The Importance of Working Together: The Fertilizer Recommendation Support Tool

FRST

FERTILIZER RECOMMENDATION SUPPORT TOOL

USDA NRCS Science and Technology
CIG – Water Quality

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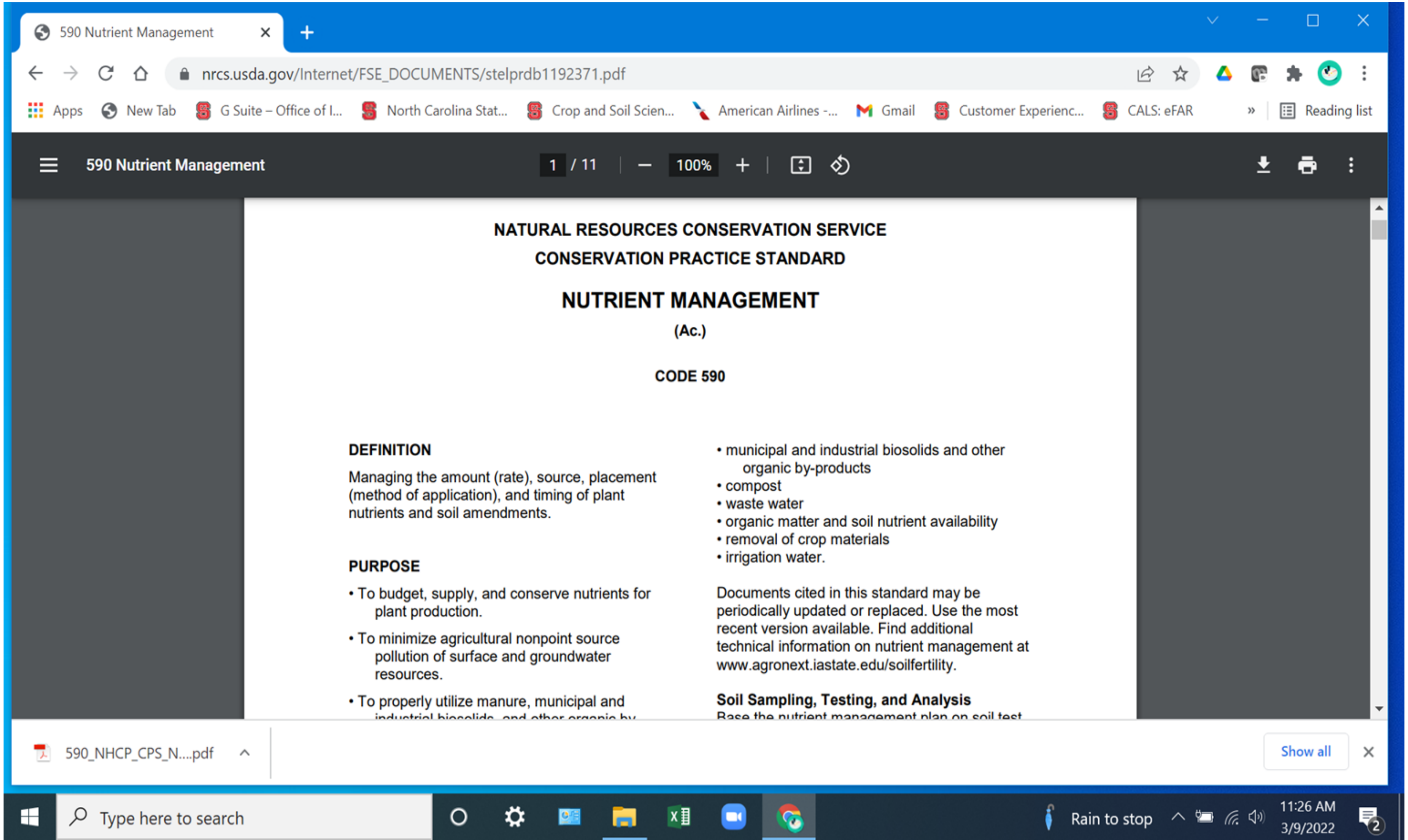
USDA NRCS 590 Standard



NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

NUTRIENT MANAGEMENT

(Ac.)

CODE 590

DEFINITION

Managing the amount (rate), source, placement (method of application), and timing of plant nutrients and soil amendments.

PURPOSE

- To budget, supply, and conserve nutrients for plant production.
- To minimize agricultural nonpoint source pollution of surface and groundwater resources.
- To properly utilize manure, municipal and industrial biosolids, and other organic by-

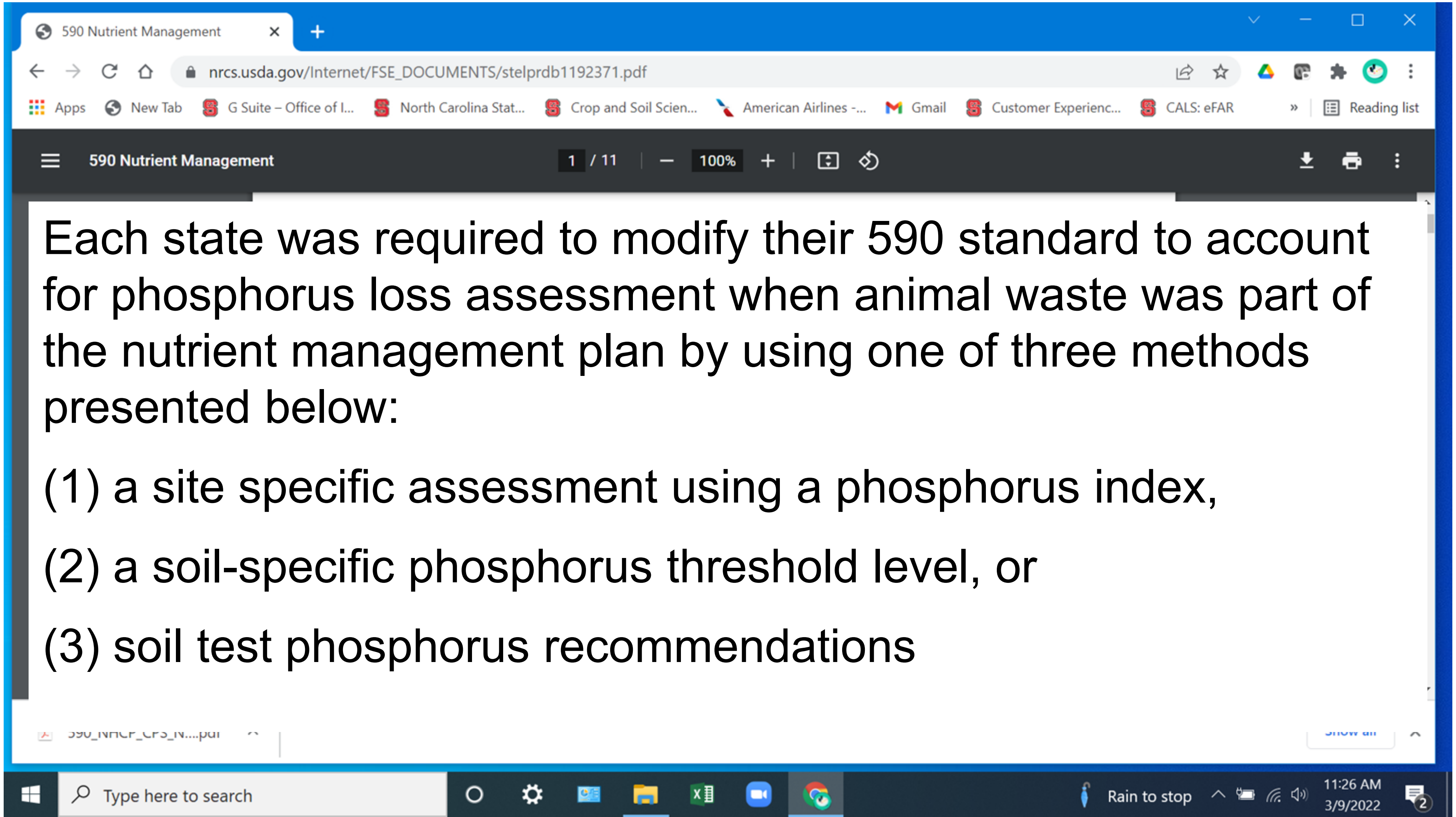
- municipal and industrial biosolids and other organic by-products
- compost
- waste water
- organic matter and soil nutrient availability
- removal of crop materials
- irrigation water.

Documents cited in this standard may be periodically updated or replaced. Use the most recent version available. Find additional technical information on nutrient management at www.agronext.iastate.edu/soilfertility.

Soil Sampling, Testing, and Analysis

Base the nutrient management plan on soil test

USDA NRCS 590 Standard:
Added Phosphorus Index Component (1999)



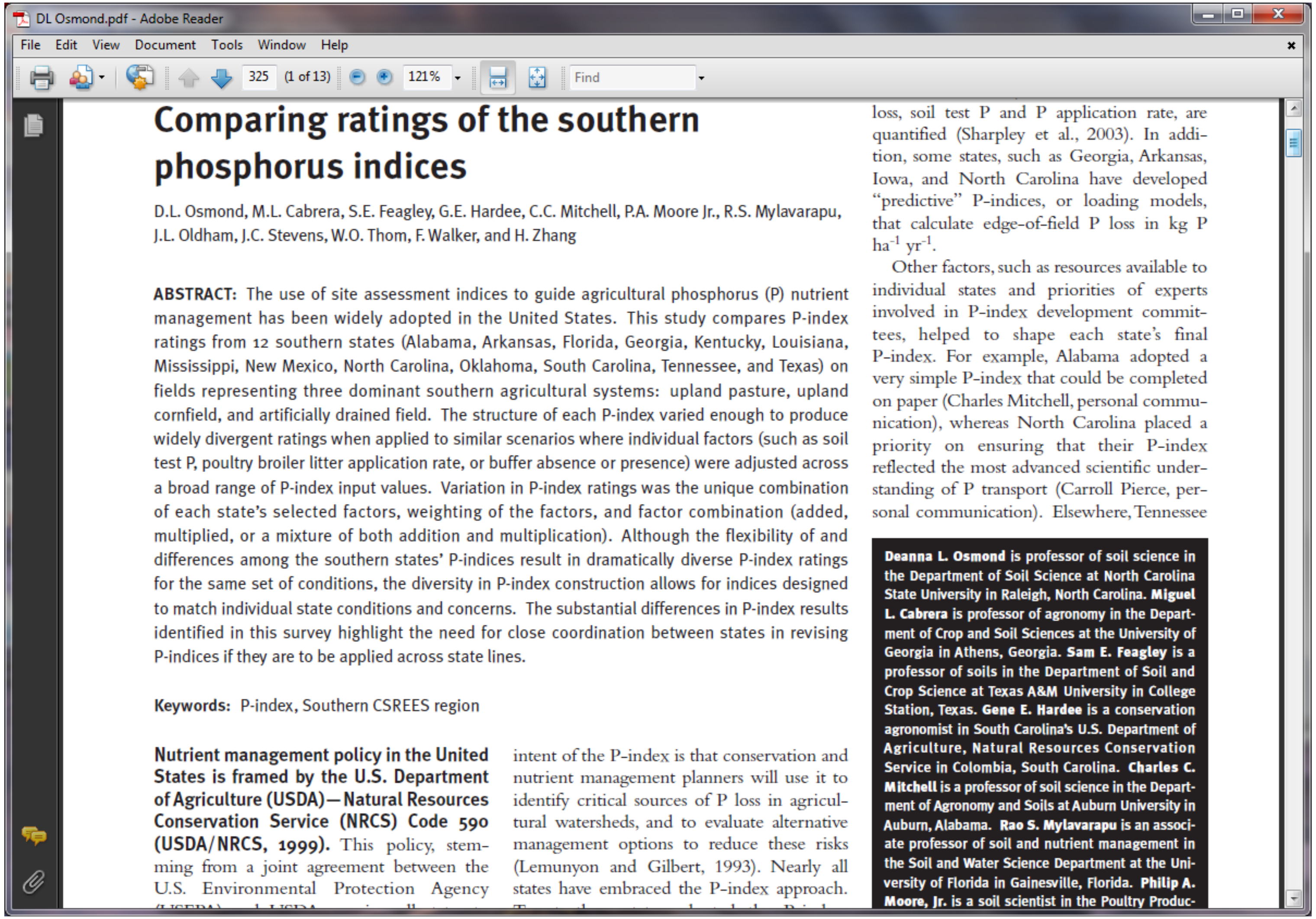
Each state was required to modify their 590 standard to account for phosphorus loss assessment when animal waste was part of the nutrient management plan by using one of three methods presented below:

(1) a site specific assessment using a phosphorus index,

(2) a soil-specific phosphorus threshold level, or

(3) soil test phosphorus recommendations

USDA NRCS 590 Standards: Comparing Ratings of Southern P Indices



Comparing ratings of the southern phosphorus indices

D.L. Osmond, M.L. Cabrera, S.E. Feagley, G.E. Hardee, C.C. Mitchell, P.A. Moore Jr., R.S. Mylavarapu, J.L. Oldham, J.C. Stevens, W.O. Thom, F. Walker, and H. Zhang

ABSTRACT: The use of site assessment indices to guide agricultural phosphorus (P) nutrient management has been widely adopted in the United States. This study compares P-index ratings from 12 southern states (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, New Mexico, North Carolina, Oklahoma, South Carolina, Tennessee, and Texas) on fields representing three dominant southern agricultural systems: upland pasture, upland cornfield, and artificially drained field. The structure of each P-index varied enough to produce widely divergent ratings when applied to similar scenarios where individual factors (such as soil test P, poultry broiler litter application rate, or buffer absence or presence) were adjusted across a broad range of P-index input values. Variation in P-index ratings was the unique combination of each state's selected factors, weighting of the factors, and factor combination (added, multiplied, or a mixture of both addition and multiplication). Although the flexibility of and differences among the southern states' P-indices result in dramatically diverse P-index ratings for the same set of conditions, the diversity in P-index construction allows for indices designed to match individual state conditions and concerns. The substantial differences in P-index results identified in this survey highlight the need for close coordination between states in revising P-indices if they are to be applied across state lines.

Keywords: P-index, Southern CSREES region

Nutrient management policy in the United States is framed by the U.S. Department of Agriculture (USDA)—Natural Resources Conservation Service (NRCS) Code 590 (USDA/NRCS, 1999). This policy, stemming from a joint agreement between the U.S. Environmental Protection Agency

intent of the P-index is that conservation and nutrient management planners will use it to identify critical sources of P loss in agricultural watersheds, and to evaluate alternative management options to reduce these risks (Lemunyon and Gilbert, 1993). Nearly all states have embraced the P-index approach.

loss, soil test P and P application rate, are quantified (Sharpley et al., 2003). In addition, some states, such as Georgia, Arkansas, Iowa, and North Carolina have developed "predictive" P-indices, or loading models, that calculate edge-of-field P loss in kg P ha^{-1} yr^{-1}.

Other factors, such as resources available to individual states and priorities of experts involved in P-index development committees, helped to shape each state's final P-index. For example, Alabama adopted a very simple P-index that could be completed on paper (Charles Mitchell, personal communication), whereas North Carolina placed a priority on ensuring that their P-index reflected the most advanced scientific understanding of P transport (Carroll Pierce, personal communication). Elsewhere, Tennessee

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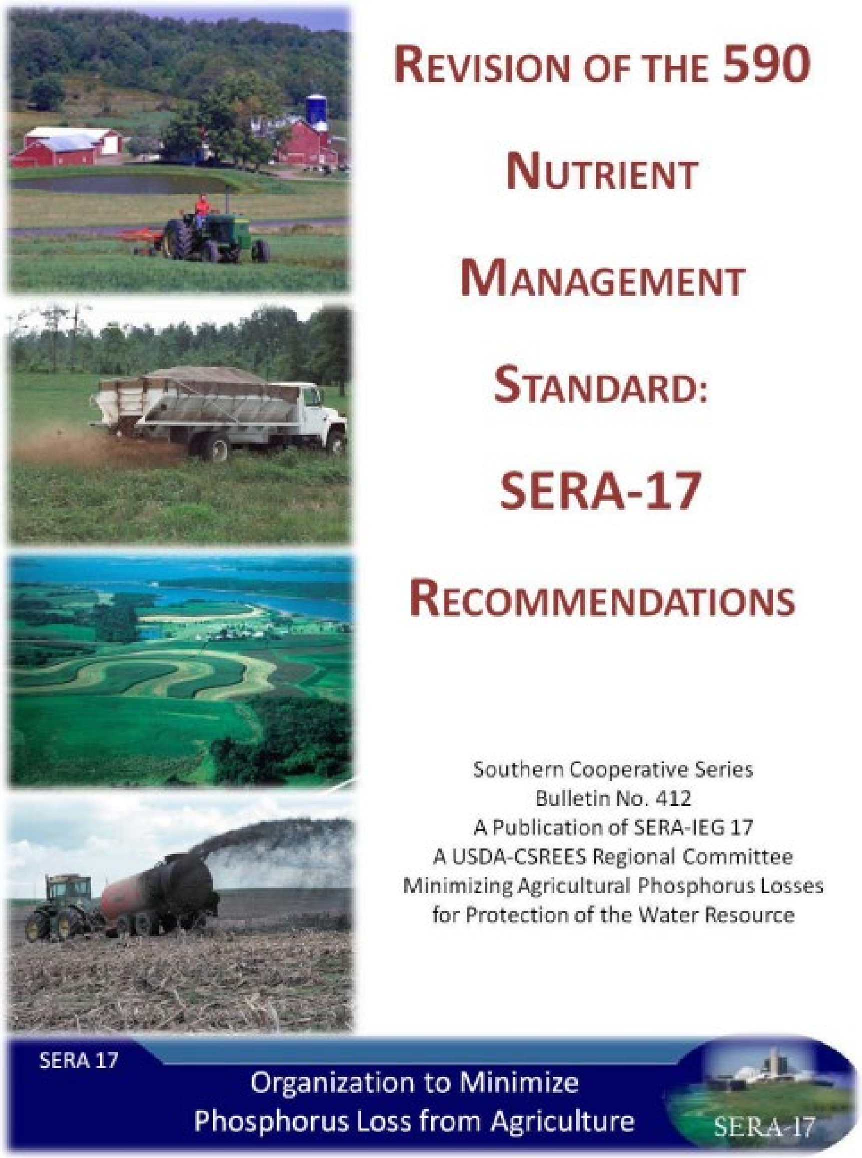
SERA-17 Responds to NRCS' Proposal to Use APEX

