Seeds of NRSP 11: An origin story for FRST

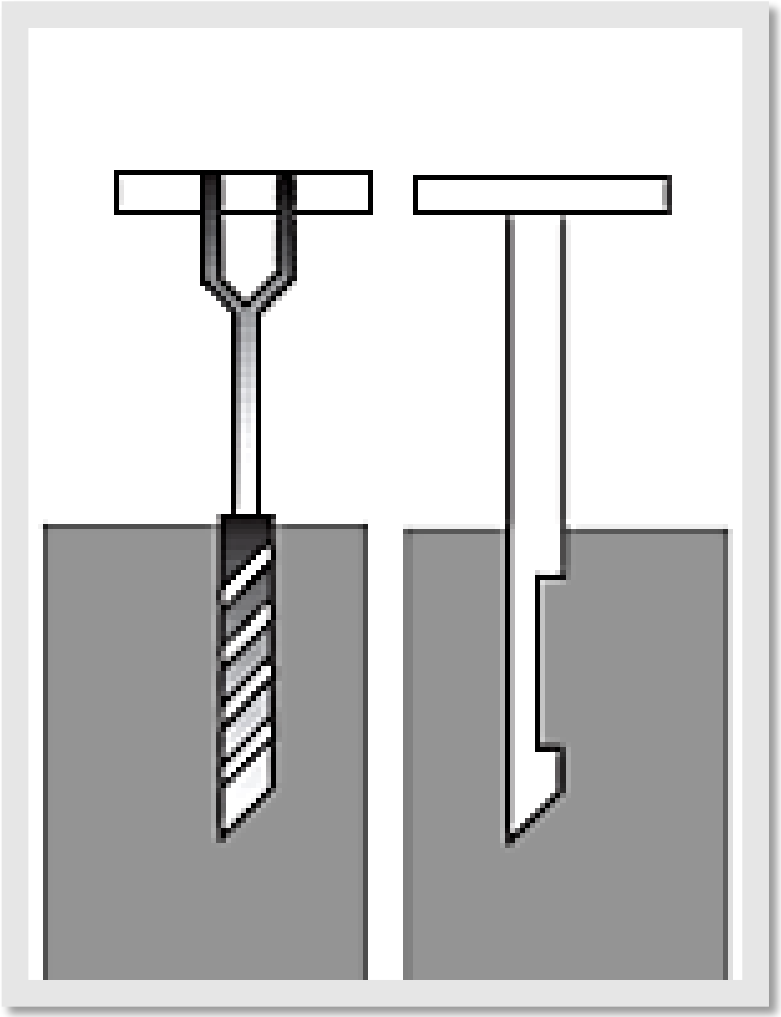
NRSP 11 Meeting

Bloomington, MN

3 June 2024

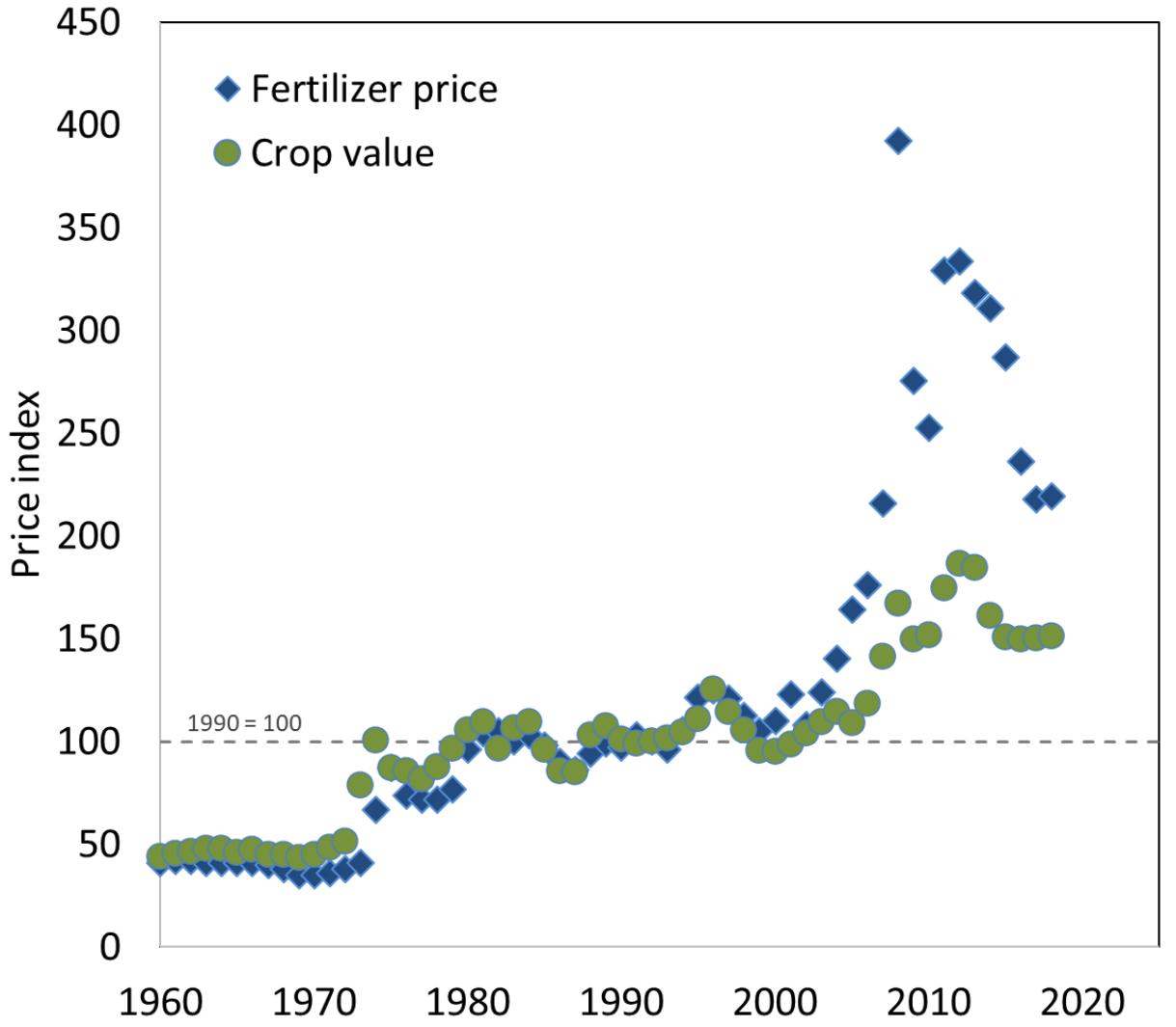
Soil fertility testing serves as the foundation of nutrient management in modern agricultural production systems.

When methods, interpretations, & recommendations are based on local field calibration, soil testing provides valuable information needed to develop a sustainable fertility management program.



