.caes.uga.edu/publications/C1322/soil-test-extractants-principles-applications-and-implications/

Cycle 59 Soils



Soil properties of four soils from ALP cycle 59 evaluated for the M3 extraction reagent source study. SRS-2601 was removed as having a pH of 8.15.

Property	**SRS-2602**	***SRS-2603***	**SRS-2604**	***SRS-2605***
Texture	Silt Loam	Fine Sandy Loam	Silt Loam	*Gr. Sandy Loam*
pH $_{1:1\ H2O}$	6.42	6.12	7.00	*5.47*
M3-P ICP (mg/kg)	22.6	11.1	61.6	*37.1*
SOM-LOI (%)	3.53	1.77	2.75	*2.83*
CEC (cmol/kg)	17.6	4.6	14.2	*6.0*

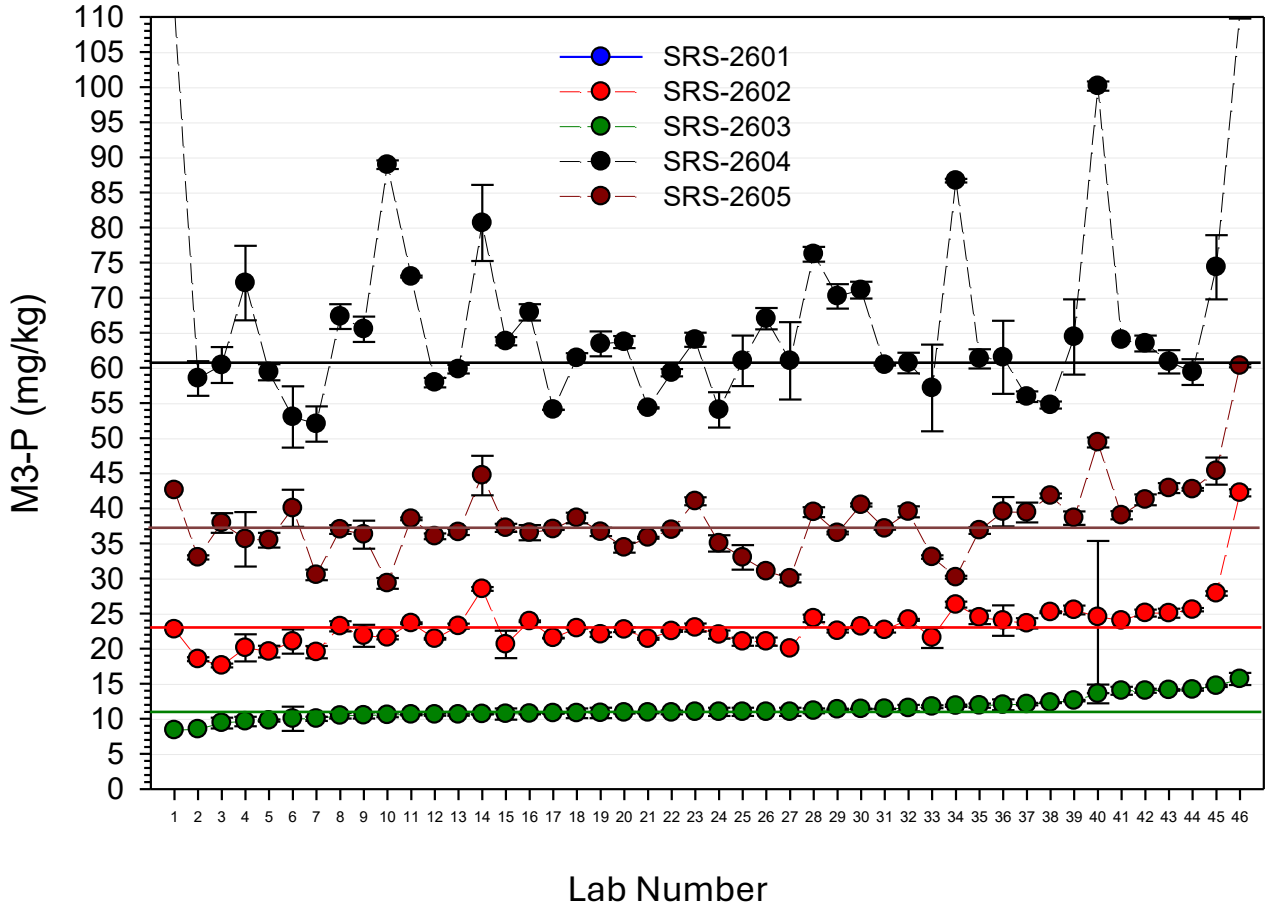
[1] ALP cycle 59 consensus median values.