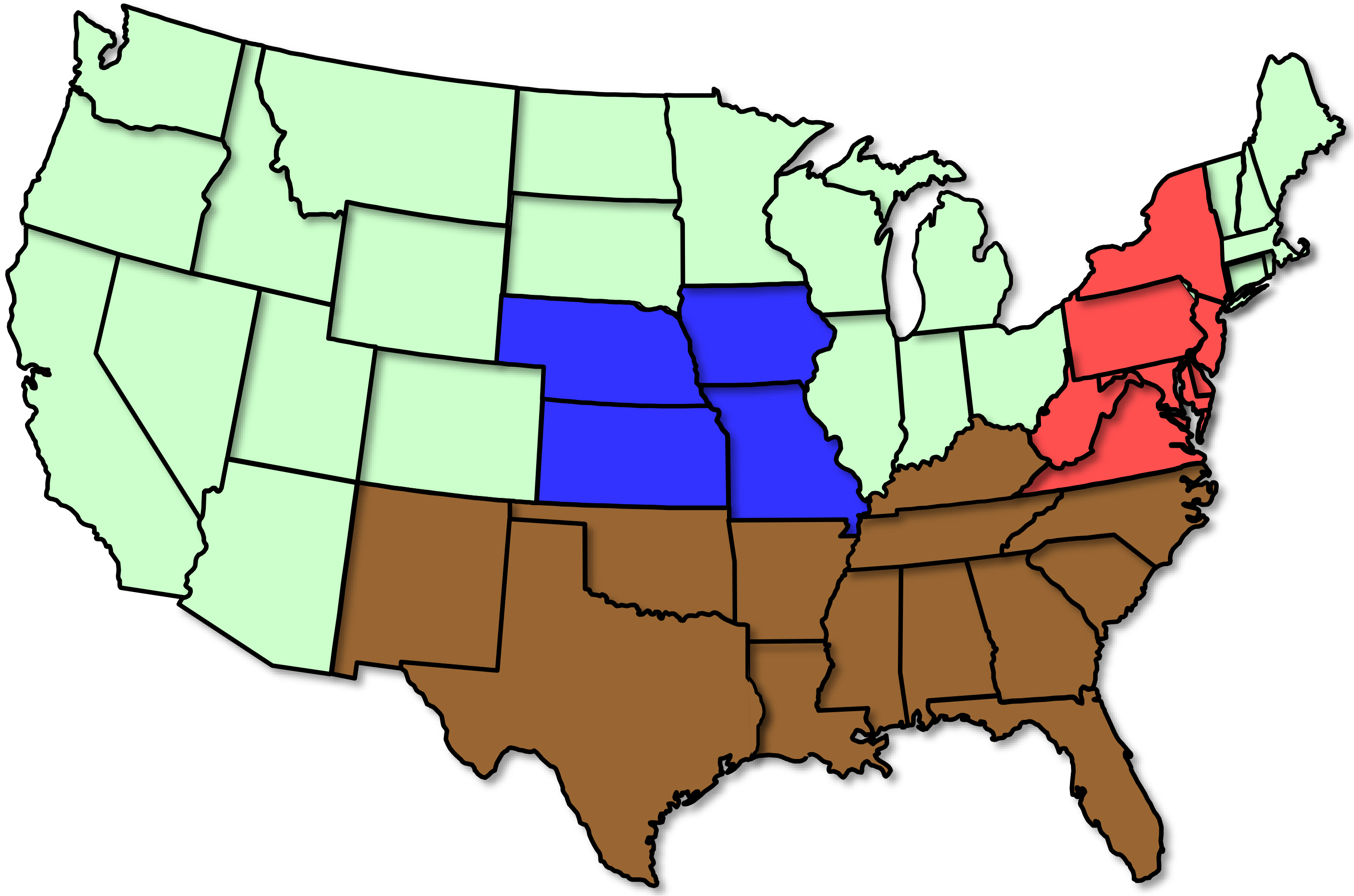

REVISION OF THE 590
NUTRIENT
MANAGEMENT
STANDARD:
SERA-17
RECOMMENDATIONS

Southern Cooperative Series
Bulletin No. 412
A Publication of SERA-IEG 17
A USDA-CSREES Regional Committee
Minimizing Agricultural Phosphorus Losses
for Protection of the Water Resource

SERA 17
Organization to Minimize
Phosphorus Loss from Agriculture
SERA-17

Regional CIGs to Assess and Refine P Indices

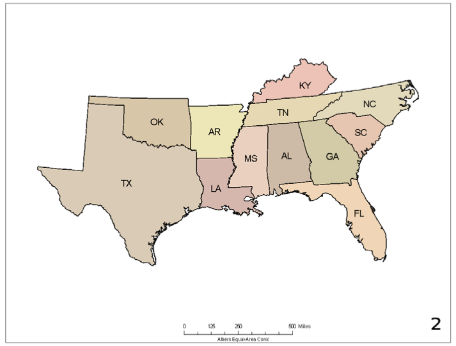
- Chesapeake Bay: DE, NY, PA,VA, & WV
- Heartland: IA, KS, MO, & NE
- Southern: AL, AR, FL, GA, LA, KY, MS, NC, OK, SC, TN, & TX
- National synthesis project



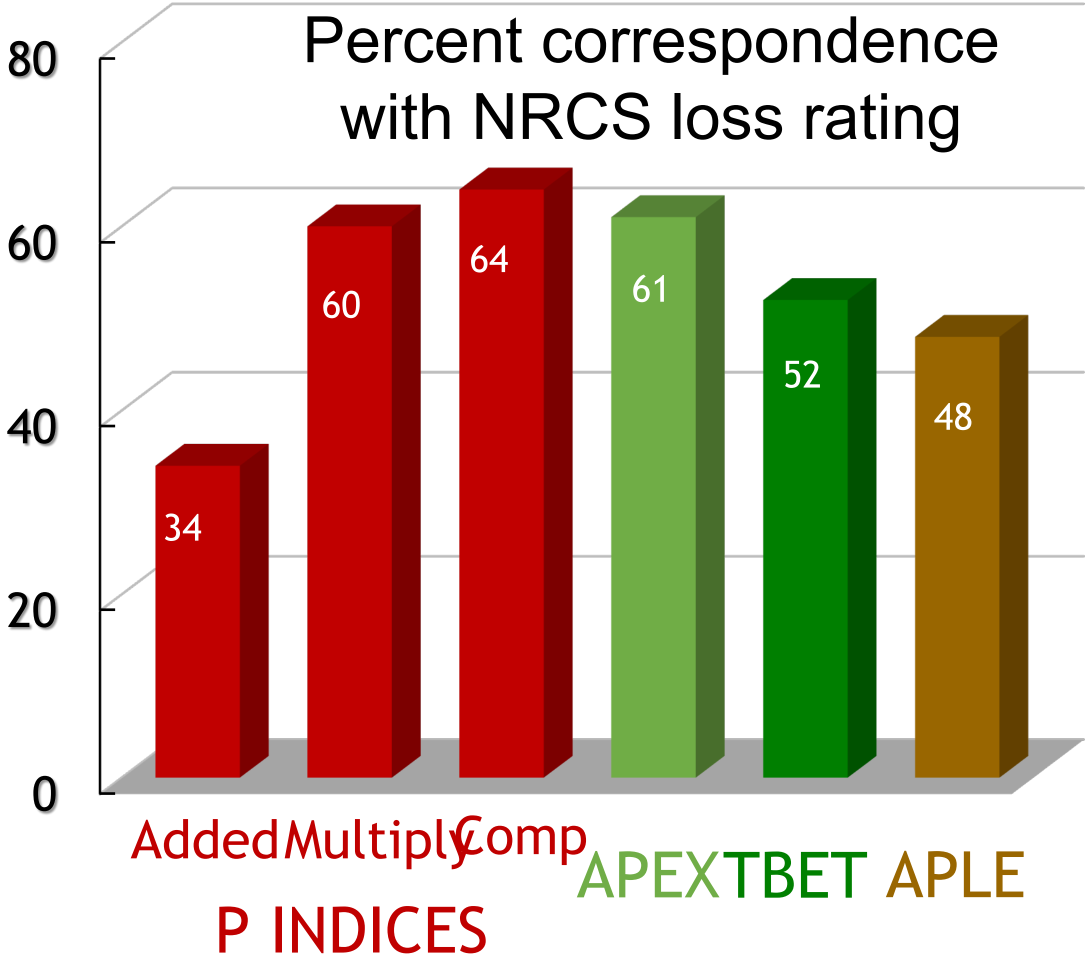
Southern Phosphorus CIG to Assess and Refine P Indices (69-3A75-12-182): Objectives

1. Determine pre-existing watershed or plot-scale (11) sites where accuracy of P Indices to estimate site P loss potential can be evaluated.
2. Compare fate and transport models against water quality data from benchmark sites.
3. Compare predictions of P-Indices to water quality data from benchmark sites.
4. **Compare predictions of P Indices against fate and transport water quality models (APEX, TBET, APLE) and water quality models against each other.**
5. Refine P Indices to ensure better consistency in ratings across state boundaries and within physiographic provinces.

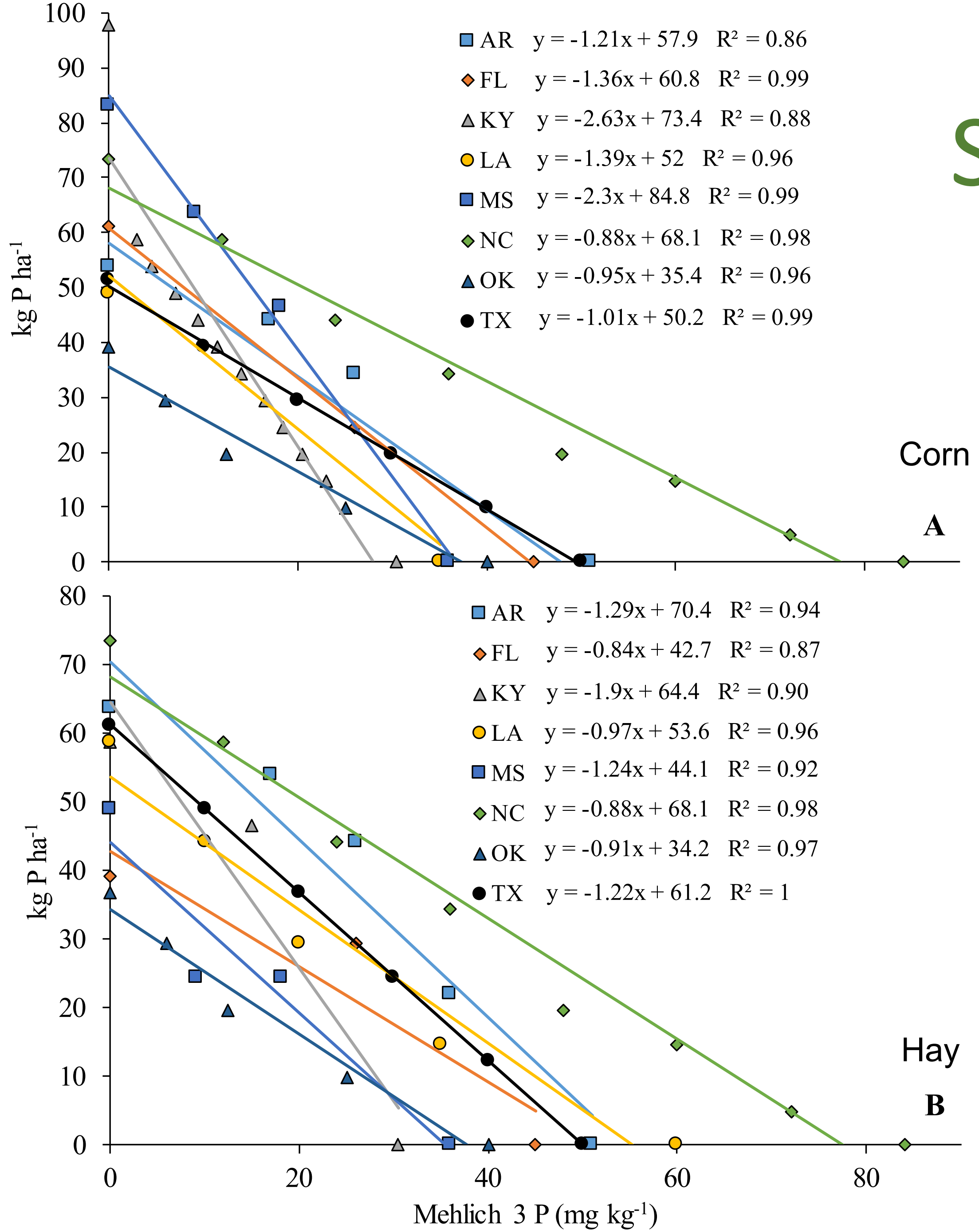
Results Southern States CIG



- RUSLE 2 estimates of erosion were up to an order of magnitude greater than measured values
- NRCS P loss ratings
  - Low < 2.2 kg ha^{-1} yr^{-1}
  - Moderate 2.2 to 5.5 kg ha^{-1} yr^{-1}
  - High > 5.5 kg ha^{-1} yr^{-1}
- How did tools compare with NRCS P loss ratings?



FRST Began with Southern Soil Fertility Working Group (June 2018)

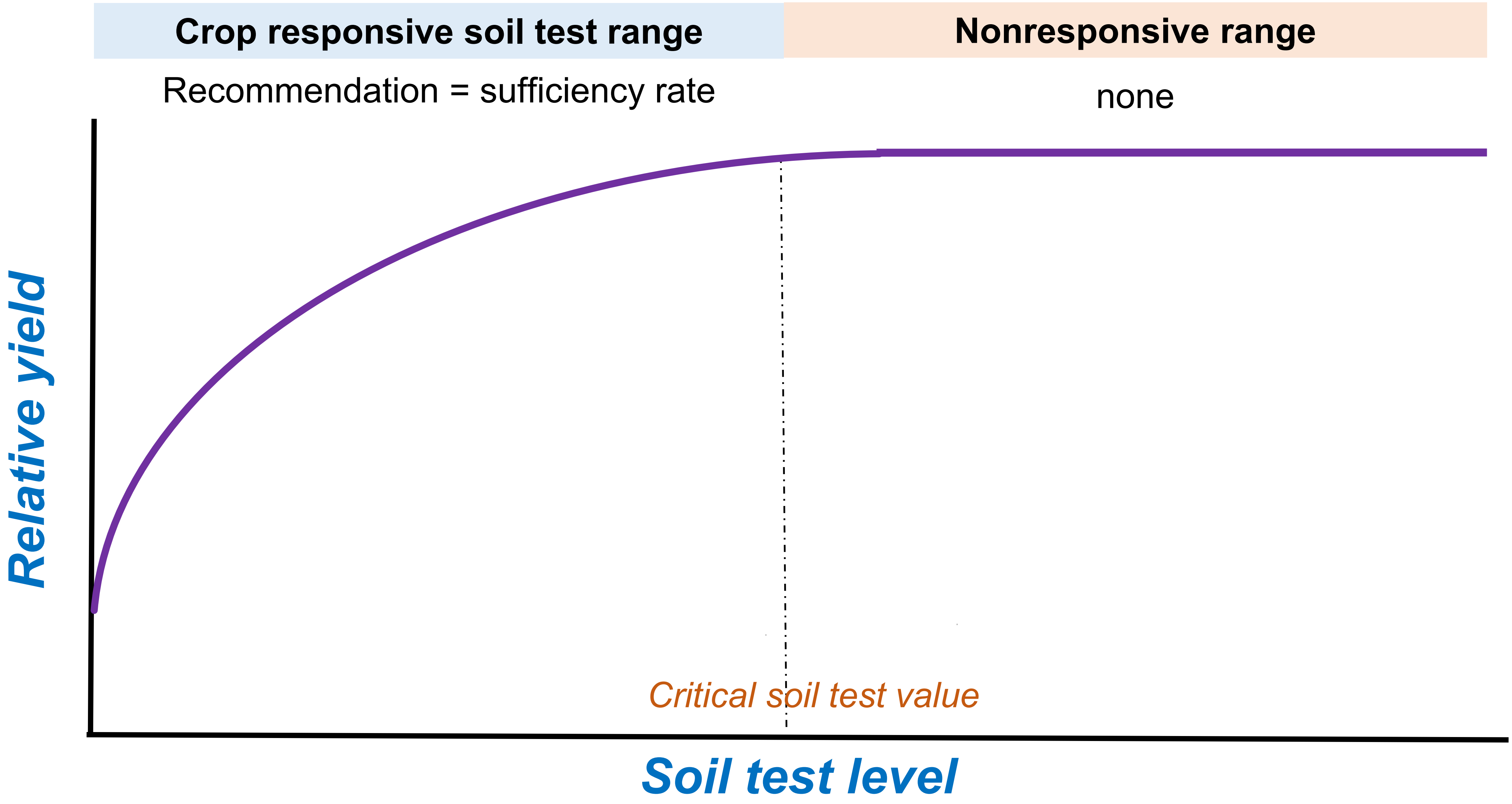


Zhang, H., J. Antonangelo, J.H. Grove, D.L. Osmond, S. Alford, R.J. Florence, G. Huluka, D.H. Hardy, J.T. Lessl, R.O. Maguire, R.S. Mylavarapu, L. Oldham, E.M. Pena-Yewtukhiw, T.L. Provin, N.A. Slaton, L.S. Sonon, D. Sotomayor, and J.J. Wang. 2020. Soil Test Based P and K Rate Recommendations across the Southeast: Similarities and Differences; Opportunities and Challenges. Soil Sci. Soc. Am. J.
DOI: 10.1002/saj2.20280