Getting it right is more important now than ever

Cost of fertilizer rising faster than the value of crops

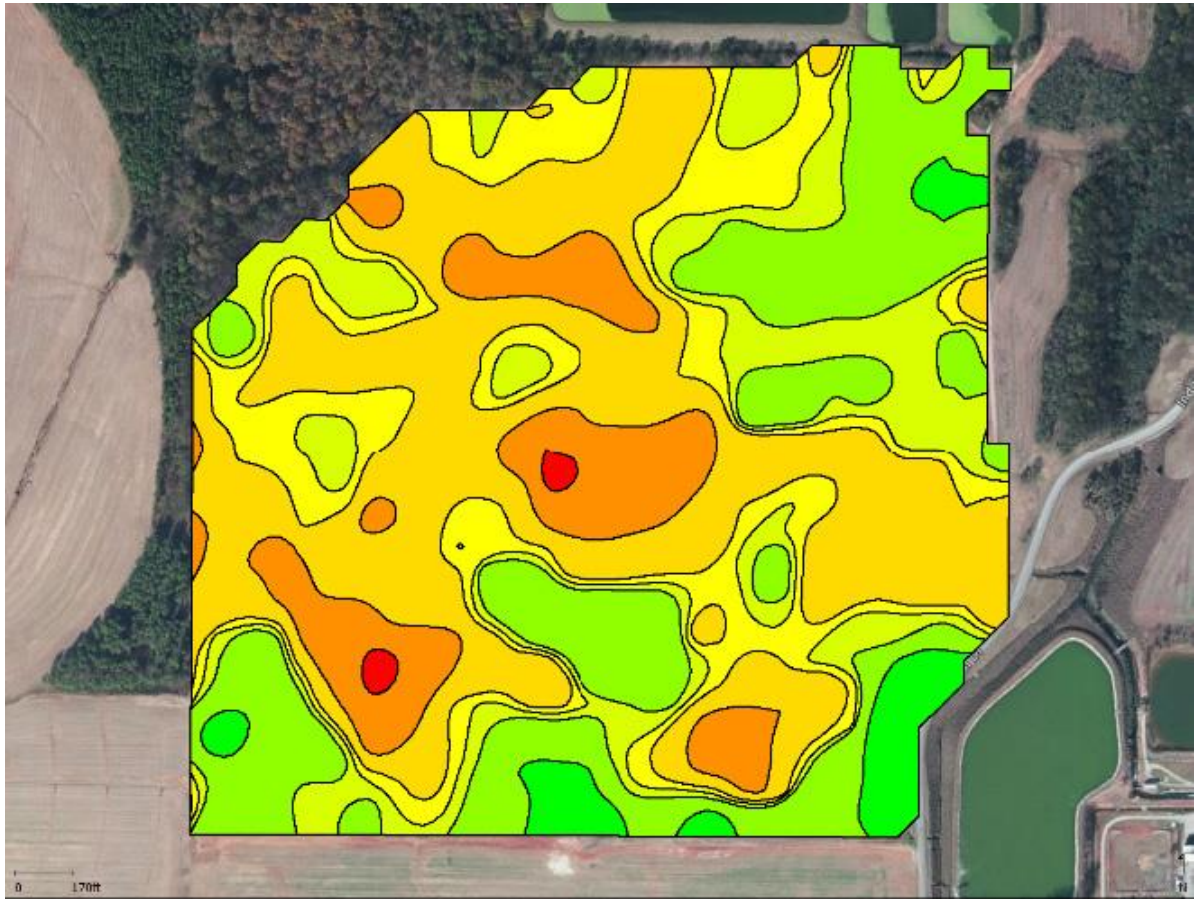


(Summarized from USDA-ERS data)

Getting it right is more important now than ever

Large percentage of P & K are applied using variable rate.

We can vary fertilizer applications at a very fine resolution, but we can't (precisely) predict nutrient need at that same scale.

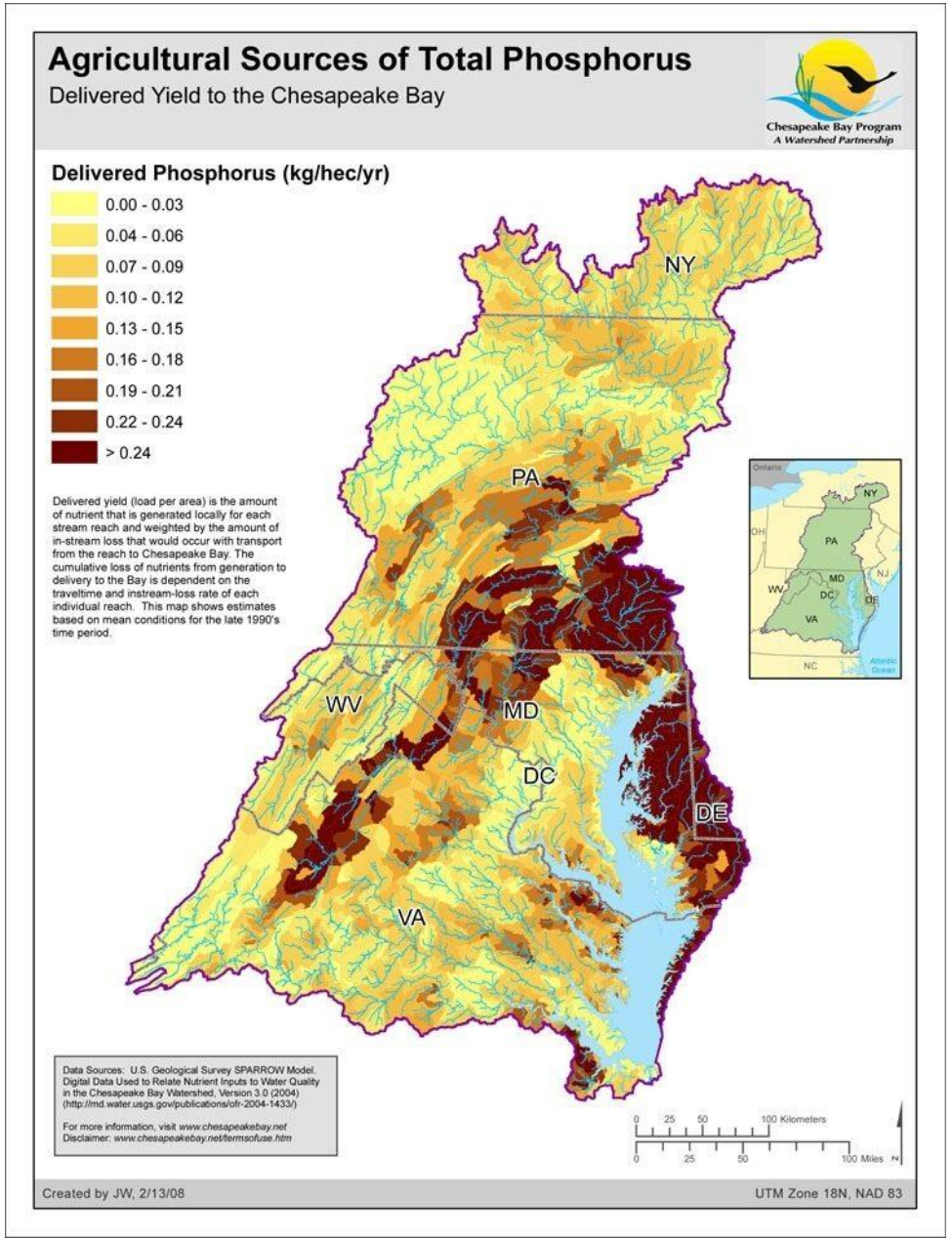


https://ohioline.osu.edu/factsheet/fabe-565

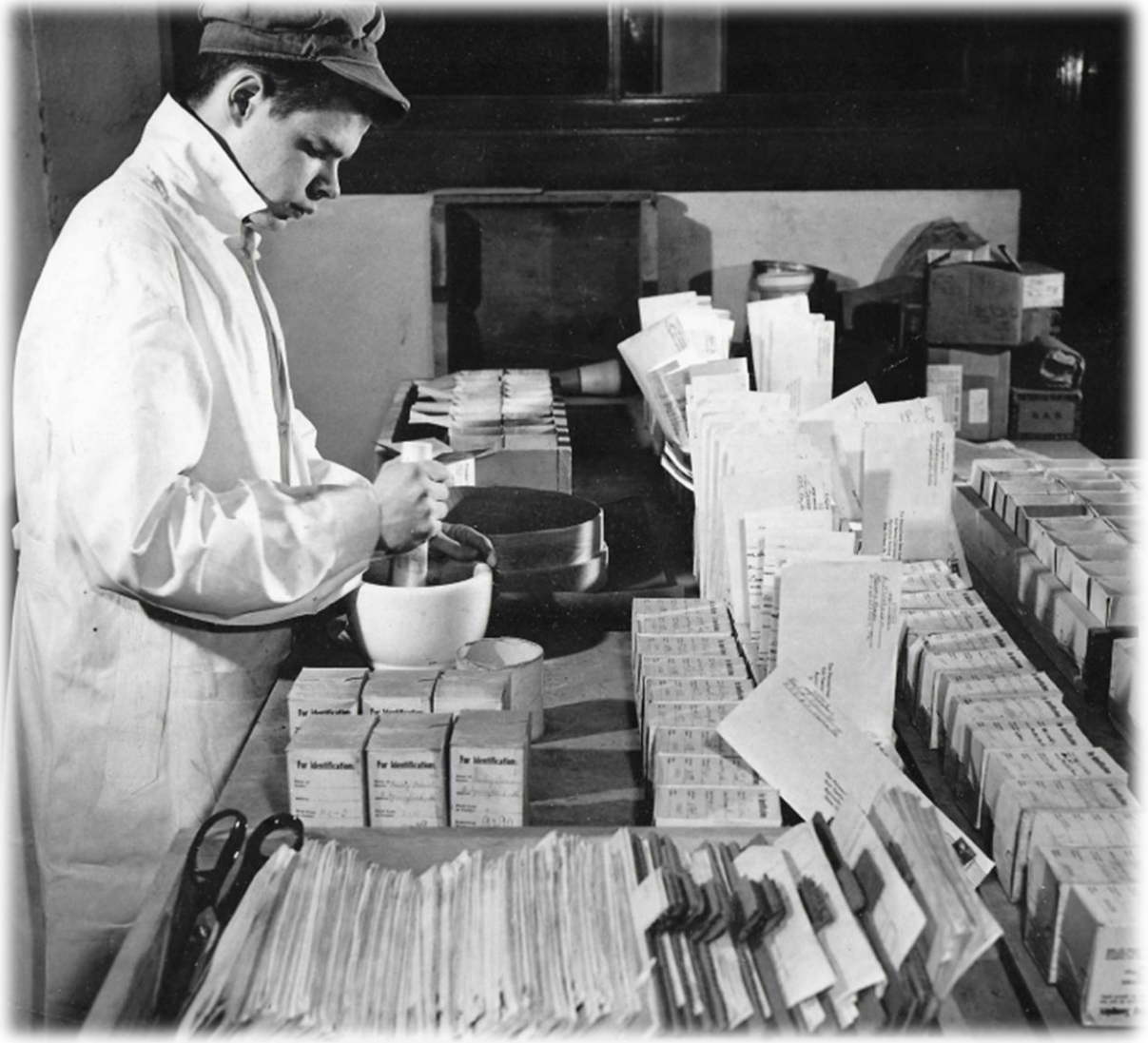
Getting it right is more important now than ever