ALP Cycle 59 M3-P

M3-P ICP soils results of four soils was evaluated (Soil ID SRS-2601 was deprecated as pH 8.15). Median M3-P ranged from 10.9 – 60.6 mg/kg

Results of 46 labs were sorted from high to low based on SRS-2603, lowest in M3-P.

Specific labs, #1, #14, #40 and #46 had high bias, labs #4, #10, #14, #27 and #34 were inconsistent.

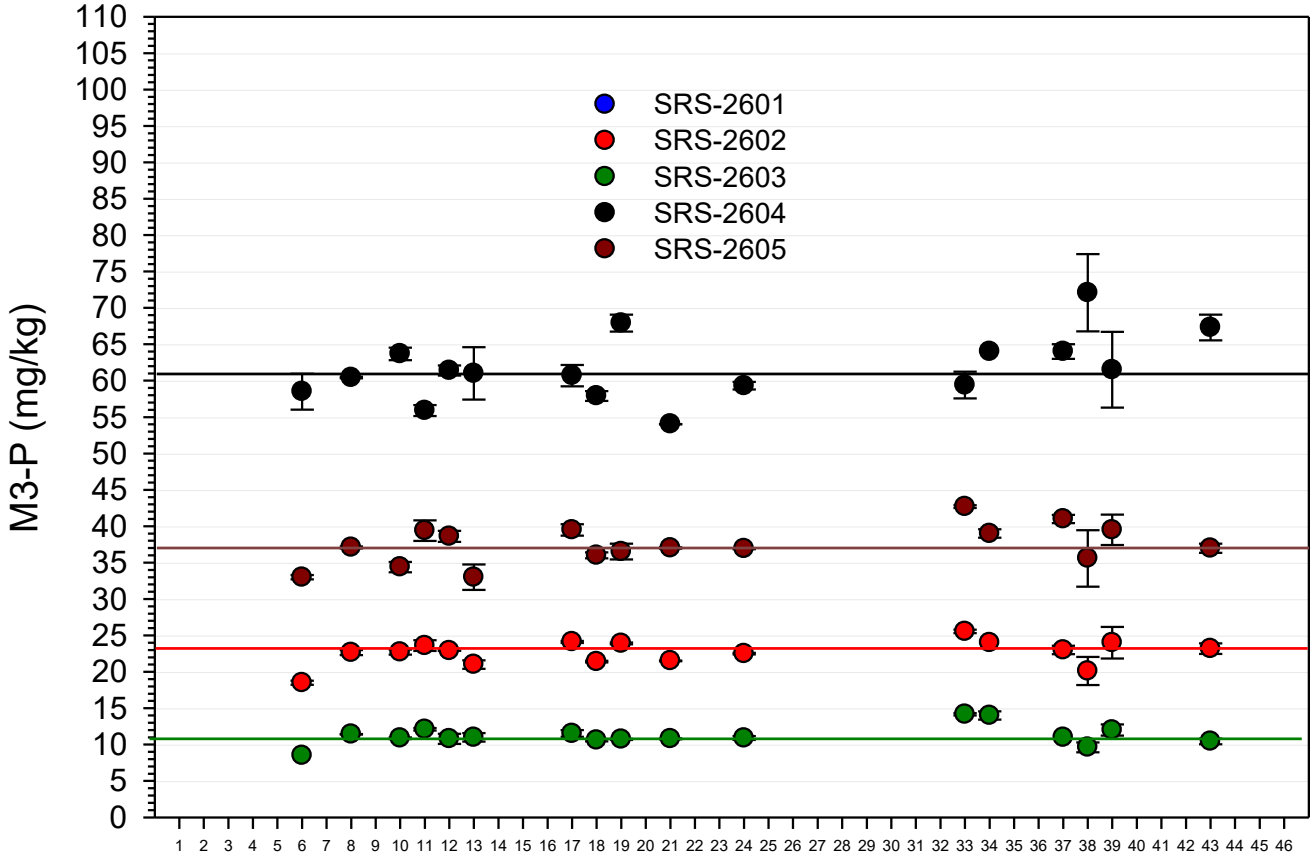


Cycle 59 M3-P – Survey labs

Survey lab M3-P ICP results indicated a majority of survey labs had values approximating the median value for all four soils from ALP cycle 59.

Inter-lab variation increased with increasing M3-P concentration.

Lab #6 showed consistent low bias relative to the median across all four soils.

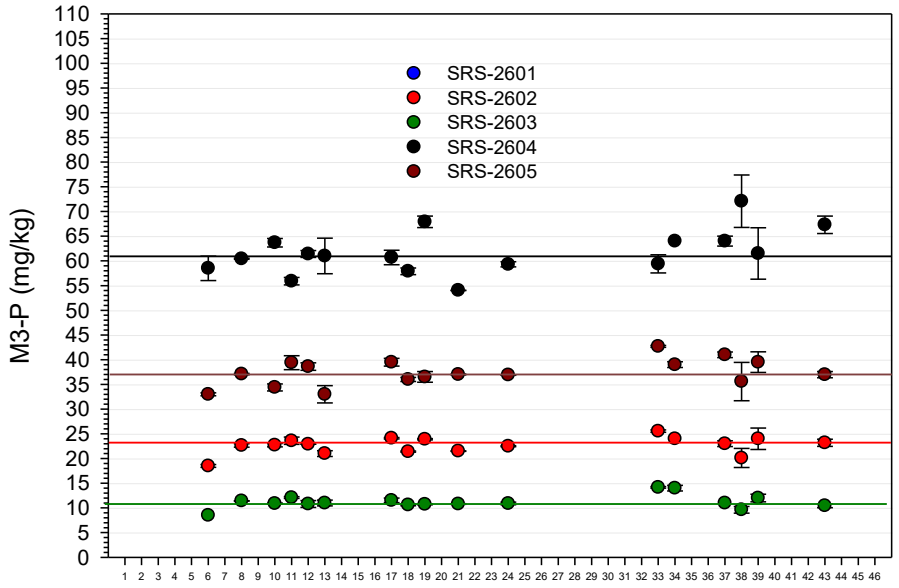


M3 reagent comparison

An assessment of ALP cycle M3 results comparing M3 reagent source, lab prepped vs vendor purchase, showed no significant statistical bias in M3-P values across the five soils.

One lab which prepared M3 from stock chemicals showed consistent low bias across all soils, whereas two labs showed high bias on three of four soils.

It is worth noting that lab bias maybe result of additional factors: scoop method, reagent dispensing and/or ICP-OES calibration and not the source of the M3 extraction reagent.



Additional survey notes

List lab SOP protocol(s) used to assess M3 reagent formulation quality

Verify final Volume of 160 L
M3 solution pH 2.45 – 2.50
Clear free of dissolved solids

Check Method Blank on ICP-OES so that all elements are below PQL;

Check Lab Control Sample pass (85%-115%);

Testing pH weekly to make sure it is stable (2.5 pH).

Verify "blank" on ICP against current M3 batch

The SOP for preparation of the M3 extraction reagent should incorporate all seven points to ensure quality.

Thank you for your time and attention

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