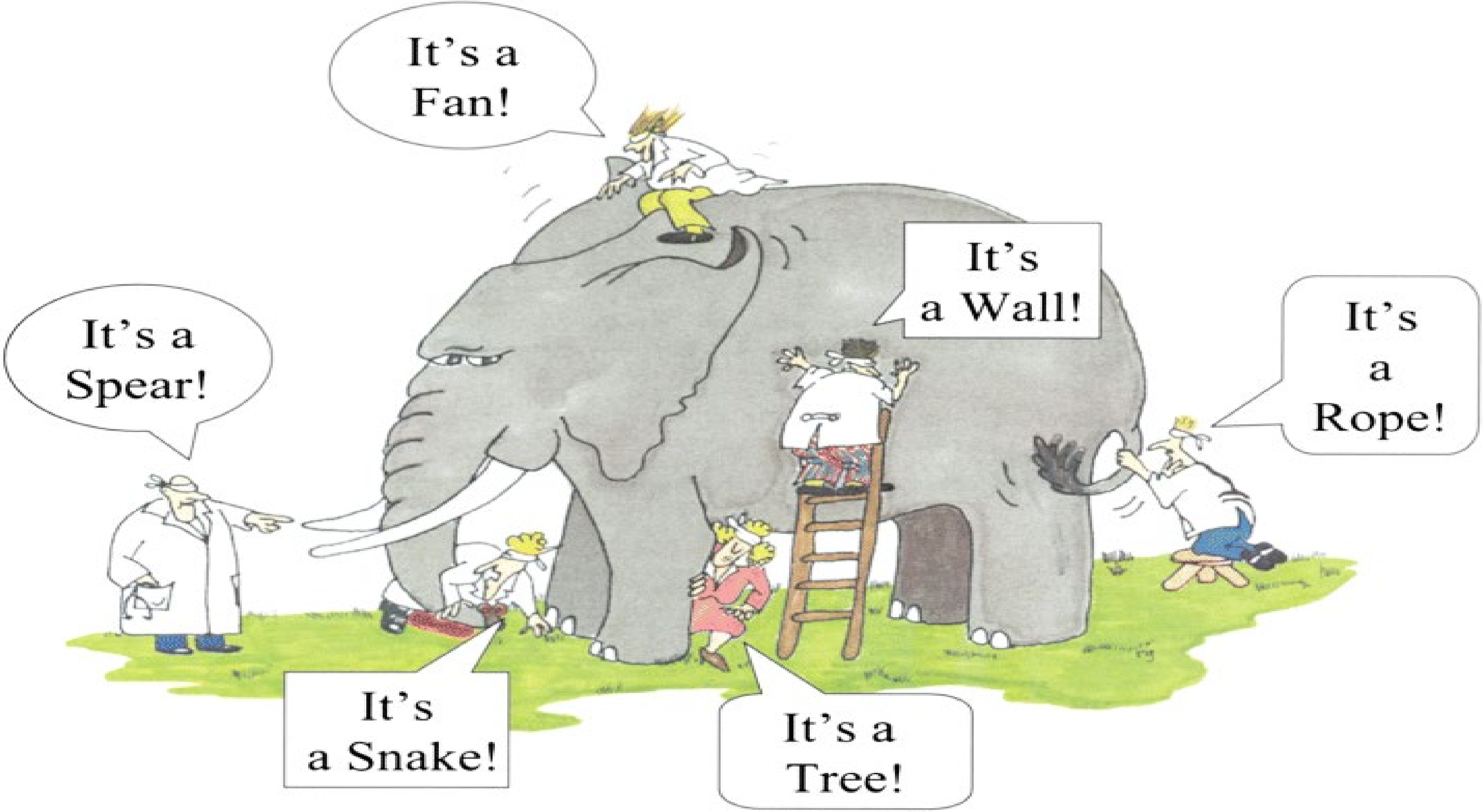
And others in attendance: AL: R. Prasad; AR: A. Sharpley; GA: M. Cabrera, G. Harris; KY: C. Bolster (ARS), B. Lee, J. McGrath, E. Ritchie, F. Sikora; MS: K. Jones, L., J. Ramirez; OK: B. Arnall; SC: B. Farmaha; TN: F. Walker; TX: S. Feagley, J. Mowrer; PA: John Spargo and Pete Kleinman

USDA NRCS 69-3A75-17-45

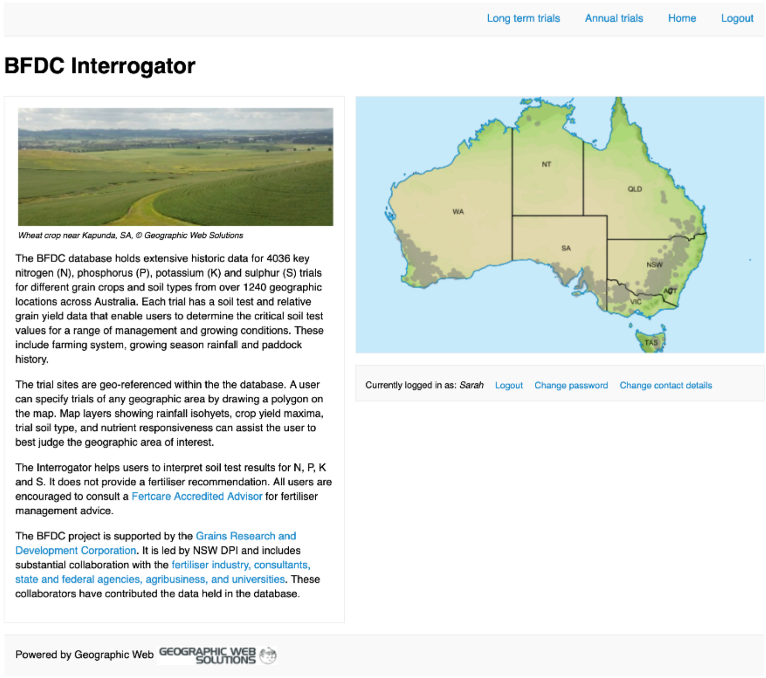
Results of Critical Soil Test Value Discussion

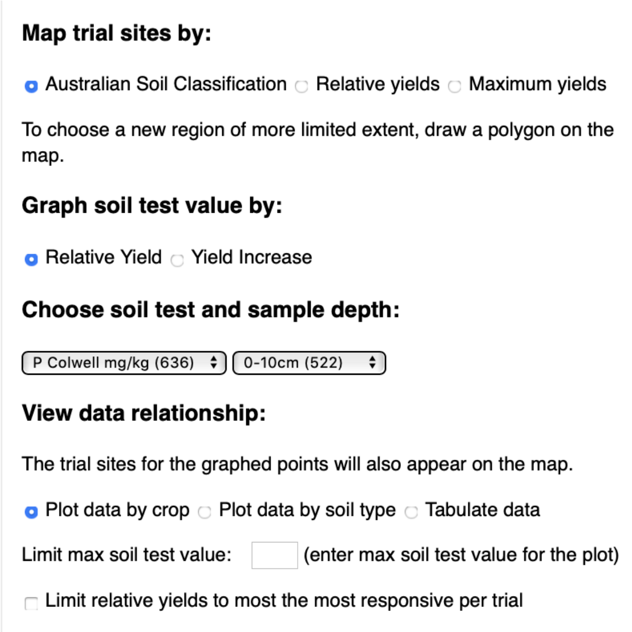


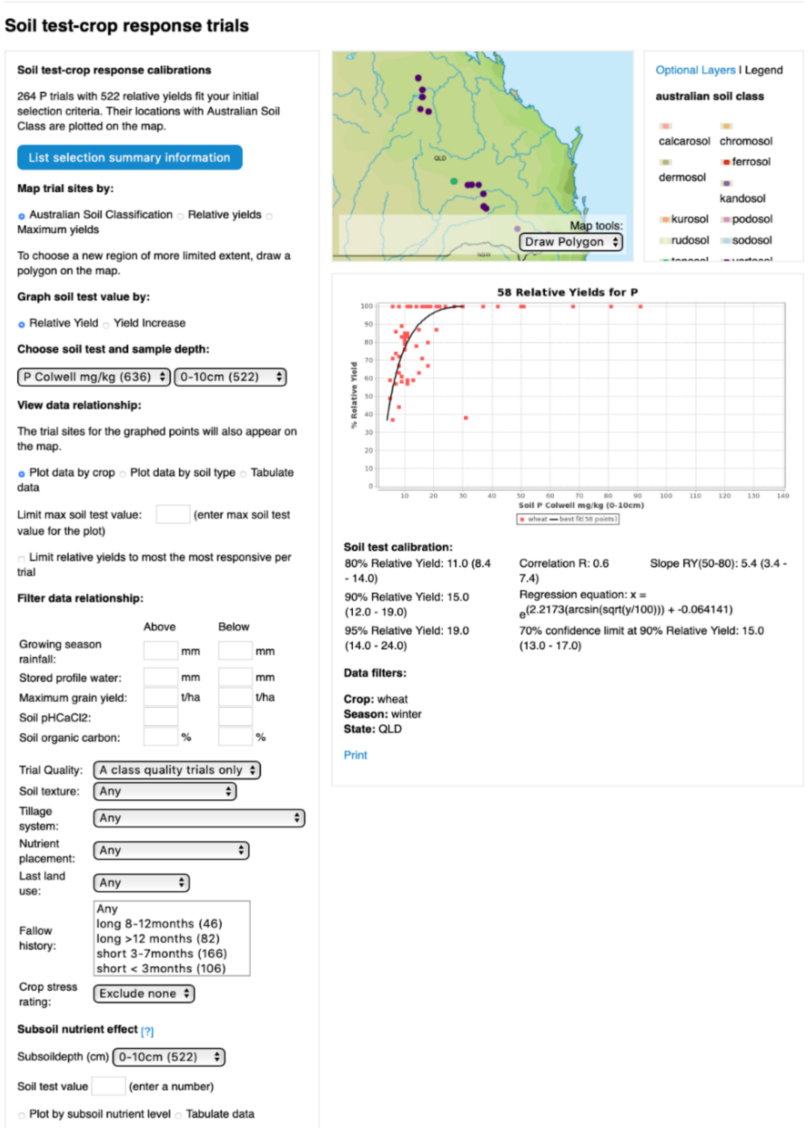
Results of Critical Soil Test Value Discussion



Another Way:
Work Across State Lines Using "Big Data"







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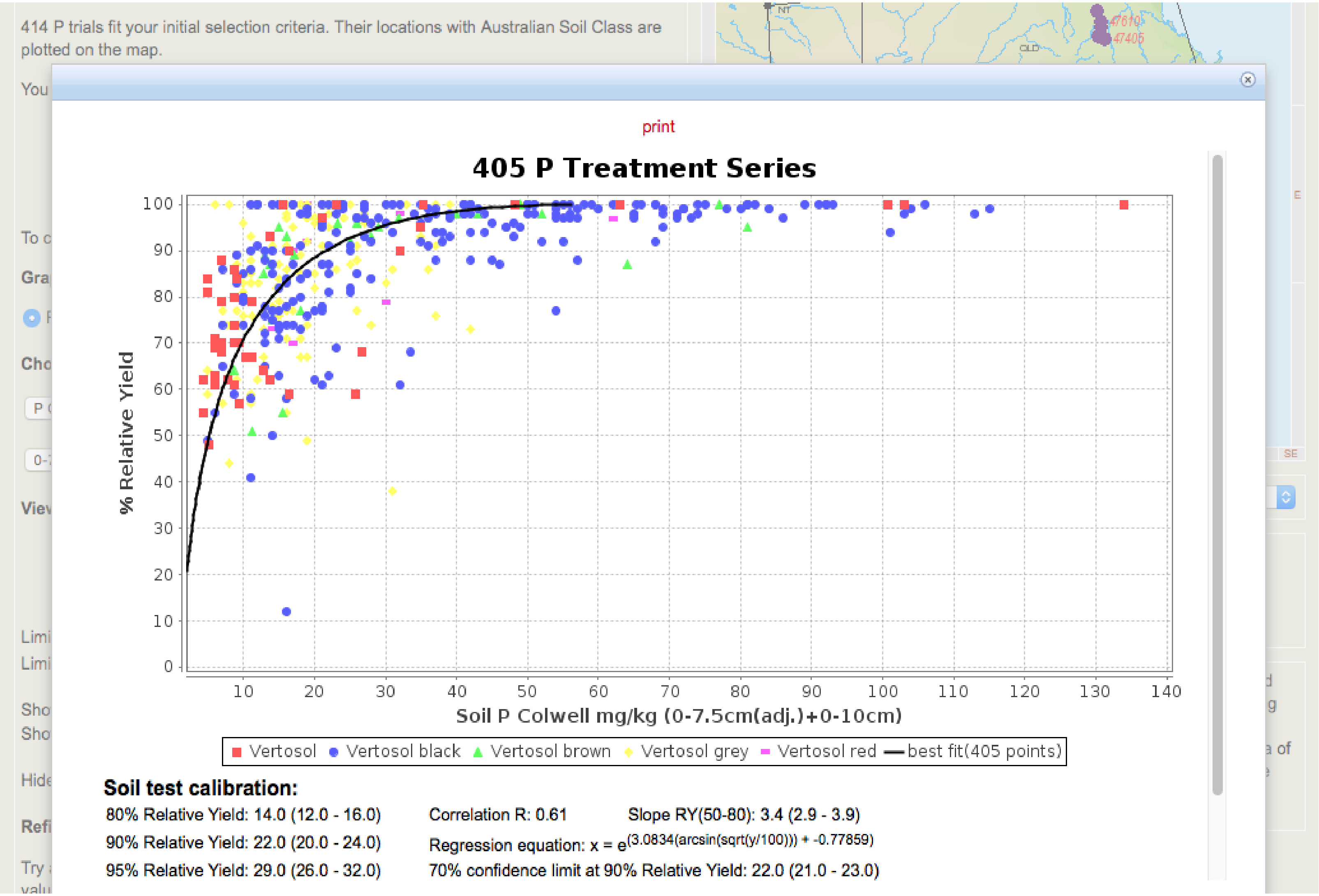

Fertilizer Recommendations Support Tool (FRST):
A Foundation for Modernizing Fertilizer Recommendations

Goal of FRST

To advance the accuracy of soil-test-based fertilizer recommendations by developing a database and decision tool from which recommendations can be scientifically developed and defended as best management practices.

Objectives of FRST

1. Develop a community of practice to galvanize interest and participation around soil fertility.
2. Develop a searchable tool that provides soil test correlation and calibration graphs with statistical confidence intervals for the area of interest (general users). The first step will be to identify the soil test level above which there is no response (correlation) and the next step will be to provide rate recommendations when there is a response (calibration).
3. Provide data for nutrient management scientists and modelers for in-depth analysis of soil test calibration and correlation data (researchers).