Ongoing concerns about nutrient management/water quality

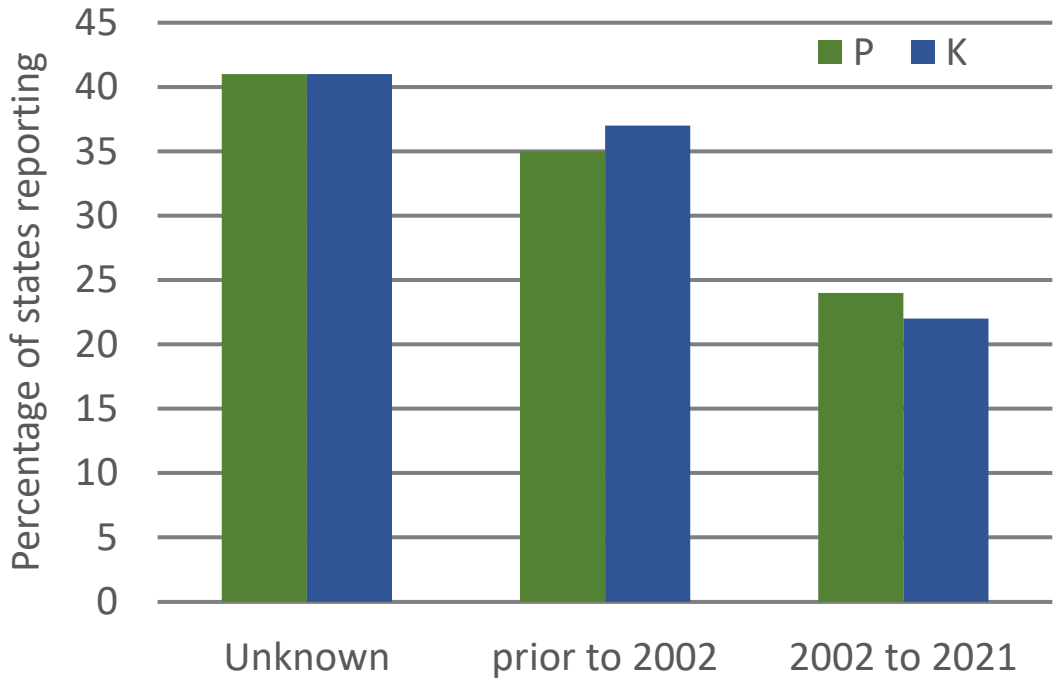
West Branch Susquehanna River, Lycoming Co., PA (Chesapeake Bay Program)



However, most soil fertility recommendation systems for P and K are based on decades-old soil-test correlation/calibration data with limited coordination between states.



When were the current soil test P & K correlation established or last validated?



Percentage of states reporting year current soil test P & K correlation established or last validated for field corn

Received: 20 October 2022 | Accepted: 11 February 2023
DOI: 10.1002/saj2.20536
Soil Science Society of America Journal
ORIGINAL ARTICLE
Soil Nutrient Management & Soil & Plant Analysis

Current status of US soil test phosphorus and potassium recommendations and analytical methods

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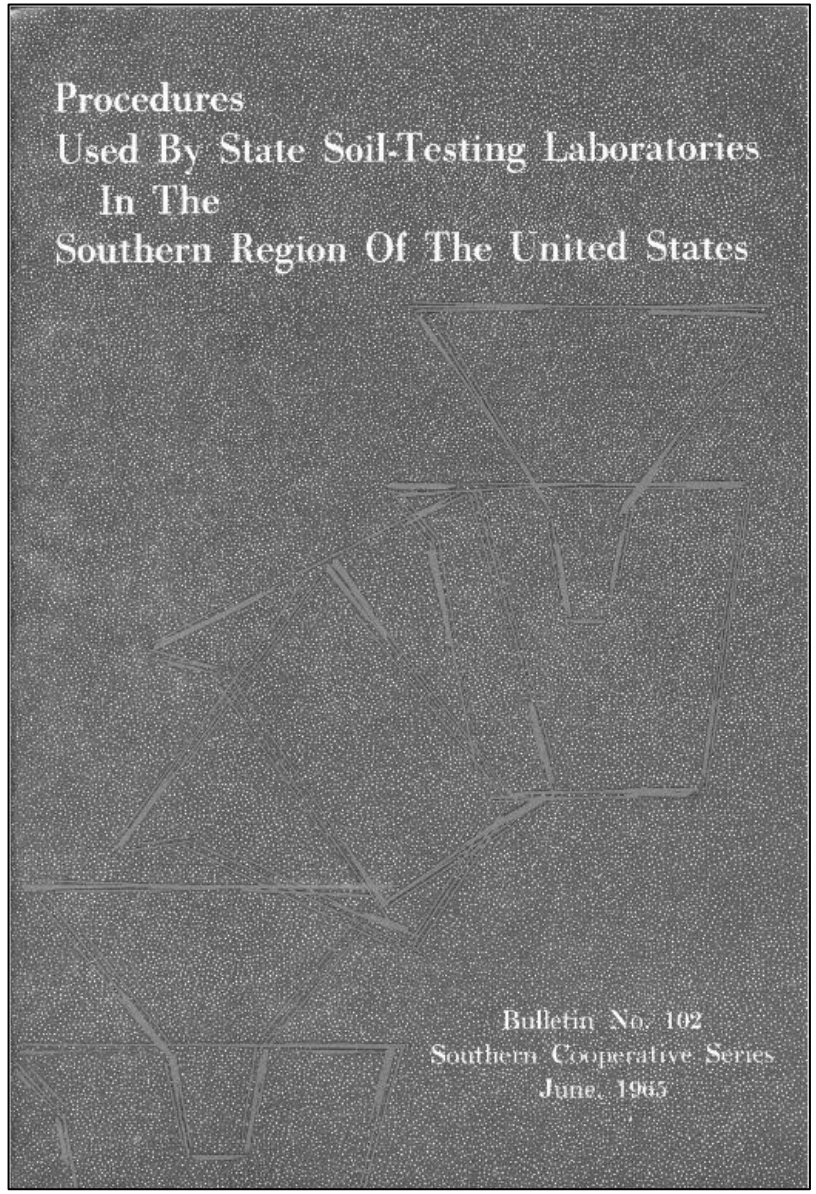
Assigned to Associate Editor Carl Bolster.