FRST Team + Collaborators

*Retired

Nutifafa Adotey	University of Tennessee
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Dana Ashford	USDA-NRCS
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Jagman Dhillon	Mississippi State University
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Bhupinder Farmaha	Clemson University
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Bryan Hopkins	Brigham Young University
Gobena Huluka	Auburn University
Javed Iqbal	University of Nebrask
Sindhu Jagadamma	University of Tennessee
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John Jones	University of Wisconsin
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Pete Kleinman	USDA-ARS
Gabe LaHue	Washington State University
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Joshua McGrath	University of Kentucky
David Mengel*	Kansas State University
Fernando Miguez	Iowa State University
Robert Miller	Colorado State University
Amber Moore	Oregon State University
Tom Morris*	University of Connecticut
Jake Mowrer	Texas A&M University
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Rao Mylavarapu	University of Florida
Kelly Nelson	University of Missouri
Nathan Nelson	Kansas State University
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Deanna Osmond	North Carolina State Univ.
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Eugenia Pena-Yewtukhiw	Univ. of West Virginia
Tim Pilkowski	USDA-NRCS
Rishi Prasad	Auburn University
Tony Provin	Texas A&M University
Ed Rayburn	West Virginia University
Mark Reiter	Virginia Tech University
Edwin Ritchey	University of Kentucky
Amir Sadeghpour	Southern Illinois University
Hubert Savoy*	University of Tennessee
Charles Shapiro*	University of Nebraska
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Andrew Sharpley *	University of Arkansas
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Frank Sikora	University of Kentucky
Henry Sintem	University of Georgia
Nathan Slaton	University of Arkansas
Jared Spackman	University of Idaho
Carissa Spencer	USDA-FSA
David Sotomayor	University of Puerto Rico
John Spargo	Penn State
Haiying Tao	University of Connecticut
David Tarkalson	USDA-ARS
Gurpal Toor	University of Maryland
Teferi Tsegaye	USDA-ARS
Pete Vadas	USDA-ARS
Jeff Volenec	Purdue University
Jordon Wade	University of Missouri
Forbes Walker	University of Tennessee
Jim Wang	Louisiana State University
Charles White	Penn State
Stephen Wood	The Nature Conservancy
Matt Yost	Utah State University
Frank Yin	University of Tennessee
Hailin Zhang	Oklahoma State University

Washington State University

South Dakota State University

FRST
FERTILIZER RECOMMENDATION SUPPORT TOOL

Purdue University

Cornell University

Oregon State University

University of Nebraska Lincoln

The Ohio State University

UCONN University of Connecticut

UC Davis University of California

University of Illinois Urbana-Champaign

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

University of Kentucky

PennState

Montana State University

SIU Southern Illinois University Carbondale

USDA ARS
United States Department of Agriculture
Agricultural Research Service

West Virginia University

Rutgers

University of Idaho

University of Missouri

UTIA Institute of Agriculture
The University of Tennessee

University of Delaware

Iowa State University

Kansas State University

FSA Farm Service Agency

FAR Foundation for Agronomic Research

Mississippi State University

University of Maryland

College of Agriculture and Applied Sciences
Utah State University

OSU Oklahoma State University

Plant Nutrition Canada

Auburn University

Virginia Tech

Brigham Young University

Texas A&M University

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USDA ARS
58-8070-8-016

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University of Arkansas System

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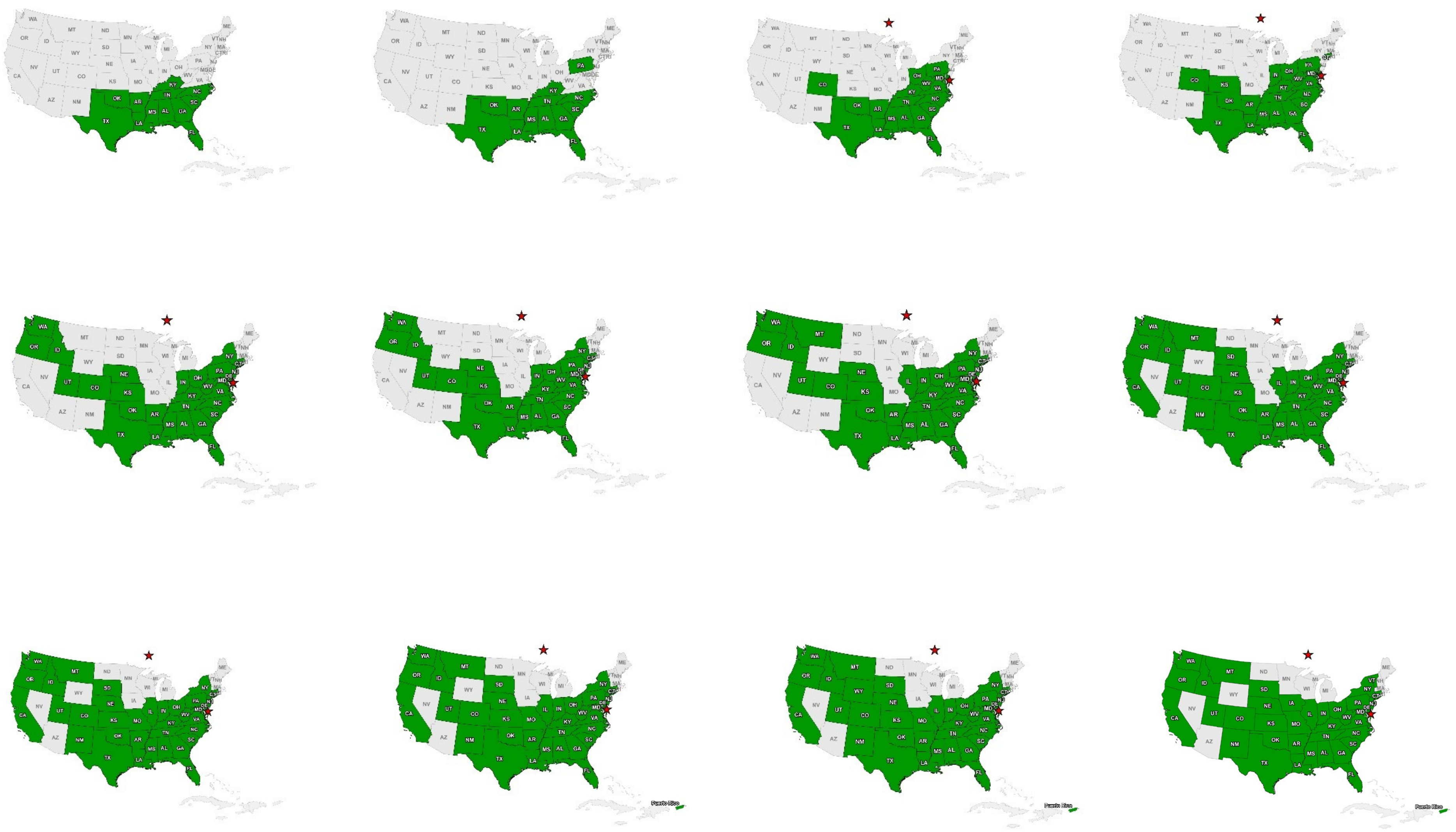
UPR Recinto Universitario de Mayagüez

Clemson University

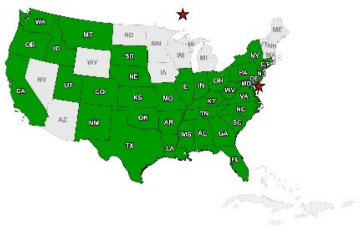
FRST Project Collaboration: 2018-2022

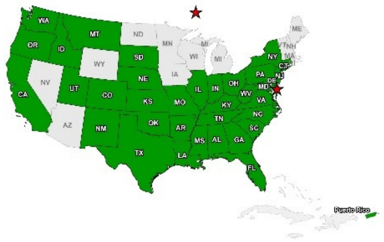


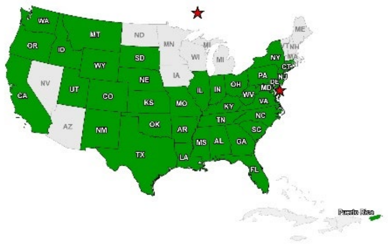
FRST Project Collaboration: 2018-2022

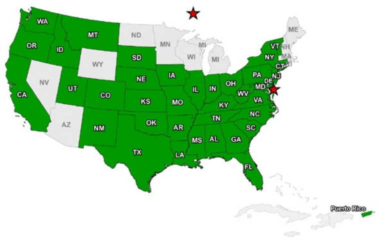
Buy-in from the “community”

- In-person meetings 2019, 2020
- Monthly conference calls
- Volunteers for specific activities









FRST Project: Step-wise activities

1. Survey of land grant faculty on current soil test practices and recommendations (Spargo)
2. Define a minimum dataset requirement for soil test correlation and calibration trials (Slaton)
3. Collect legacy soil test correlation and calibration data and develop an accompanying relational database (Lyons and Arthur)
4. Determine the most appropriate relative yield definition for FRST (Pearce, Lyons and Slaton)
5. Collaborator soil test fertility trials 2021 (Osmond and Lyons)
6. Sampling depth study (Culman and Spargo)
7. Modeling soil test correlation data
8. Develop a user-friendly, searchable interface (decision tool) and internal structure that allows for input, output, and geospatial context (Buol, Arthur and Osmond)
9. FRST-associated project: lime equations (Miller)

FRST Project: Step-wise activities

1. **Survey of land grant faculty on current soil test practices and recommendations (Spargo) – almost complete**
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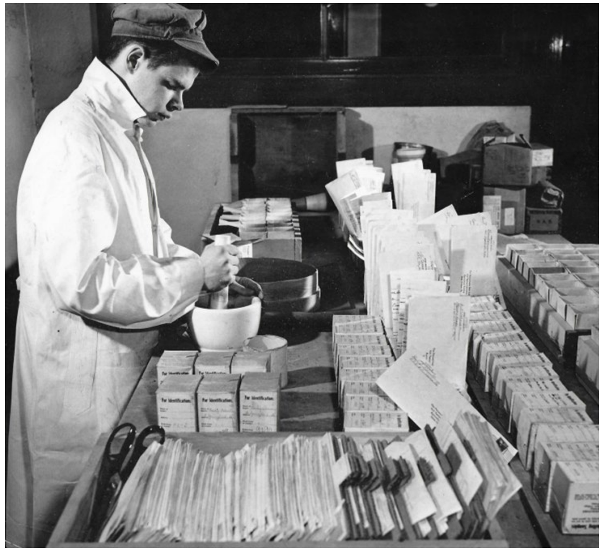
National Land Grant University Soil Fertility Survey: Goals

Goals are to gain a better understanding of the current status of soil testing across the U.S. to direct collaborative efforts among states and regions, and to identify where opportunities exist to harmonize recommendation guidelines.



Collect Information About:

- analytical methods
- fertilizer recommendations and philosophy used
- status of correlation/calibration data

National Land Grant University Soil Fertility Survey: Overview

General
- Public soil test service lab?
- FTEs working on calibration
- Sources of funding

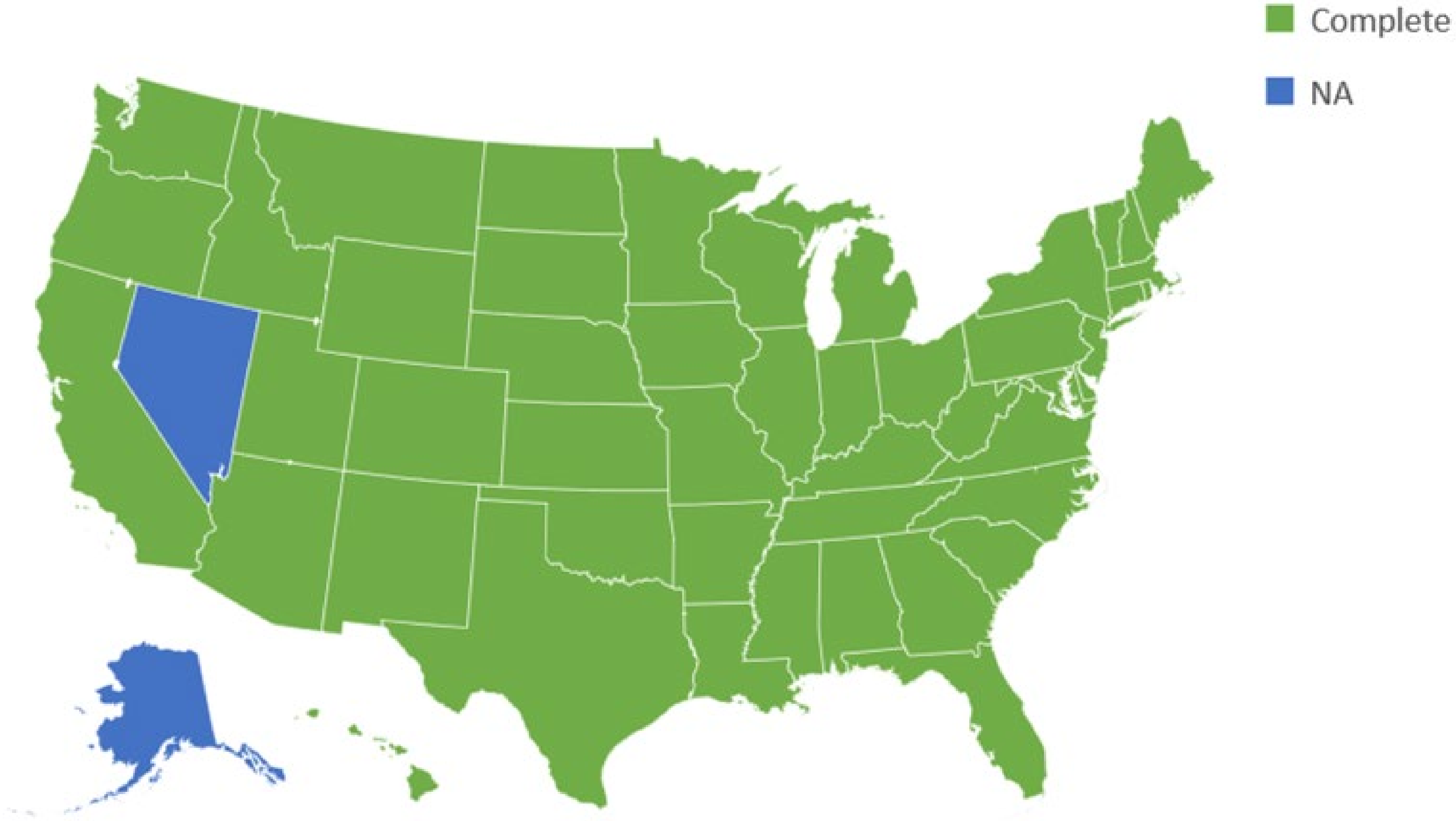
Recommendations
- P and K calibration status
- Critical and *cutoff* levels for important crops
- Philosophy and terminology

Test methods
- Sampling guidelines
- Macro and micronutrients
- OM, NO_3 and Cl
- pH and acidity

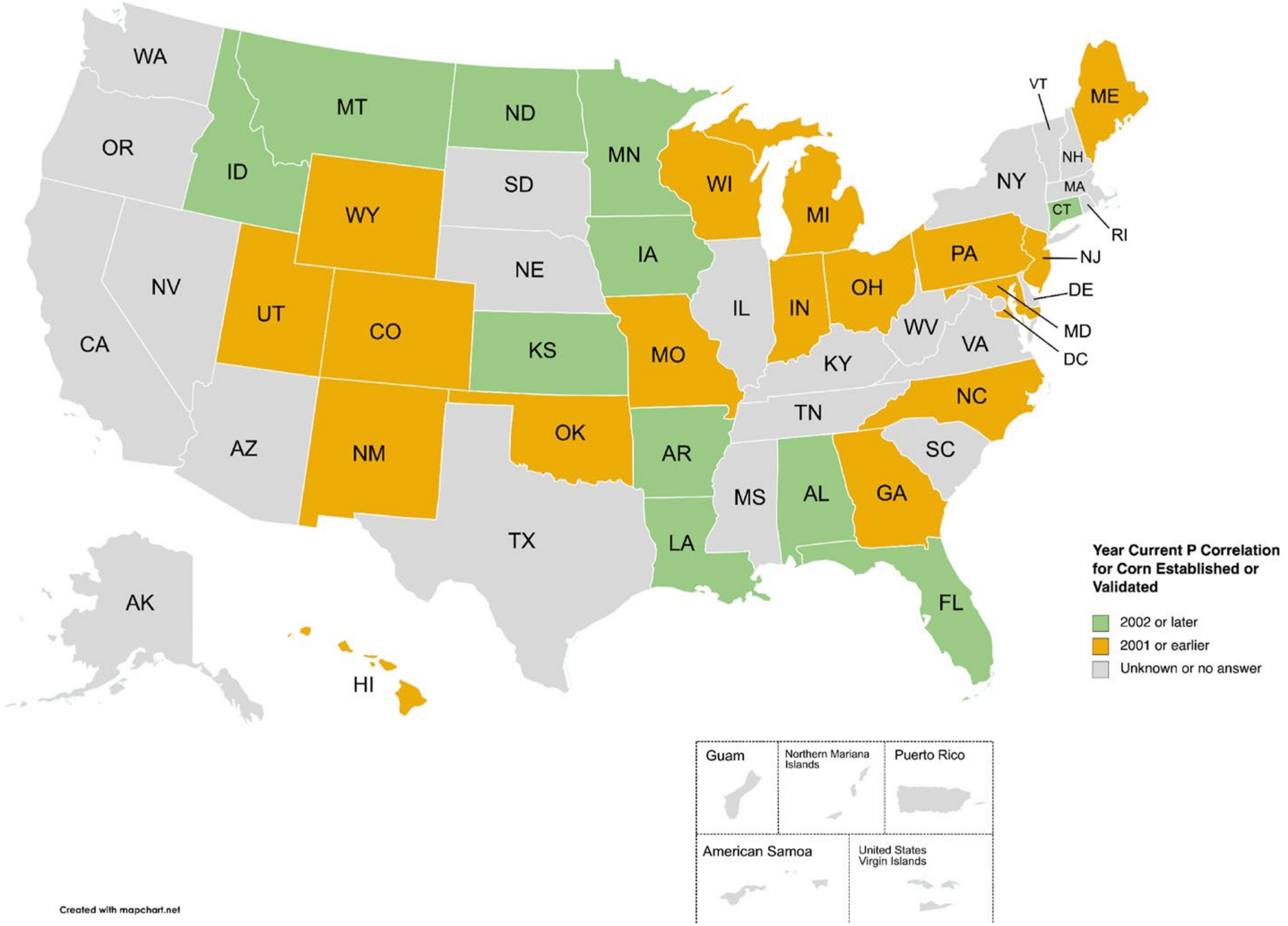
Miscellaneous topics
- Soil health
- Proficiency testing

National Land Grant University Soil Fertility Survey: Participation

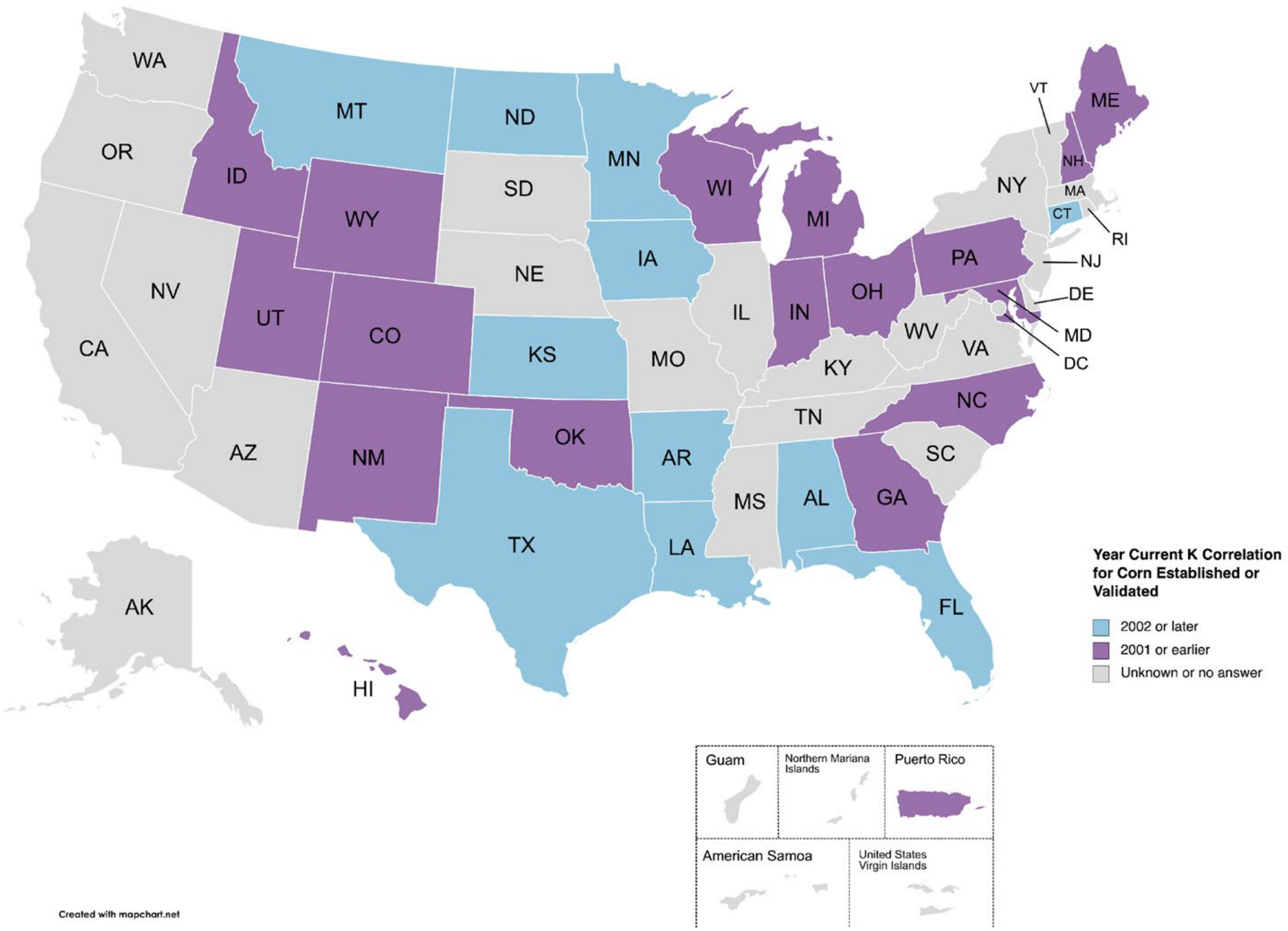
By June 2nd, 2020 we logged 60 responses representing 48 states and Puerto Rico



National Land Grant University Soil Fertility Survey Results: Corn Phosphorus Calibration Year



National Land Grant University Soil Fertility Survey Results: Corn Potassium Calibration Year



FRST Project: Step-wise activities

1. Survey of land grant faculty on current soil test practices and recommendations (Spargo)
2. **Define a minimum dataset requirement for soil test correlation and calibration trials (Slaton) - complete**
3. Collect legacy soil test correlation and calibration data and develop an accompanying relational database (Lyons and Arthur)
4. Determine the most appropriate relative yield definition for FRST (Pearce, Lyons and Slaton)
5. Collaborator soil test fertility trials 2021 (Osmond and Lyons)
6. Sampling depth study (Culman and Spargo)
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9. FRST-associated project: lime equations(Miller)

Development of a Minimum Dataset Protocol for Soil Test Correlation and Calibration Trials

- Standardize information/data that should be collected to guide soil-test correlation and calibration research
    - Consensus among scientists
    - Guide research protocols and publication of research results
    - Qualify data for inclusion in meta-analyses
    - Promote good science but not be overly restrictive
        - Required vs recommended data
- Facilitate data sharing

Minimum Dataset Organization

- Data origin and ownership
- Soil sample collection and processing details
- Soil analysis and properties
- Metadata
  - Trial & treatment description
  - Cropping system metadata
  - Field management
  - Location & weather
  - Harvest details
  - Experiment design, structure and analysis
- Data
  - Means vs plot-level data

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REVIEW & ANALYSIS

Minimum dataset and metadata guidelines for soil-test correlation and calibration research

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Abstract
Soil-test correlation and calibration data are essential to modern agriculture, and their continued relevance is underscored by the expansion of precision farming and the persistence of sustainable soil management priorities. In support of transparent, science-based fertilizer recommendations, we seek to establish a core set of required and recommended information for soil-test P and K correlation and calibration studies, a minimum dataset, building on previous research. The Fertilizer Recommendation Support Tool (FRST) project team and collaborators are developing a national database that will support a soil-test-based nutrient management decision aid tool. The FRST team includes over 80 scientists from 37 land-grant universities, two state universities, one private university, three federal agencies, two private not-for-profit organizations, and one state department of agriculture. The minimum dataset committee developed and vetted a robust set of factors fo minimum dataset consideration that includes information on soil sample collection and processing, soil chemical and physical properties, experimental design and statistical analyses, and metadata

Abbreviations: 4RNS, 4R Nutrient Stewardship; BFDC, Better Fertilizer Decisions for Cropping Systems; FRST, Fertilizer Recommendation Support Tool.

Minimum Data Set – Soil Properties

Soil property	Minimum Data Set Category [a]	Level of Measurement[b]		Data [c]	Units	Comments
		Single Year Trial	Multi-Year Trial			
Soil pH	Required	Block	Treatment	*n*, μ, SE	--	See Footnote [d]
Soil organic matter	Required	Block	Treatment	*n*, μ, SE	$g\ kg^{-1}$	See Footnote [d]
Soil-test P	Required	Block	Treatment	n, μ, SE	$mg\ kg^{-1}$	See Footnote [d]
Soil-test K	Required	Block	Treatment	*n*, μ, SE	$mg\ kg^{-1}$	See Footnote [d]
Soil-test Ca	Required	Block	Treatment	*n*, μ, SE	$mg\ kg^{-1}$	See Footnote [d]
Soil-test Mg	Required	Block	Treatment	*n*, μ, SE	$mg\ kg^{-1}$	See Footnote [d]
Soil-test Na	Recommended	Site	Site	μ	$mg\ kg^{-1}$	See Footnote [d]
Particle size	Recommended	Site	Site	μ	$g\ kg^{-1}$	See Footnote [d]
Exch. acidity	Recommended	Site	Site	μ	$cmol_c\ kg^{-1}$	See Footnote [d]
Soil buffer pH	Recommended	Site	Site	μ	--	See Footnote [d]

[a] Assigned data set definitions: Required is the absolute minimum for inclusion in the database. Recommended data should be included if possible.

[b] Level of measurement abbreviations, SYT, single year trial; MYT, Multi-year Trial; B, Block (or replicate); S, Site; T, Treatment;

[c] Data abbreviations: *n*, observation number; μ, mean; SE, standard error of mean

[d] Include method reference and modifications, instrument manufacturer and model, and laboratory where analysis was conducted

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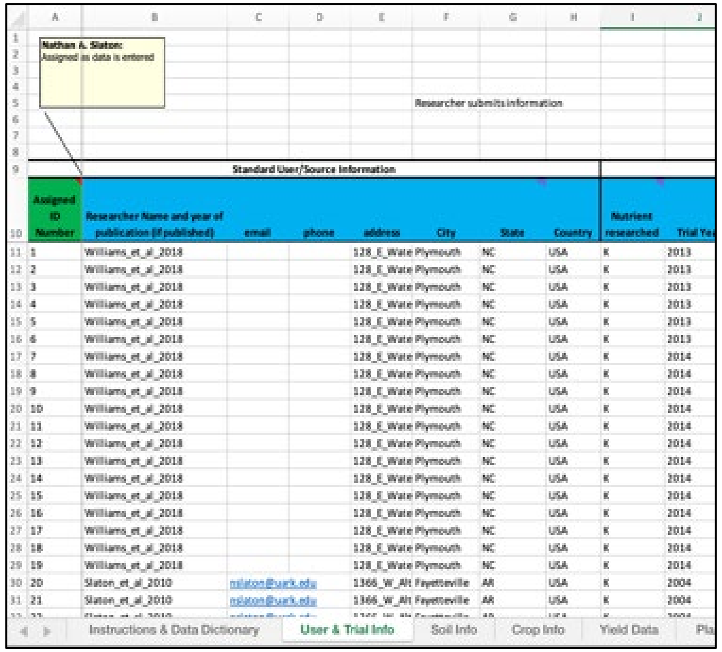
9. FRST-associated project: lime equations

FRST Database Development

- Collaborative
- Soil-test P and K correlation and calibration data
- Microsoft Excel multi-tab spreadsheet
  - Relational structure
  - Hosted by AgCROS; cataloged in NAL Ag Data Commons
- Iterative
- Data collected from many sources
  - Journal articles, extension and research bulletins, conference proceedings, dissertations and theses, spreadsheets, and word-processing documents
  - Raw and summarized



Assigned ID Number	Researcher Name and year of publication (if published)	email	phone	address	City	State	Country	Nutrient researched	Trial Yea
1	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2013
2	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2013
3	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2013
4	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2013
5	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2013
6	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2013
7	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
8	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
9	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
10	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
11	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
12	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
13	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
14	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
15	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
16	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
17	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
18	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
19	Williams_et_al_2018			128_E_Wate	Plymouth	NC	USA	K	2014
20	Slaton_et_al_2010	nslaton@uark.edu		1366_W_Alt	Fayetteville	AR	USA	K	2004
21	Slaton_et_al_2010	nslaton@uark.edu		1366_W_Alt	Fayetteville	AR	USA	K	2004

FRST Database Development: Data Sources


Published July 18, 2019

SOIL FERTILITY AND CROP NUTRITION

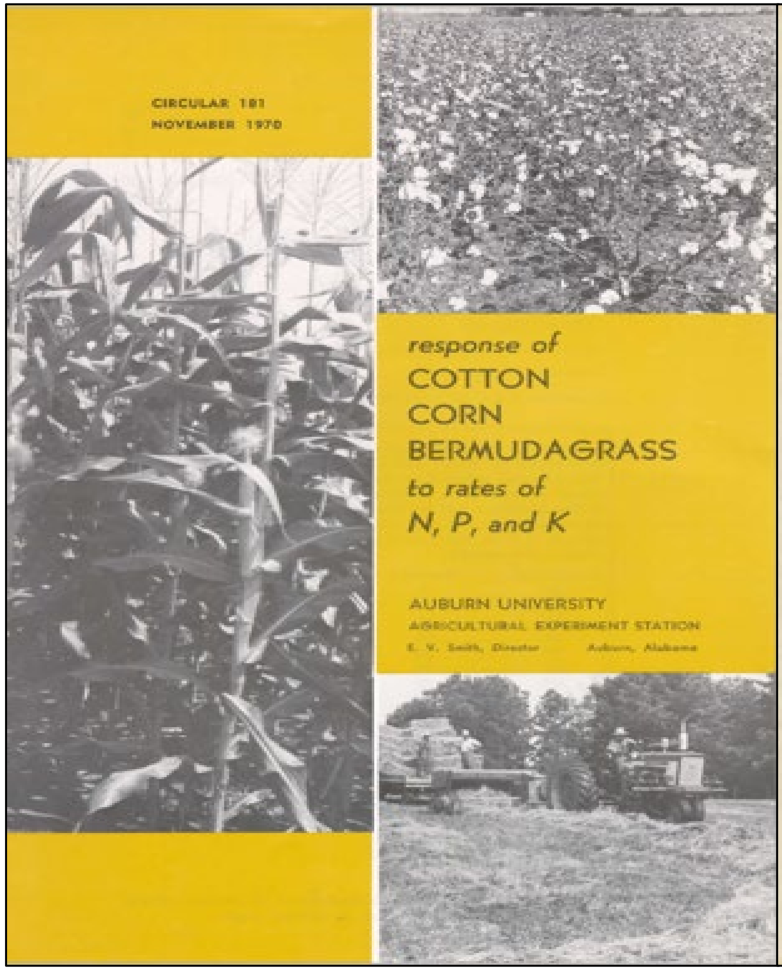
Validation of Soil-Test-Based Phosphorus and Potassium Fertilizer Recommendations for Flood-Irrigated Rice

Matthew S. Fryer, Nathan A. Slaton,* Trenton L. Roberts, Jarrod T. Hardke, and Richard J. Norman

ABSTRACT

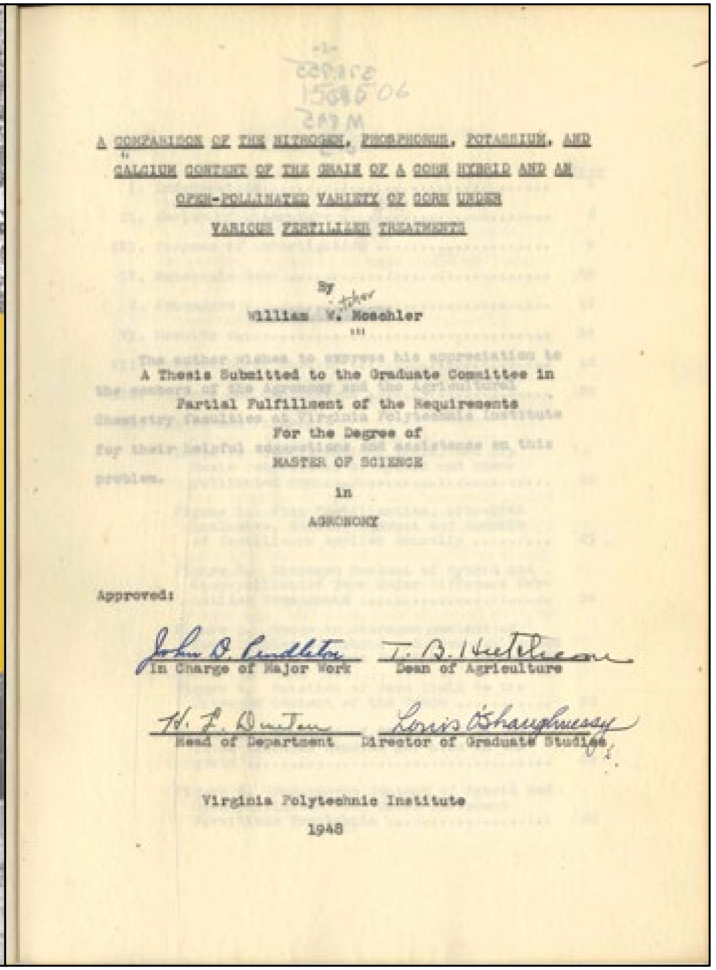
Core Ideas

Agronomy Journal • Volume 111, Issue 5 • 2019 2523


CIRCULAR 181
NOVEMBER 1970

response of
COTTON
CORN
BERMUDAGRASS
to rates of
N, P, and K

AUBURN UNIVERSITY
AGRICULTURAL EXPERIMENT STATION
E. V. Smith, Director Auburn, Alabama


A COMPARISON OF THE NITROGEN, PHOSPHORUS, POTASSIUM, AND CALCIUM CONTENT OF THE GRAIN OF A CORN HYBRID AND AN OPEN-POLLINATED VARIETY OF CORN UNDER VARIOUS FERTILIZER TREATMENTS

By

William W. Moschler

A Thesis Submitted to the Graduate Committee in Partial Fulfillment of the Requirements For the Degree of MASTER OF SCIENCE in AGRONOMY

Approved:

In Charge of Major Work — Dean of Agriculture

Head of Department — Director of Graduate Studies

Virginia Polytechnic Institute

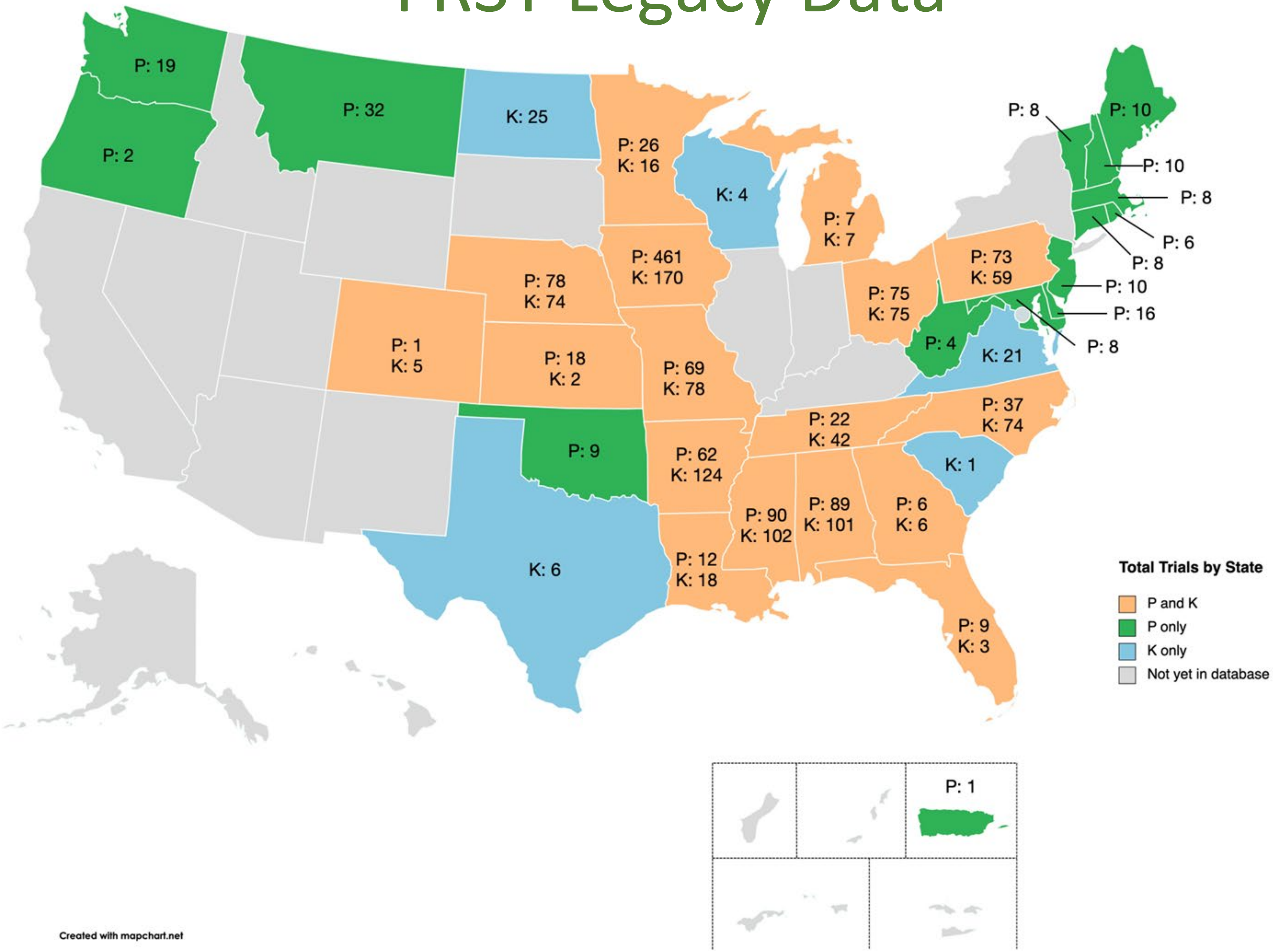
1948

FRST Database Summary

Trials	> 1,300	Years	1949 - 2021
Crops	Alfalfa, bahiagrass, bermudagrass, camelina, corn, chickpea, soybean, clover/grass mix, cotton, flax, lentil, pea, peanut, rice, sorghum, sugarcane, sweet potato, wheat	P methods	Mehlich-1 & -3, Bray-1 & -2, Olsen, Morgan, Modified Morgan, MS Soil Test (Lancaster), acetic acid, resin, Pi, water, double acid, total P, Oxalate, ammonium acetate, Haney, Truog, sodium acetate, oxalate, AB-DTPA
States	AL, AR, CO, CT, DE, FL, GA, IA, KS, LA, MA, MD, ME, MI, MN, MO, MS, MT, NC, ND, NE, NH, NJ, OH, OR, PA, RI, SC, TN, TX, VA, VT, WA, WI, WV	K methods	Mehlich-1 & -3, ammonium acetate, nitric acid, saturation, rate of release, MS Soil Test (Lancaster), Olsen, Morgan, Modified Morgan, resin, tetraphenylboron, calcium chloride

> 100 articles, dissertations, and bulletins currently on file to be entered. Updated October 2021.

FRST Legacy Data



FRST Project: Step-wise activities

1. Survey of land grant faculty on current soil test practices and recommendations (Spargo)
2. Define a minimum dataset requirement for soil test correlation and calibration trials (Slaton)
3. Collect legacy soil test correlation and calibration data and develop an accompanying relational database (Lyons and Arthur)
4. **Determine the most appropriate relative yield definition for FRST (Pearce, Lyons and Slaton) – almost complete**
5. Collaborator soil test fertility trials 2021 (Osmond and Lyons)
6. Sampling depth study (Culman and Spargo)
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8. Develop a user-friendly, searchable interface (decision tool) and internal structure that allows for input, output, and geospatial context (Buol, Arthur and Osmond)
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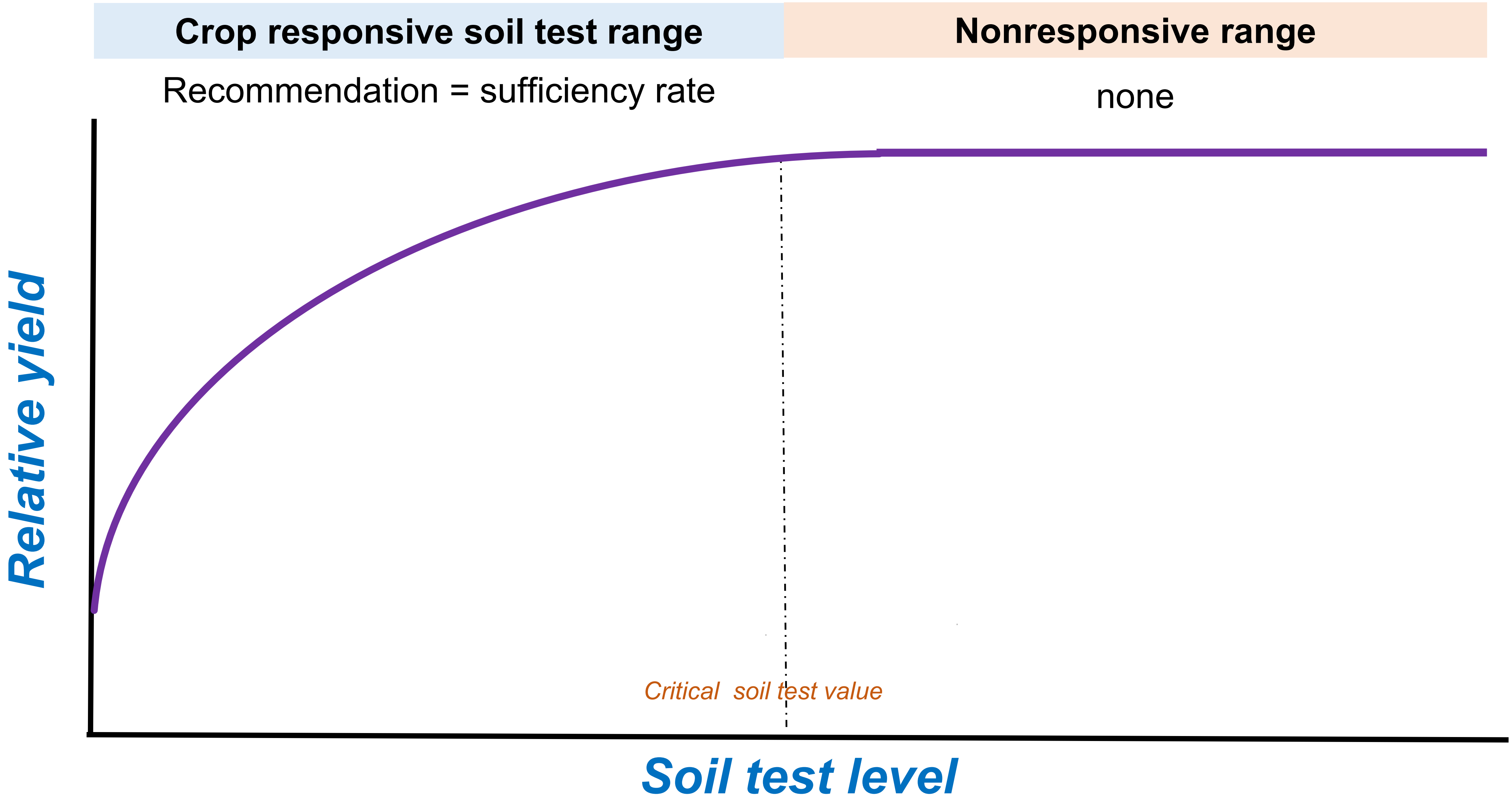
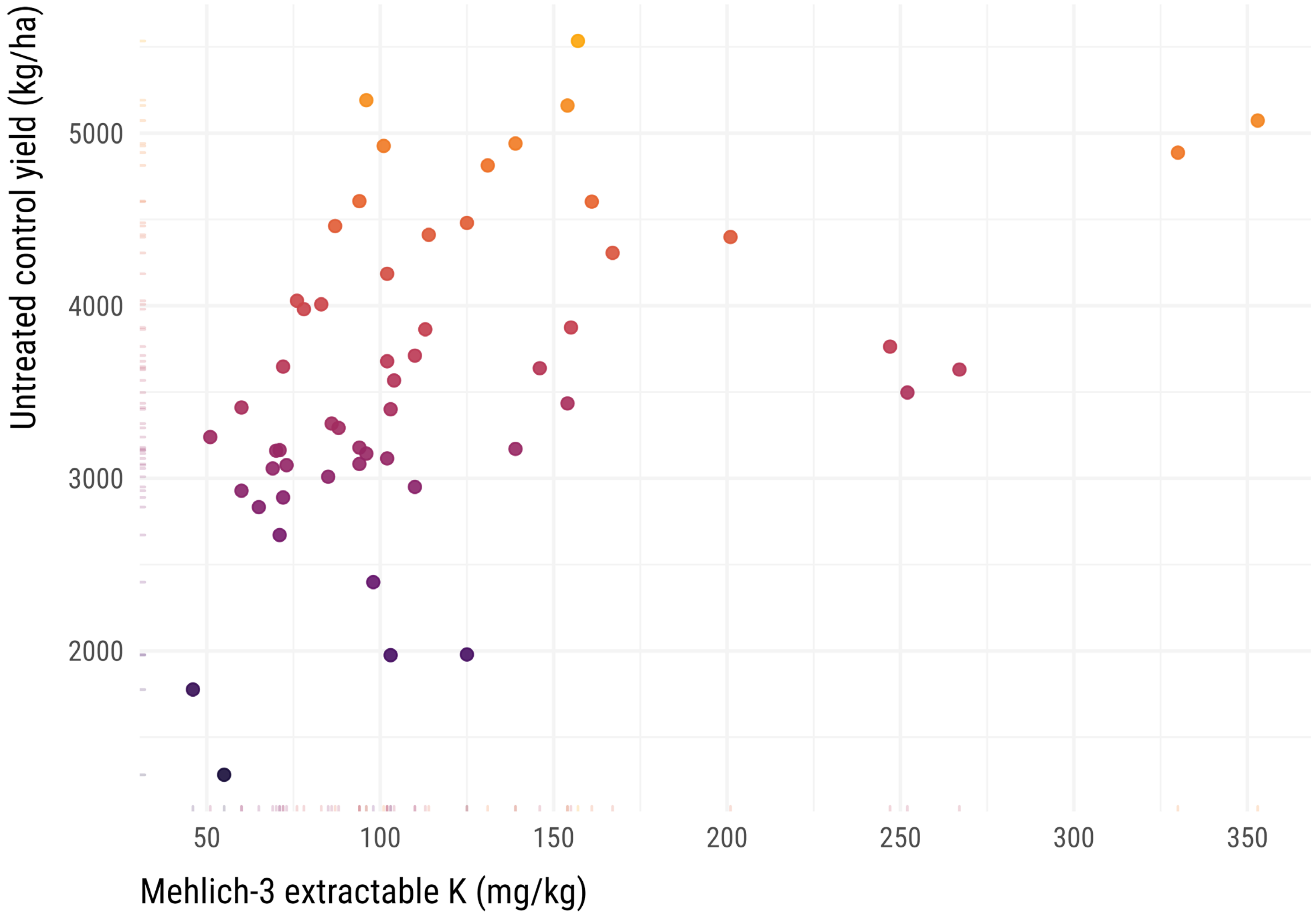
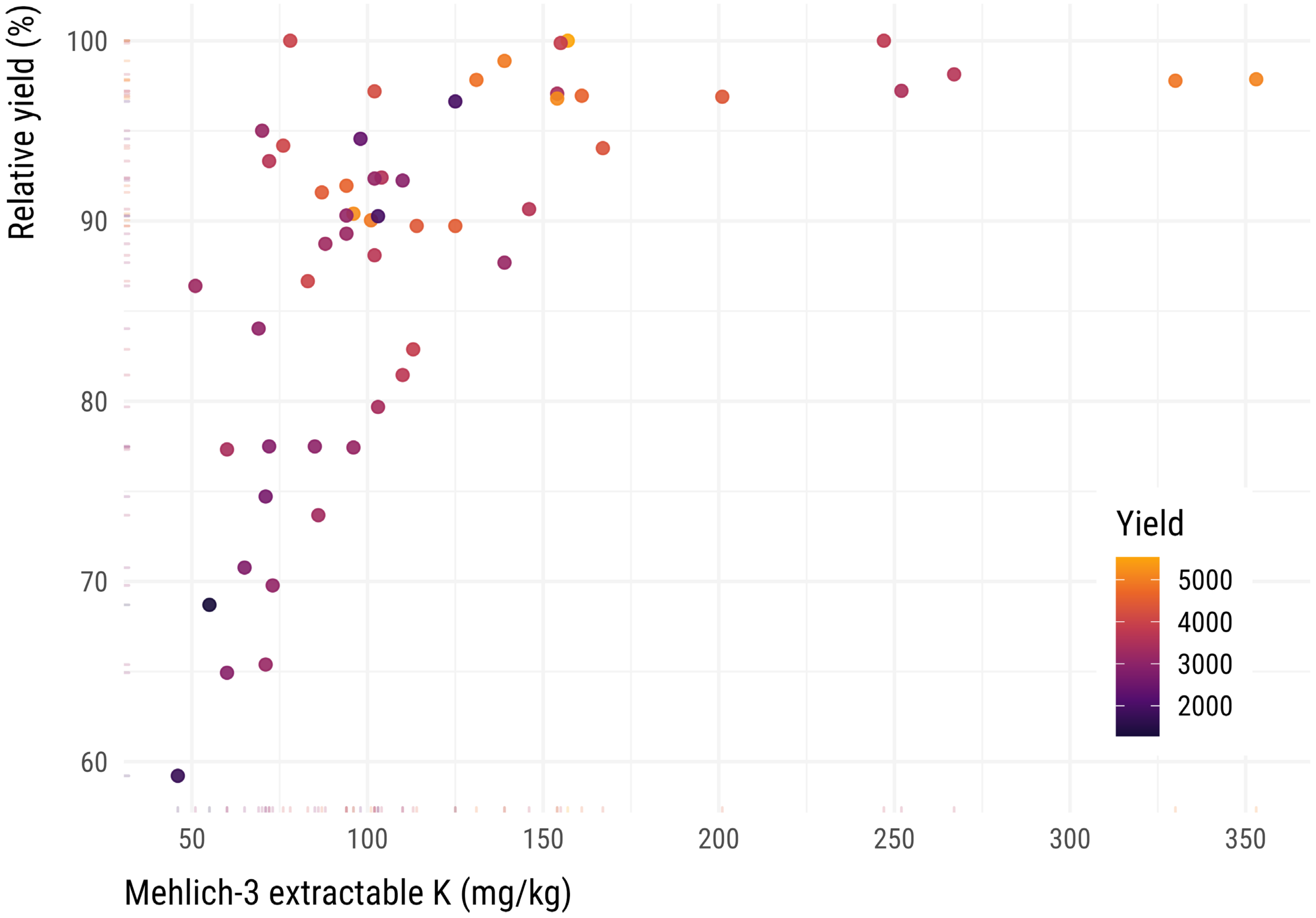
Importance of Relative Yield



Soil Test Calibration and Correlation Trials: Yield



Soil Test Calibration and Correlation Trials: Relative Yield



Basis of the "Relative Yield" Study

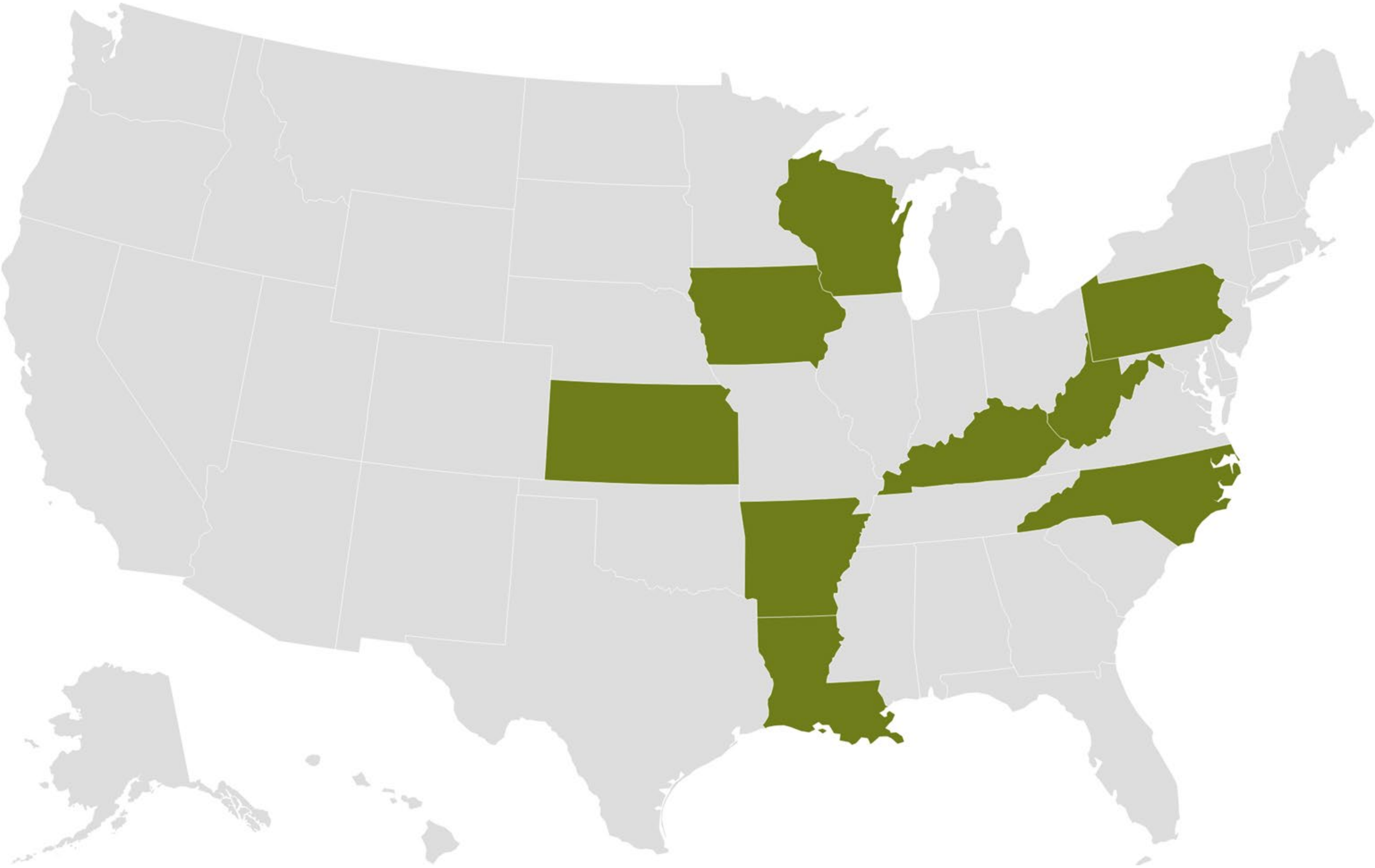
Problem: Relative yield (RY or %Y) common crop response metric

- **BUT** many definitions exists
- **AND** unclear which to use and if downstream effects on critical soil test concentrations, etc.