Funding information
Natural Resources Conservation Service, Grant/Award Number: 69-3A75-17-45; Agricultural Research Service, Grant/Award Number: 58-8070-8-016

Abstract
Soil testing is the foundation of fertilizer recommendations in the United States. Fertilizer recommendations have primarily been developed by land-grant universities with limited coordination among programs. The individual state approach to develop fertilizer recommendations has resulted in discrepancies in recommended soil sampling protocols, soil analysis methods, and fertilizer recommendations at similar soil nutrient levels. A national survey was developed to summarize the status of soil testing and fertility work in the United States to inform future collaborative efforts among states and regions and identify opportunities to harmonize recommendation guidelines. Topics included relevant funding, multi-state collaborations, state soil-test recommendations and related data, fertilization philosophies, and analytical and soil sampling methods. Responses from 48 states and Puerto Rico showed inconsistencies across state boundaries in every category. The number of faculty full-time equivalents working in soil fertility now averages 1.3 per state, a 21.5% decrease every 10 years since the 1950s. Land-grant university soil-test-based phosphorus (P) and potassium (K) recommendation philosophies were categorized as *Sufficiency* (37%), *Build and Maintain* (19%), hybrid (20%), or multiple philosophies for which recommendations are provided (20%). Respondents in two states did not know the recommendation philosophy (4%). Fertilizer-P and K recommendations for corn (*Zea mays* L.) were based on eight different extractants with differences across and within regions. While there have been some successful regional efforts in the past, additional multi-state collaborative efforts are needed to identify research gaps and develop comprehensive strategies to update soil-test correlation and calibration data to address modern agronomic, economic, and environmental concerns.

“You can’t really know where you are going until you know where you have been.”

Maya Angelou

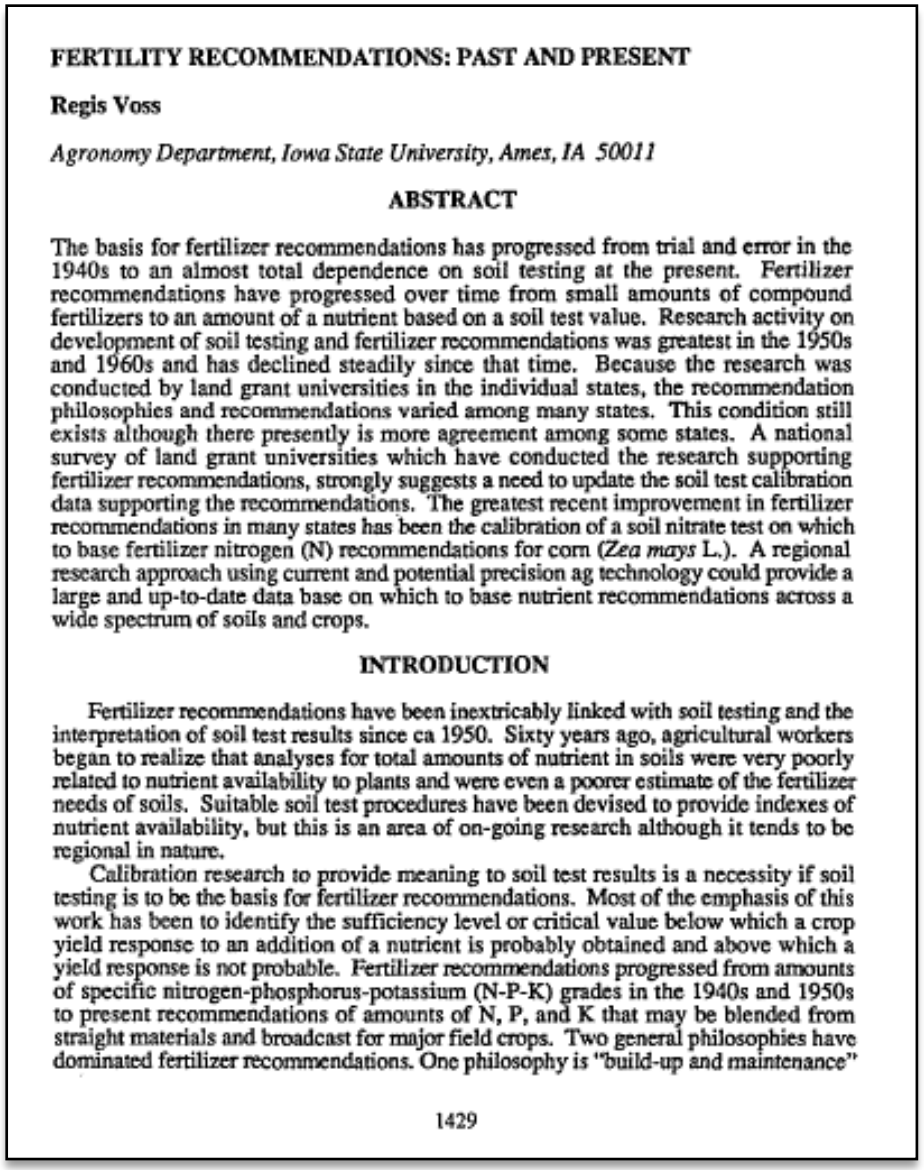


Despite the progress which has been made, the candid observer must admit that there are troubles ahead for soil testing. One of these troubles is a lack of uniform recommendations when state lines are crossed. This is evident even when given soil types extend from one state to another. While it probably is idealistic to look for uniform recommendations on a given soil as one goes from state to state, it also is foolish for adjacent states to ignore the problem that exists.

G.W. Thomas (TAMU), 1965

http://aesl.ces.uga.edu/sera6/publications.asp

"If resources become available, it is strongly suggested that the research be done regionally as opposed to each individual state and that current data management systems be used so that at any future date the data and analysis can be reviewed and that research data can be added to the data bank. This approach will ensure data access and nutrient management supported by an up-to-date database." R. Voss (Iowa State), 1994



FERTILITY RECOMMENDATIONS: PAST AND PRESENT

Regis Voss

Agronomy Department, Iowa State University, Ames, IA 50011

ABSTRACT

The basis for fertilizer recommendations has progressed from trial and error in the 1940s to an almost total dependence on soil testing at the present. Fertilizer recommendations have progressed over time from small amounts of compound fertilizers to an amount of a nutrient based on a soil test value. Research activity on development of soil testing and fertilizer recommendations was greatest in the 1950s and 1960s and has declined steadily since that time. Because the research was conducted by land grant universities in the individual states, the recommendation philosophies and recommendations varied among many states. This condition still exists although there presently is more agreement among some states. A national survey of land grant universities which have conducted the research supporting fertilizer recommendations, strongly suggests a need to update the soil test calibration data supporting the recommendations. The greatest recent improvement in fertilizer recommendations in many states has been the calibration of a soil nitrate test on which to base fertilizer nitrogen (N) recommendations for corn (*Zea mays* L.). A regional research approach using current and potential precision ag technology could provide a large and up-to-date data base on which to base nutrient recommendations across a wide spectrum of soils and crops.

INTRODUCTION

Fertilizer recommendations have been inextricably linked with soil testing and the interpretation of soil test results since ca 1950. Sixty years ago, agricultural workers began to realize that analyses for total amounts of nutrient in soils were very poorly related to nutrient availability to plants and were even a poorer estimate of the fertilizer needs of soils. Suitable soil test procedures have been devised to provide indexes of nutrient availability, but this is an area of on-going research although it tends to be regional in nature.

Calibration research to provide meaning to soil test results is a necessity if soil testing is to be the basis for fertilizer recommendations. Most of the emphasis of this work has been to identify the sufficiency level or critical value below which a crop yield response to an addition of a nutrient is probably obtained and above which a yield response is not probable. Fertilizer recommendations progressed from amounts of specific nitrogen-phosphorus-potassium (N-P-K) grades in the 1940s and 1950s to present recommendations of amounts of N, P, and K that may be blended from straight materials and broadcast for major field crops. Two general philosophies have dominated fertilizer recommendations. One philosophy is "build-up and maintenance"

1429

Commun. Soil Sci. Plant Anal., 29:1429-1440

Is there a fertile future for the discipline of soil fertility?

Paul Fixen, International Plant Nutrition Institute Americas

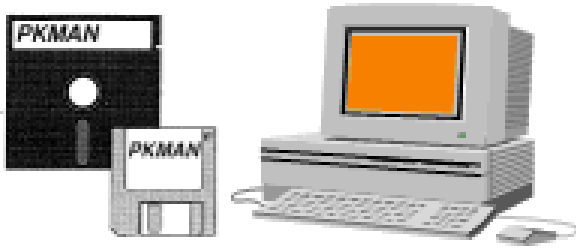
Leo M. Walsh Soil Fertility Distinguished Lectureship

Tampa, FL
4 Nov. 2013

In the 90's the Potash and Phosphate Institute (PPI) created PKMAN, a decision support tool for nutrient management.