Objectives:

- To compare the multiple definitions of Relative Yield, their advantages, limitations, and influence on downstream results such as critical soil-test concentrations.
- The ultimate goal of this analysis is to guide which definition(s) will be used in the Fertilizer Recommendation Support Tool (FRST).

Relative Yield Definition for FRST: Participation



Relative Yield Definitions and Sources

№	Label for Analysis	Formula for RY_0† express as %, multiply by 100	Definition‡ mean yield of control treatment plots divided by …	Example
			--Arithmetic --	
1	MAX		Maximum among all treatment yield means (including control)	Rouse (1968) Bolland et al. (1989)
2	MAXF		Maximum among fertilized treatment yield means	Slaton et al. (2010) Williams et al. (2018)
3	MEANF		Mean yield of fertilized treatments	Mallarino & Blackmer (1992)
4	TOP2		Mean of the top 2 yielding treatments	Mallarino & Blackmer (1994)
5	MAXRATE		Mean yield of plots receiving maximum rate treatment	Barbagelata & Mallarino (2013)
6§	MEAN		Mean yield of all treatments (including control)	Clover and Mallarino (2013)
7§	MEAN-SET		Mean yield of treatment j set by researcher, being specific to experimental question	Cope (1981) Heckman et al. (2006)
			--Model-based --	
8¶	FITMAX		Fitted minimum AND fitted maximum yield from site-year-specific modeling	Bell et al. (2013) Dyson et al. (2013)
9	STATMAX †		Mean of all treatment yield means that are statistically similar to or greater than the yield-maximizing rate estimated by the best fitting model	Clover and Mallarino (2013)

Relative Yield Equations

Y_0/A;

$Y_0/A_{rate}>0$;

$Y_0/Y_{rate}>0$;

$Y_0/(A+A_{2nd/2})$;

$\mathbf{Y_0/Y_{max}}$;

Y_0/Y_{all};

$RY_0 = Y_0/Yj$;

fitted Y_0/fitted A;

$RY_0 = Y_0/(Y_{xx} + \ldots. + Y_{n,ss/n})$

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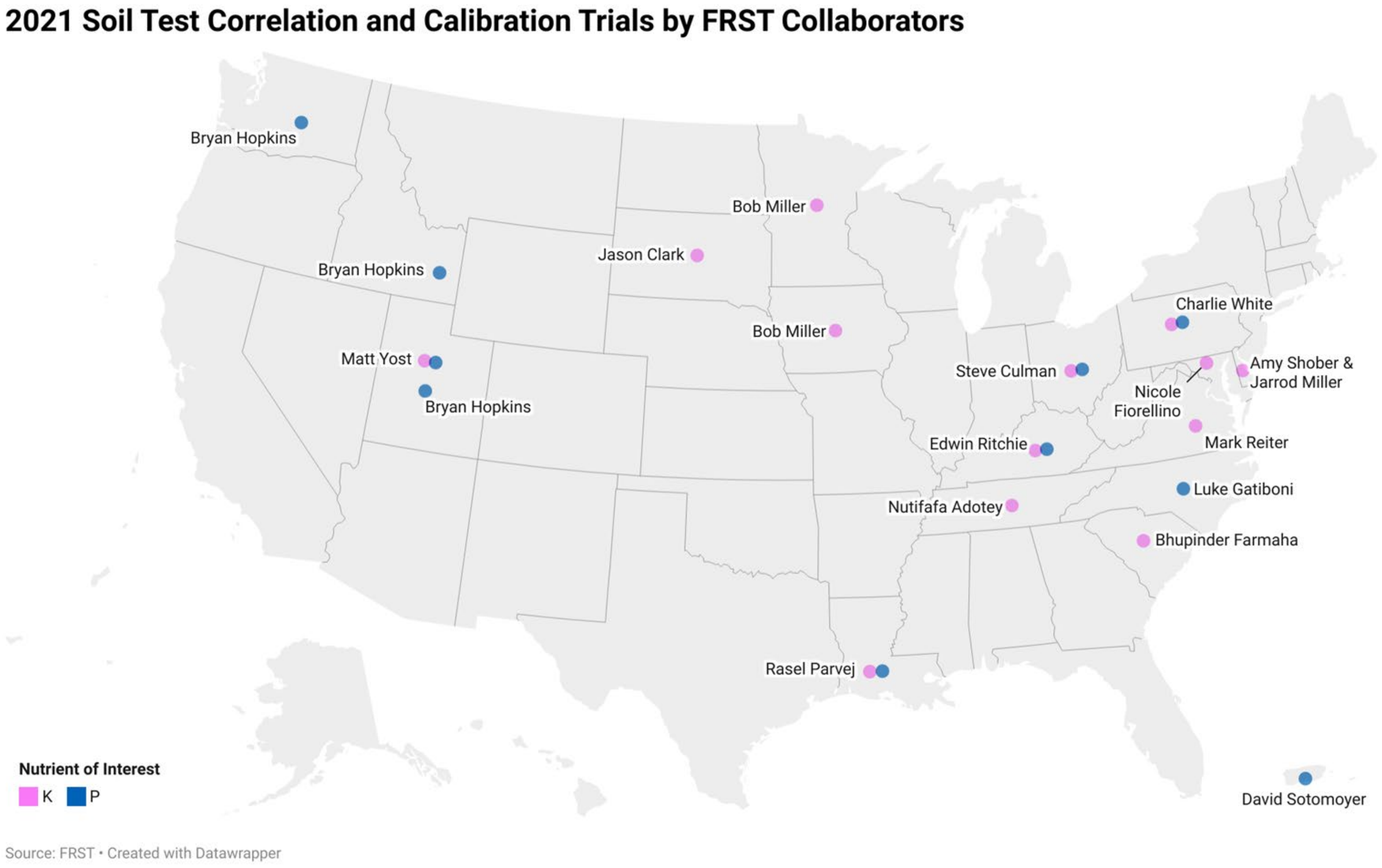
9. FRST-associated project: lime equations (Miller)

FRST 2021 Soil Test Trials: Participation



- Increase project inclusion
- Generate needed state soil fertility data
- Provide additional information for the FRST database
- Test upload tool

FRST Project: Step-wise activities

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4. Determine the most appropriate relative yield definition for FRST (Pearce, Lyons and Slaton)
5. Collaborator soil test fertility trials 2021 (Osmond and Lyons)
6. **Sampling depth study (Culman and Spargo) – on-going**
7. Modeling soil test correlation data
8. Develop a user-friendly, searchable interface (decision tool) and internal structure that allows for input, output, and geospatial context (Buol, Arthur and Osmond)
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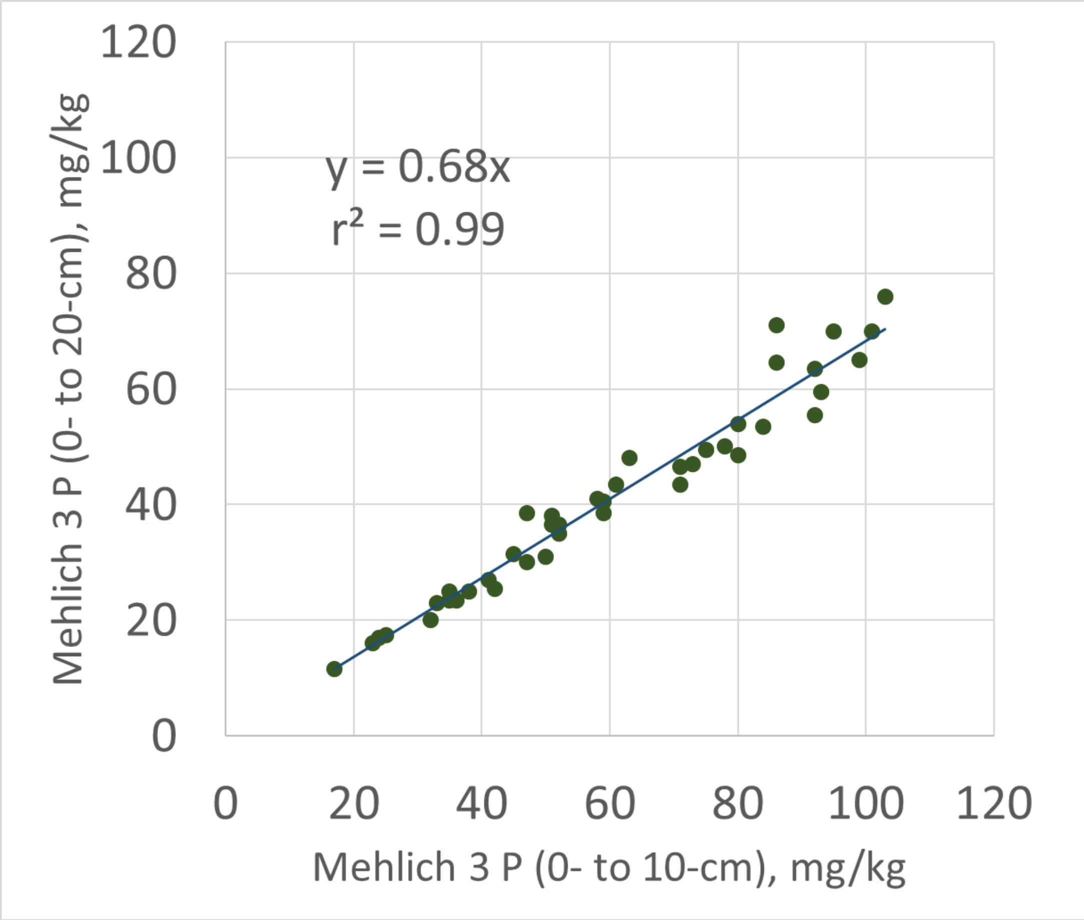
FRST Sampling Depth Study: End Goal

Define a correction factor that can used to estimate equivalent soil test levels (and *critical ranges*) for different depths based on different metadata:

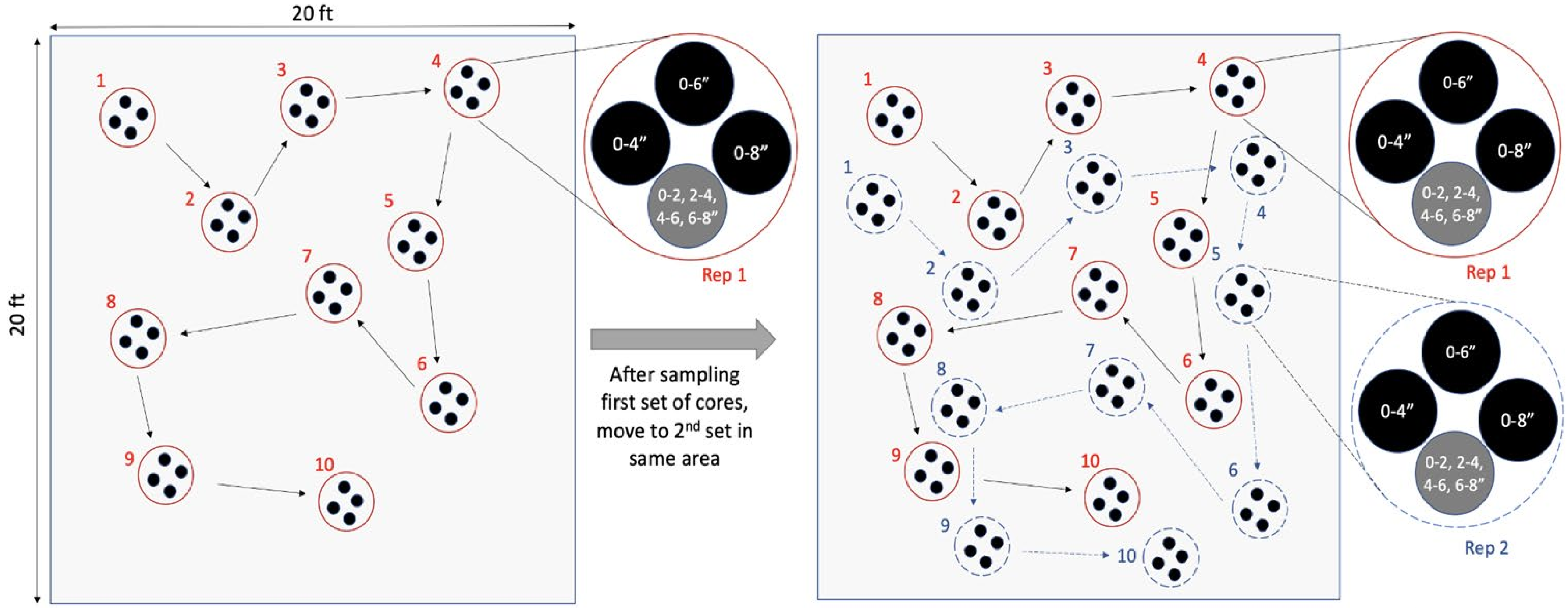
i. Cropping system
ii. Management
iii. Region/soil type



FRST Sampling Depth Study: Objectives & Sampling

Objectives

- Determine the relationship between soil test P and K at varying soil sample depth
- Use different sampling methods to determine soil test levels at varying depths

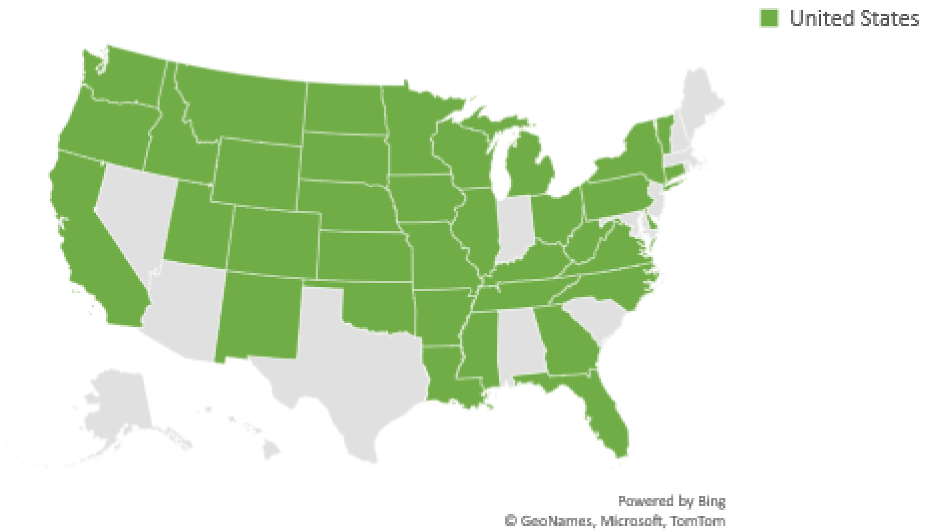


Diagram, Steve Culman

FRST Sampling Depth Study: Participation and Logistics

Logistics

- 5-10 fields per state
- Samples to PSU for Mehlich 3, OM, pH; if northeastern state to Maine for Modified Morgan; if pH > 7.2 to KSU for Olsen
- Western states add a depth, 8-12"
- Metadata collected



Schedule

- Deadline for sample submission April 31
- Data analysis, early fall 2022
- Results, early winter 2023