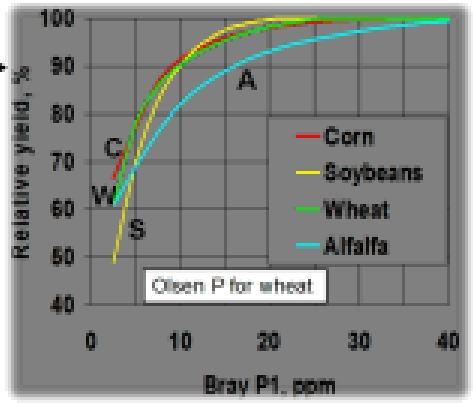
Lack of access to soil test calibration data severely limited its utility. Could be used for teaching purposes but it had limited value for usable recs due to lack of data.

PKMAN (1990s)



A tool for improving the accuracy of P and K soil test interpretation

- Most important output = Estimate of the **optimum soil test level**
- Major inputs:
  - Calibration information
  - Yield potential
  - Net crop price, P and K costs
  - Total uptake and removal
  - First year recovery
  - Minimum return on investment
  - Interest rate and land tenure
  - P_2O_5 or K_2O per ppm soil test level



Major obstacle: access to calibration data

PPI, 1994

The GRDC (Grains Research & Development Corporation) created a national web-based application to support soil test calibration.

Includes legacy calibration data from refereed literature, grey literature, and unpublished. Curated and screened to meet established minimum data requirements: meta data (soil type, location, weather), statistical validity, yield (Y_o and Y_{max}), recognized soil test, sampling depth, etc.

FRST
FERTILIZER RECOMMENDATION SUPPORT TOOL

Long term trials | Annual trials | Add New Data | Home | Logout

Welcome to Making Better Fertiliser Decisions for Cropping Systems in Australia, 12 November 2015

BFDC Interrogator

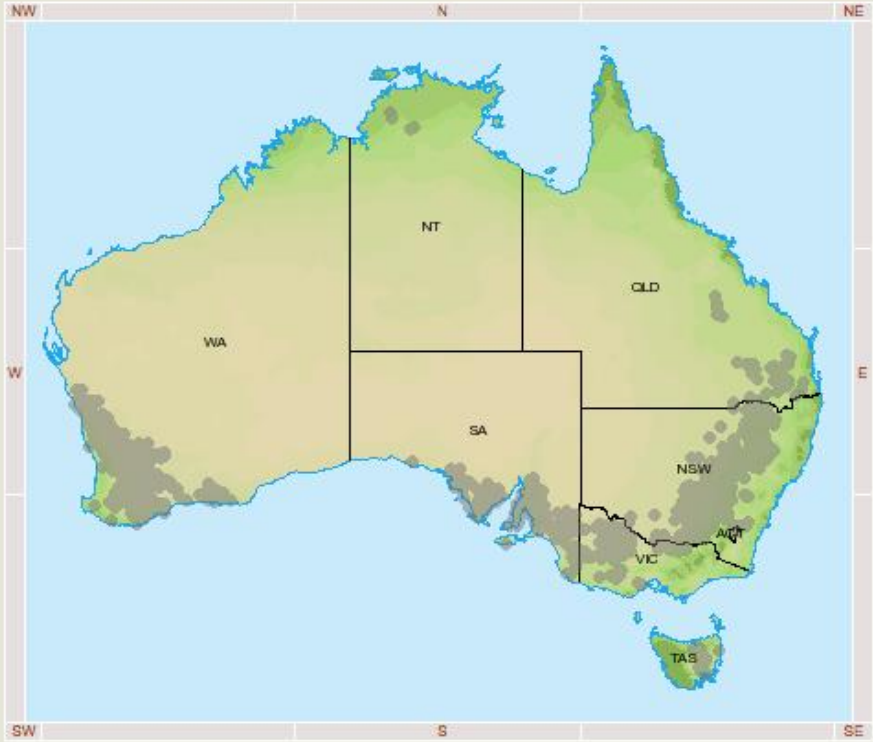
Wheat crop near Kapunda, SA, © Geographic Web Solutions

The BFDC database holds extensive historic data for 5698 key nitrogen (N), phosphorus (P), potassium (K) and sulphur (S) trial treatment series for different grain crops and soil types across Australia. Each trial has a soil test and relative grain yield data that enable users to determine the critical soil test values for a range of management and growing conditions. These include farming system, growing season rainfall and paddock history.

The trial sites are geo-referenced within the the database. A user can specify trials of any geographic area by drawing a polygon on the map. Map layers showing rainfall isohyets, crop yield maxima, trial soil type, and nutrient responsiveness can assist the user to best judge the geographic area of interest.

The Interrogator helps users to interpret soil test results for N, P, K and S. It does not provide a fertiliser recommendation. All users are encouraged to consult a Fertcare Accredited Advisor for fertiliser management advice.

The BFDC project is supported by the Grains Research and Development Corporation. It is led by NSW DPI and includes substantial collaboration with the fertiliser industry, consultants, state and federal agencies, agribusiness, and universities. These collaborators have contributed the data held in the database.



Currently logged in as: **Rob** Logout change password change contact details

FRST
FERTILIZER RECOMMENDATION SUPPORT TOOL

Soil test-crop response trials

The database holds 5698 trial treatment series undertaken at 1227 distinguishable geographic locations, many being nearest town. The treatment series are collated from 1795 N, 2386 P, 365 K and 286 S trials.

Searching the database

Trial sites are plotted on the map as grey dots. Make a selection of trials based on the search criteria below and/or by drawing a polygon on the map around your region of interest. Always begin with a broad selection, then narrow the criteria to search the selection in more detail.

Nutrient: P
Farming System: All
From Year: All
To Year: All
State: All
Season: All

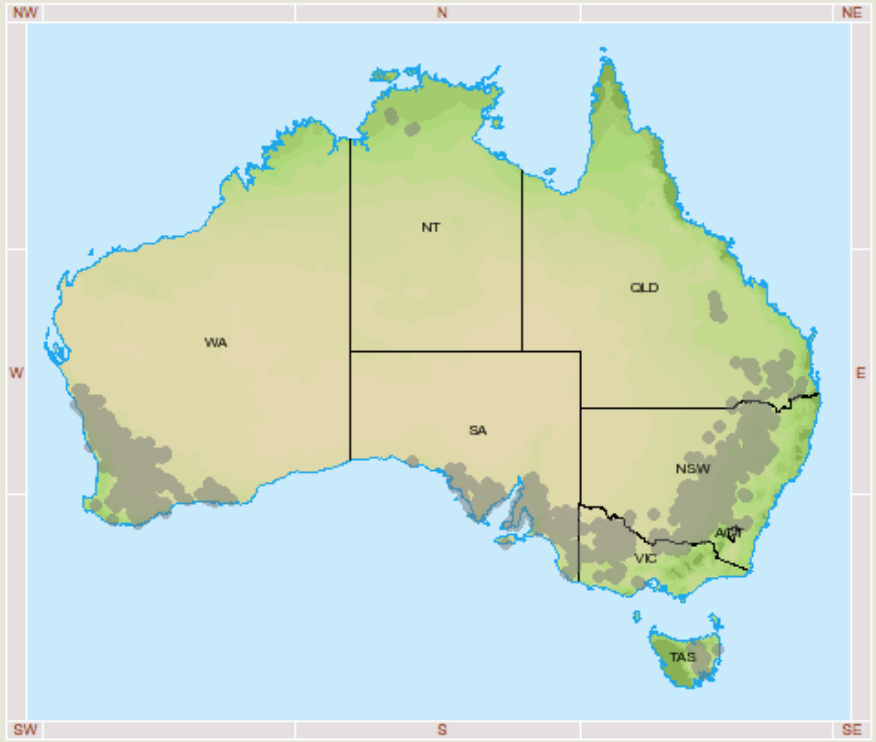
Crop:

- cereal maize
- cereal oats
- cereal sorghum
- cereal triticale
- **cereal wheat**
- grain legume bean narbon
- grain legume chickpea
- grain legume faba bean

Australian Soil Class:

- All
- Calcarosol
- Calcarosol calcic
- Calcarosol hypercalcic
- Calcarosol hypocalcic
- Calcarosol lithocalcic
- Calcarosol supracalcic
- Chromosol

Select trials that satisfy the selection criteria above



[clear] [undo] [complete] Map tools: Draw Polygon

Optional Layers | Legend

☐ Rainfall ☐ Road ☐ Vegetation

A polygon can be drawn on the map when the 'Draw Polygon' tool is selected from the Map tools menu. When doing a trial selection, only those trials falling within the polygon will be selected. To draw the polygon, click on the map to define three or more points that form a boundary around the geographic area of interest. To complete the polygon, always click the '[complete]' text below the map. The polygon boundary must not cross over itself.