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7. **Modeling soil test correlation data – just starting**
8. Develop a user-friendly, searchable interface (decision tool) and internal structure that allows for input, output, and geospatial context (Buol, Arthur and Osmond)
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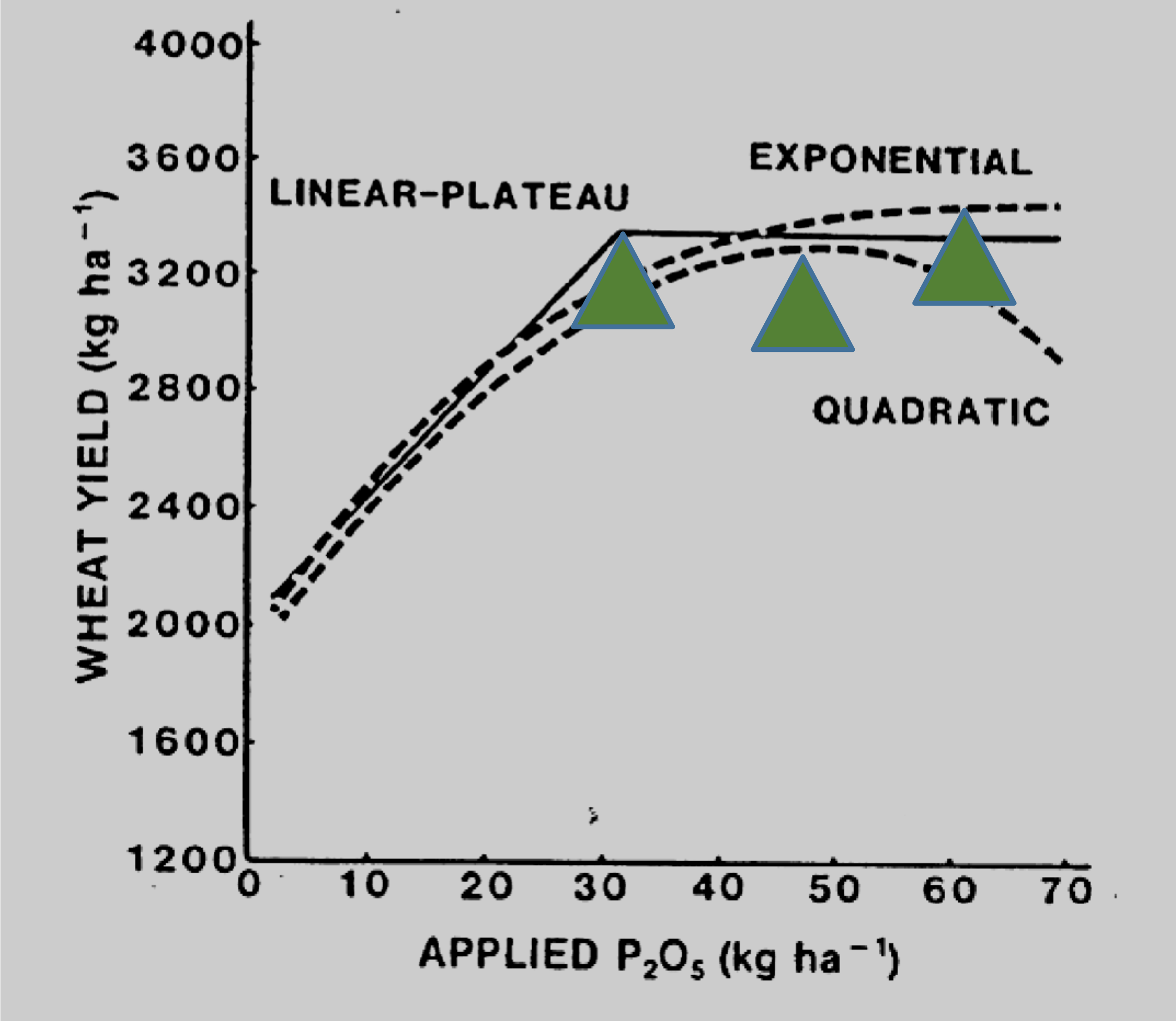
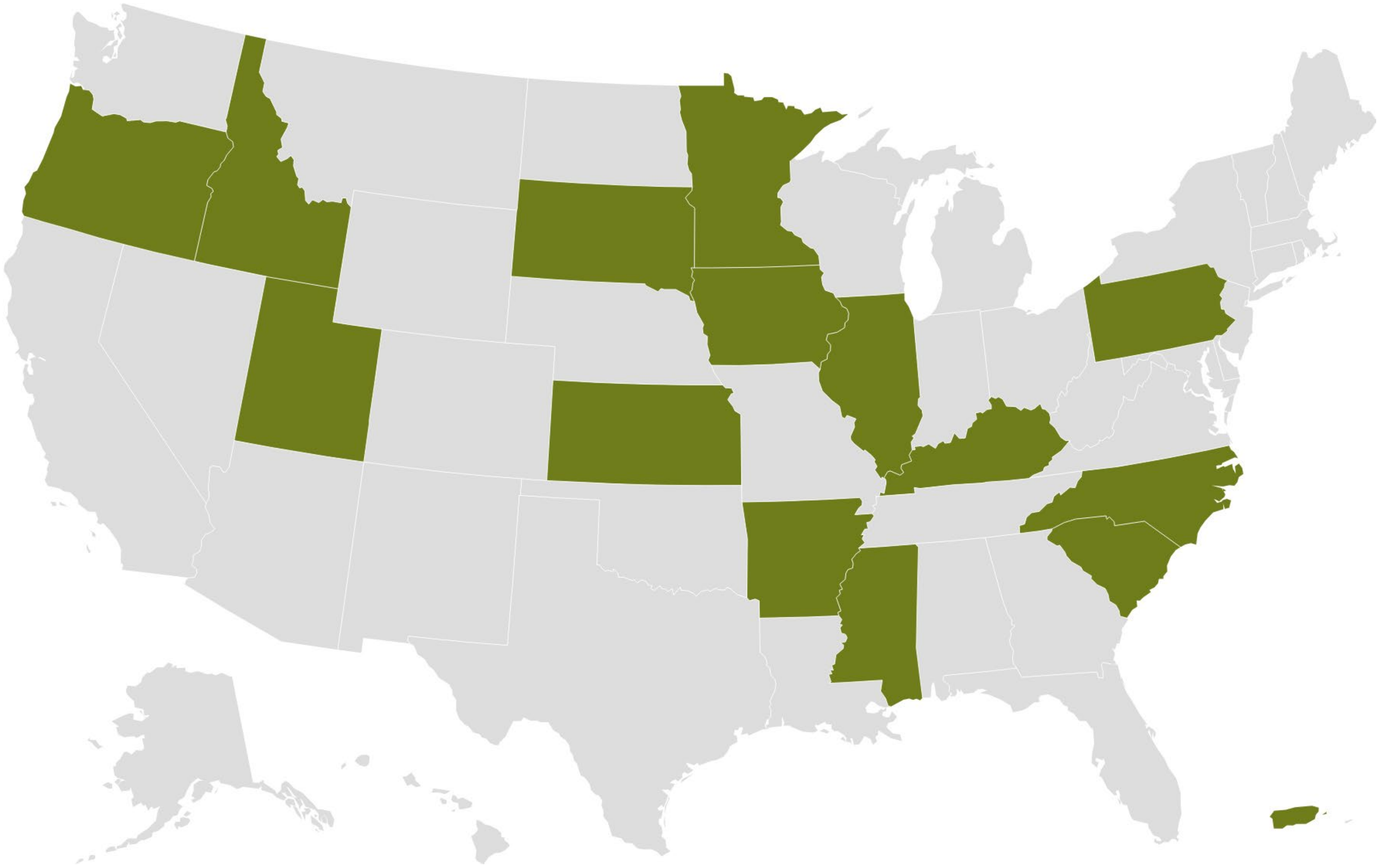
Determining the Model for Critical Soil Test Value Selection in FRST (Soil Test Calibration)



Determining the Model for Critical Soil Test Value Selection in FRST: Participation



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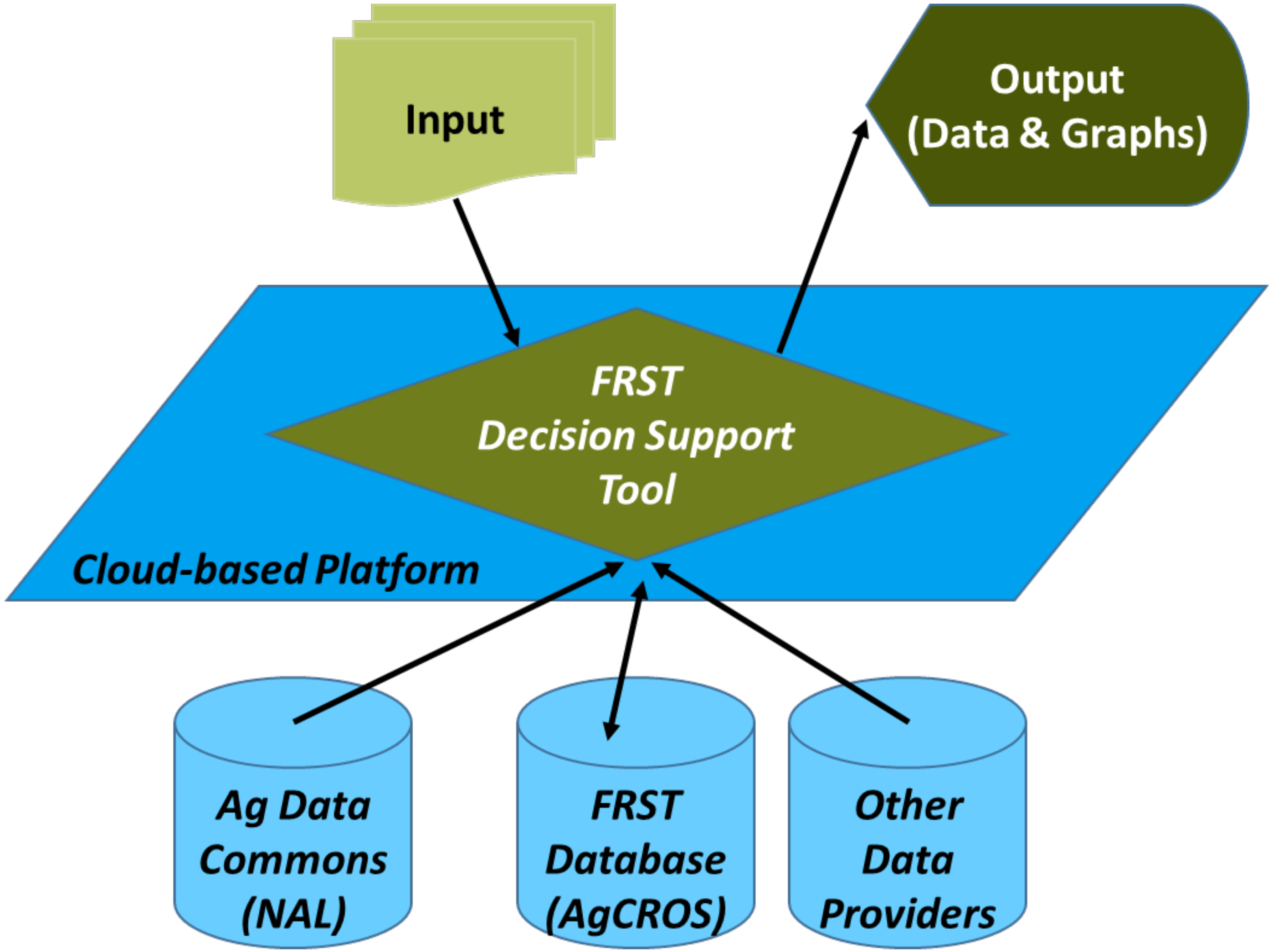
FRST Decision Support Tool and AgCROS



Principles of model development:

- Resides in neutral space
- Software "perpetuity"
- Credit for contribution

FRST Project: Step-wise activities

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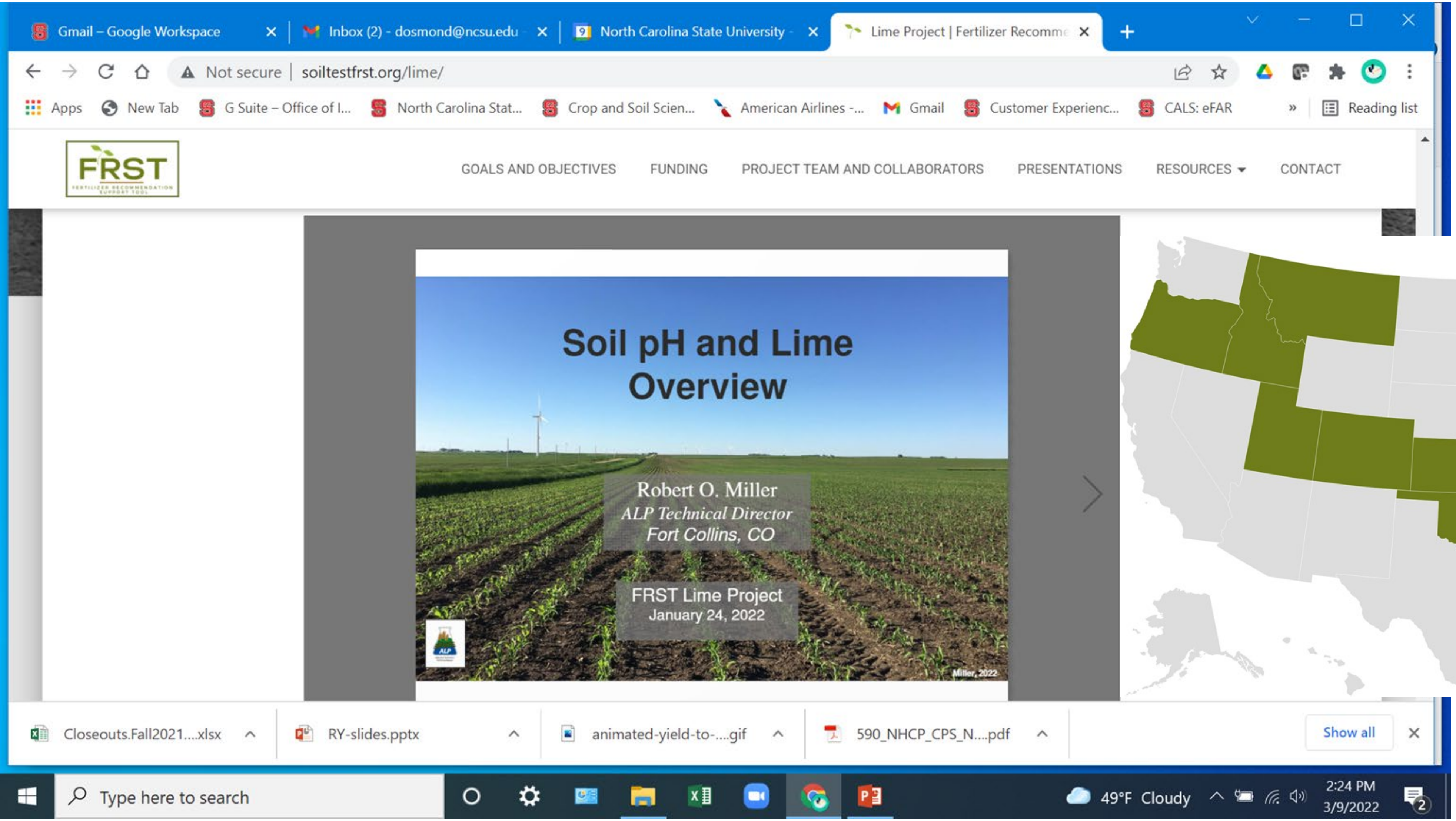
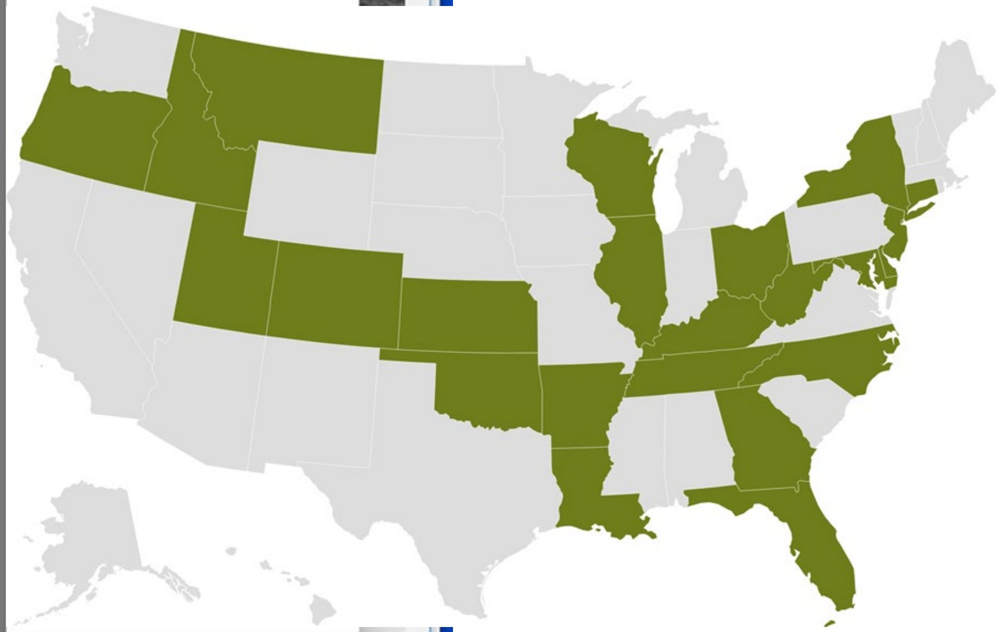
8. Develop a user-friendly, searchable interface (decision tool) and internal structure that allows for input, output, and geospatial context (Buol, Arthur and Osmond)
9. **FRST-associated project: lime equations (Miller) – just starting**

FRST-Associate Lime Project





FRST:
Where Are We and What We Need

- Unique and highly collaborative project involving multiple agencies and many land grant faculty focused on soil test correlation and calibration, which is the backbone of USDA 590 nutrient management standard.
- FRST has already contributed important knowledge: the state of the science, minimum data set, legacy database, and relative yield definition.
- FRST will continue to contribute important knowledge: critical soil test value model, soil depth translation, and decision tool.
- Much of the correlation and calibration work is old because it has only been funded by individual stares and the majority of the states (> 35) have no dedicated funding for soil test correlation and calibration trials. Those that do often have to share it with other agronomic research objectives.
- FRST needs to be expanded to additional nutrients.
- USDA needs to fund an initiative to allow states to work regionally to correlate and calibrate/recalibrate their soil test recommendations.

Fertilizer Recommendation Supp ×

Not secure | soiltestfrst.org

CONTACT FUNDING GOALS AND OBJECTIVES PRESENTATIONS PROJECT TEAM AND COLLABORATORS RESOURCES

soiltestfrst.org

Questions

Fertilizer Recommendation Support Tool

Increasing soil testing transparency by promoting clear and consistent interpretations of fertilizer recommendations by removing political and institutional (public and private) bias from soil test interpretation and providing the best possible science in order to enhance end-user adoption of nutrient management recommendations.

deanna_osmond@ncsu.edu