Norton et al.

FRST
FERTILIZER RECOMMENDATION SUPPORT TOOL

<<back

Soil test-crop response calibrations

414 P trials fit your initial selection criteria. Their locations with Australian Soil Class are plotted on the map.

You may wish to:

- list selection summary information
- map Australian Soil Classification
- map relative yields
- map maximum yields

To choose a new region draw a polygon and refresh the trial selection.

Graph soil test value by:

(•) Relative Yield ( ) Yield Increase

Choose soil test and sample depth:

P Colwell mg/kg (531)

0-7.5cm(adj.)+0-10cm

View data relationship:

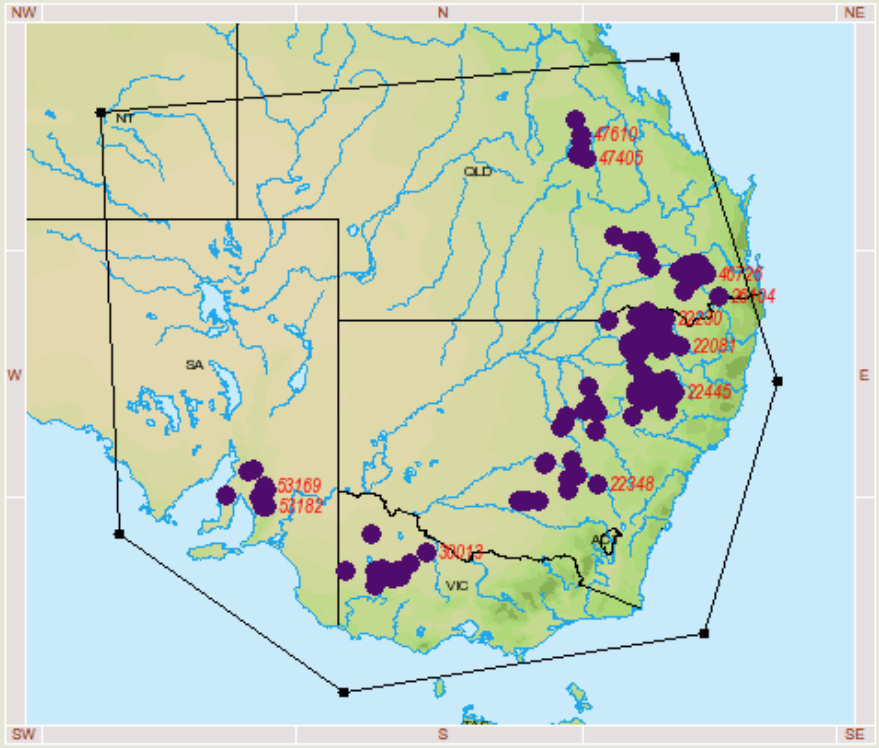
- plot data by crop
- plot data by soil type
- tabulate data

Limit max soil test value: [ ] (enter max soil test value for the plot)
Limit plot to most responsive treatment series per trial: [ ]

Show supplementary data relationship curves for the most common crops ( )
Show supplementary data relationship curves for the most common soils ( )

Hide supplementary data relationship curves for crops, soils or below filters (•)

Refine your trial selection for determining a data relationship:



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<<back

Soil test-crop response calibrations

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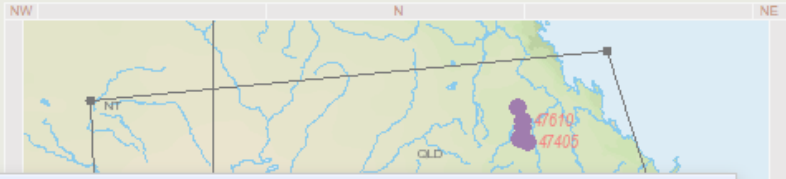
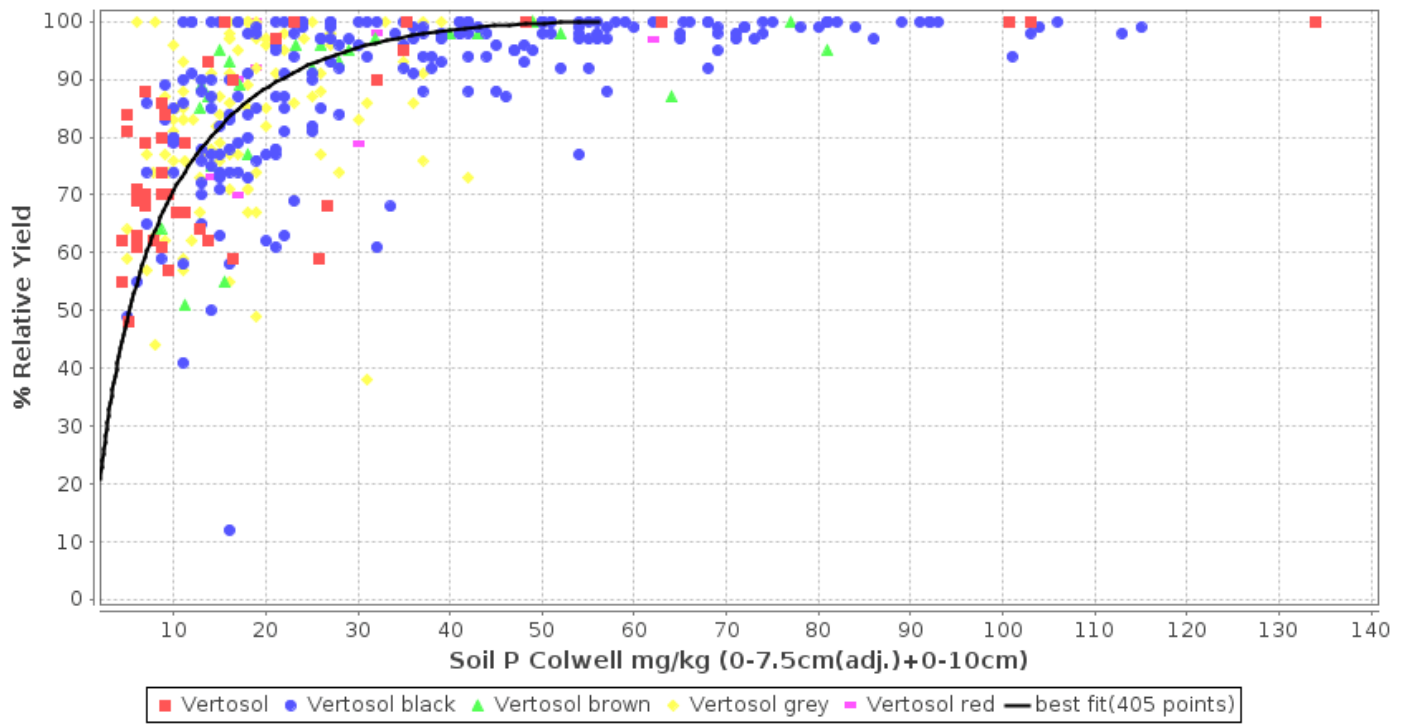


You

print

405 P Treatment Series



Soil test calibration:

80% Relative Yield: 14.0 (12.0 - 16.0)
90% Relative Yield: 22.0 (20.0 - 24.0)
95% Relative Yield: 29.0 (26.0 - 32.0)

Correlation R: 0.61

Regression equation: $x = e^{(3.0834(\arcsin(\sqrt{(y/100)})) + -0.77859)}$

Slope RY(50-80): 3.4 (2.9 - 3.9)

70% confidence limit at 90% Relative Yield: 22.0 (21.0 - 23.0)

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relationship curves will be plotted for the filter item selected. For example you may want to show the trends for each of the three most common soil textures if these data are available.

FRST
FERTILIZER RECOMMENDATION SUPPORT TOOL

The connection has timed out

The server at www.bfdc.com.au is taking too long to respond.

- The site could be temporarily unavailable or too busy. Try again in a few moments.
- If you are unable to load any pages, check your computer's network connection.
- If your computer or network is protected by a firewall or proxy, make sure that Firefox is permitted to access the web.

Try Again

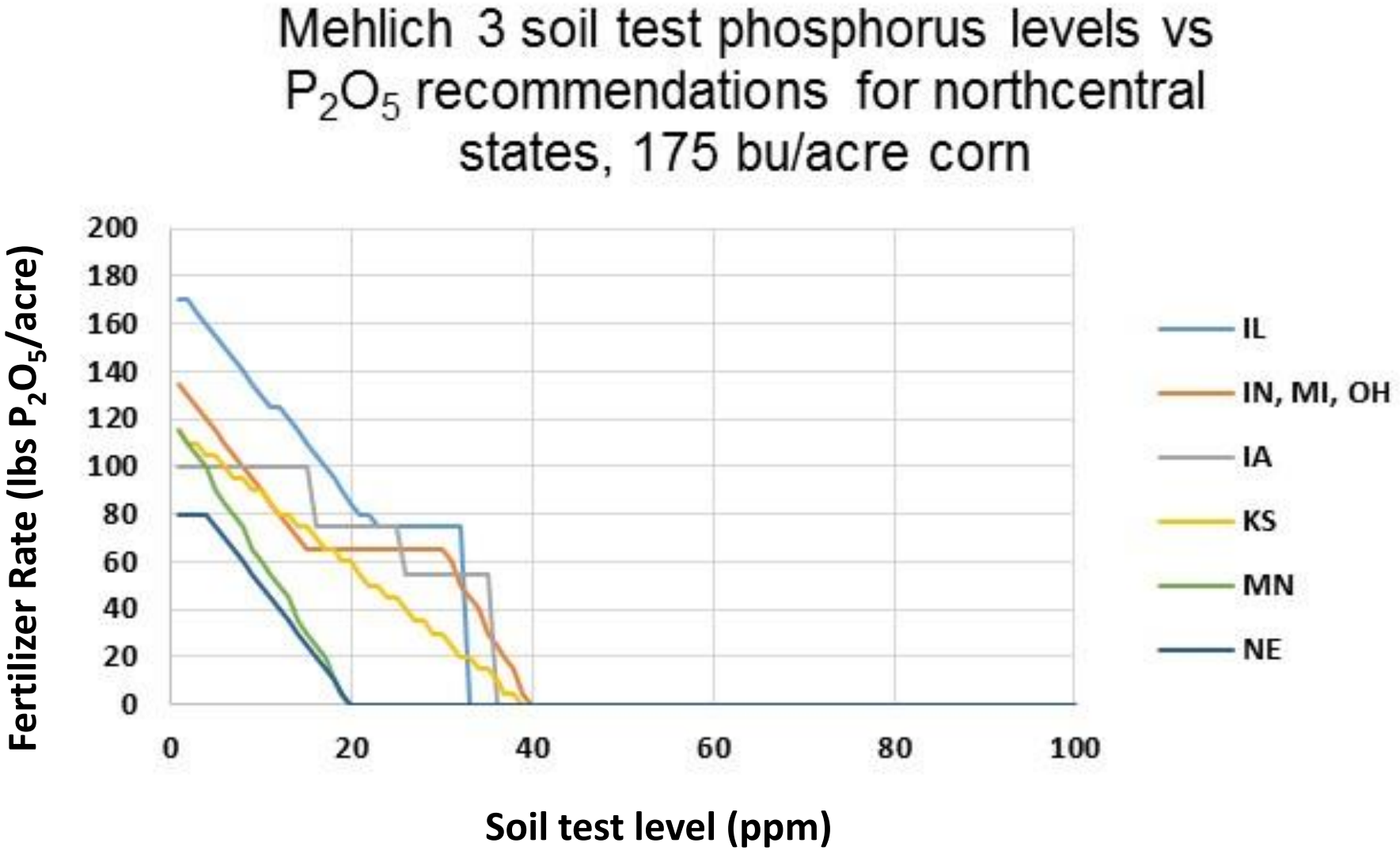
ASA Meetings
Long Beach, CA
5 November 2014

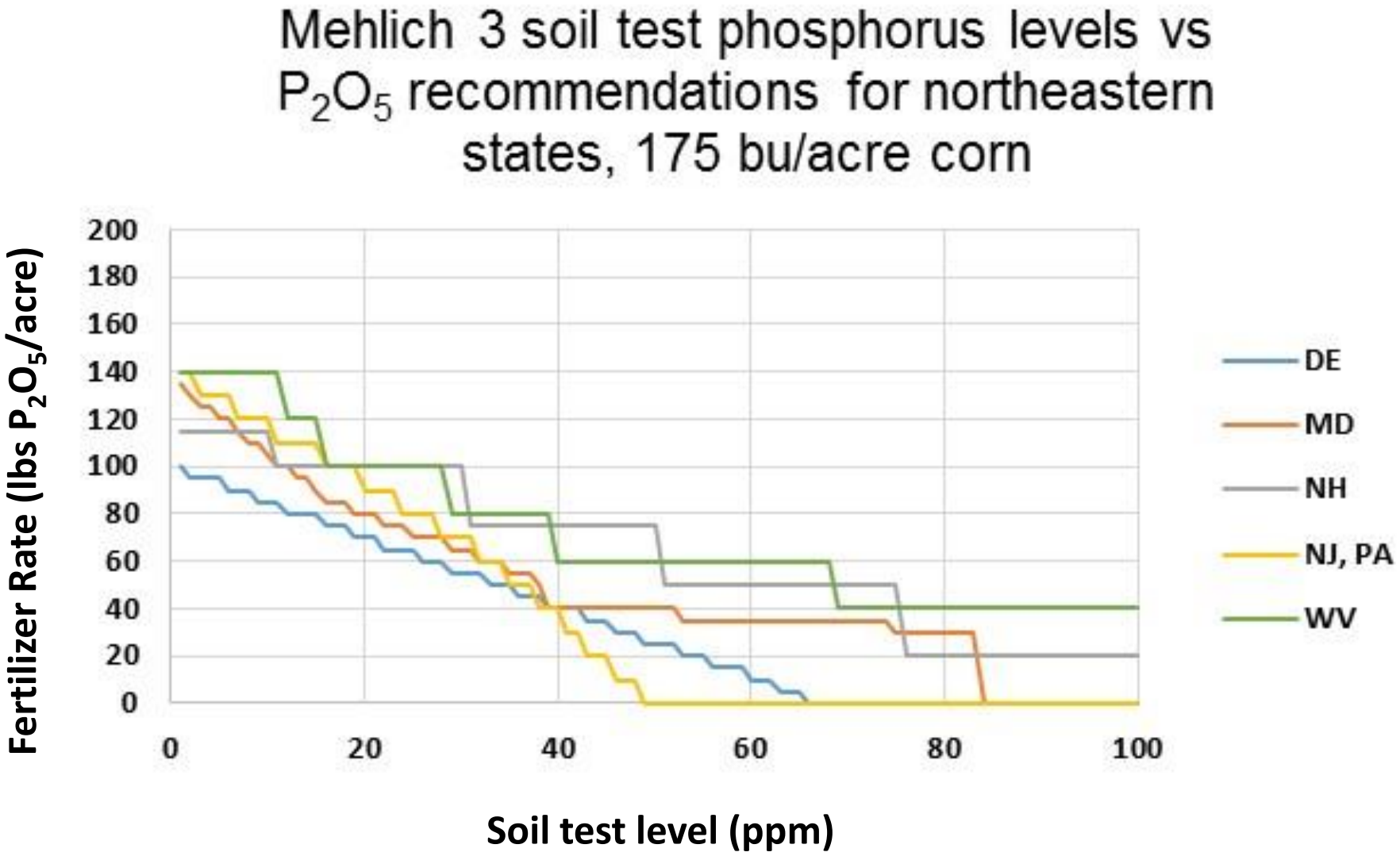
Land Grant University Fertilizer Recommendations:

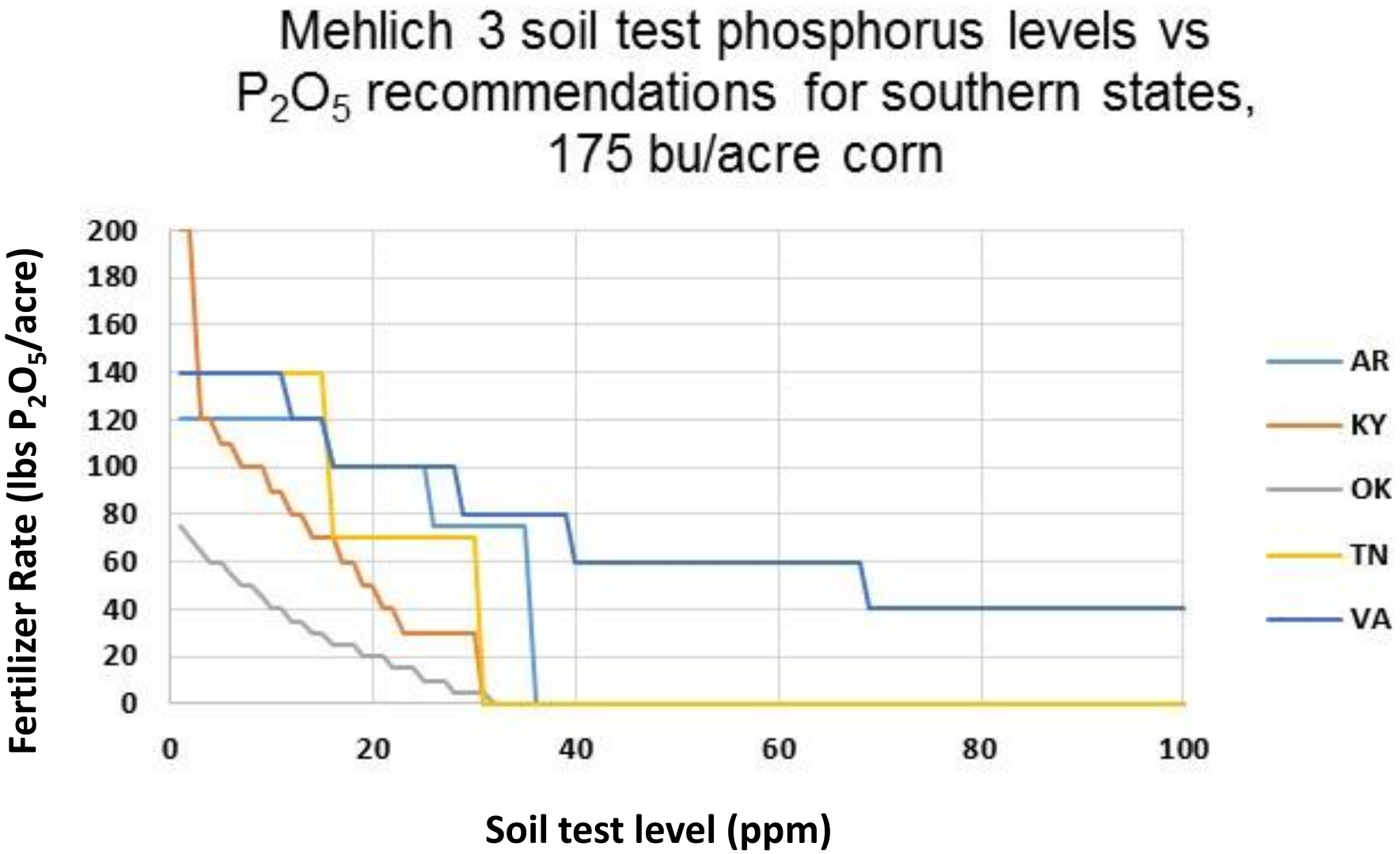
An overview and call to action

Brad Joern and Phil Hess
Department of Agronomy

PURDUE
UNIVERSITY


Mehlich 3 soil test phosphorus levels vs P_2O_5 recommendations for northcentral states, 175 bu/acre corn
Fertilizer Rate (lbs P_2O_5/acre)
200
180
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
Soil test level (ppm)
IL
IN, MI, OH
IA
KS
MN
NE


Mehlich 3 soil test phosphorus levels vs P_2O_5 recommendations for northeastern states, 175 bu/acre corn
Fertilizer Rate (lbs P_2O_5/acre)
200
180
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
Soil test level (ppm)
DE
MD
NH
NJ, PA
WV


Mehlich 3 soil test phosphorus levels vs P_2O_5 recommendations for southern states, 175 bu/acre corn
Fertilizer Rate (lbs P_2O_5/acre)
200
180
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
Soil test level (ppm)
AR
KY
OK
TN
VA

Land Grant University Fertilizer Recommendations:

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Brad Joern and Phil Hess
Department of Agronomy

PURDUE UNIVERSITY

Selection of Brad's take home messages:

- LGU recs. almost exclusively state-based
  - History, pride, bias (institutional imperialism)
  - "Magic happens at state borders"
- LGU recs. often used for regulations — never designed for this purpose
- Recs. are too prescriptive and lack flexibility
  - *Build and Maintain* vs. *Sufficiency*
- Need to provide growers more flexible guidelines and better tools. Are we willing to do this?

ASA Meetings
Long Beach, CA
5 November 2014

Indiana CCA Conference
Indianapolis, IN
16 December 2014

Mid-Atlantic Crop
Management School
Ocean City, MD
19 November 2014

Joint Soil Test Meeting
State College, PA
2016

Land Grant University Fertilizer Recommendations:

An overview and call to action

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Department of Agronomy

PURDUE UNIVERSITY

MODERNIZING FERTILIZER RECOMMENDATIONS

OPTIMIZING INVESTMENTS OF PHOSPHORUS AND POTASSIUM

JOHN SPARGO, PETE KLEINMAN, DOUG BEEGLE, JIM SHORTLE AND GARY THOMPSON

OBJECTIVES - ***Develop the foundation for consistent, comprehensive fertilizer recommendations that represent the state-of-the-science and relate to advances in agronomic, genetic, and other technologies. Scale up from local efforts to national and international frameworks.***

(1) Update fertilizer response relationships to account for advances in fertilizer management and crop genetics.
(2) Improve soil testing to establish transparency and promote consistent fertilizer recommendations.
(3) Develop a comprehensive database system that channels historical and new sources into transparent and consistent fertilizer recommendations.
(4) Promote fertilizer stewardship across all forms of agriculture.

December, 2014

2016 Joint Regional Soil Test Working Group Meeting

Northeastern (NECC-1312), North Central (NCERA-13), & Southern (SERA-6) regions

State College, Pennsylvania

July 18th – 20th

Wednesday Morning, July 20, 2016

8:00 *A brief history of soil testing, beginning with see, smell, and taste, and culminating with soil health testing* – Charles Mitchel, Auburn University

8:40 *Land grant university fertilizer recommendations: An overview and call to action* – Brad Joern, Perdue University

9:20 *Better fertiliser decisions for cropping systems in Australia* – Tom Bruulsema, IPNI

10:00 Break

10:20 Discussion, *Soil test correlation and calibration in the 21st Century*

11:20 ALP update – Robert Miller, ALP

11:40 NAPT update – Grant Cardon, Utah State University

12:00 Adjourn

SERA-17 Meeting

Phoenix, AZ. November 10, 2016

Doug Smith	Introduction	8:00-8:10
Matthew Scholz	Building a new partnership for P sustainability	8:10-8:30
Discussion 1: P fertility – soil tests/interpretation/WQ impacts		
Tom Bruulsema	Defining 4R Phosphorus Practices for Sustainable Improvement of Water Quality	8:30-8:50
Antonio Mallarino	Interpreting soil-test P results for agronomic and water quality preservation	8:50-9:10
Amy Shober	Perspectives on soil fertility recommendations from the 2016 Joint Regional Soil Testing Work Group Meeting	9:10-9:30
	Discussion	9:30-10:00
	Break	10:00-10:15

SERA-17 Meeting

Phoenix, AZ. November 10, 2016

Discussion 2: Active and needed research for P fertility, agricultural provisioning and natural resource protection		
Quirine Ketterings	P fertility field strip trials in New York	10:15-10:45
Josh McGrath	Evaluating STP critical levels at a national scale through regional collaborations	10:45-11:15
	Discussion	11:15-11:45
	Lunch – On Your Own	11:45-1:00
Discussion 3: The role of big data		
~~John Spargo~~ Josh McGrath	An open access database of soil test calibration to support better fertilizer decisions.	1:00-1:20
Phillip Owens	Evaluating soil-landscape systems and functional relationships for understanding the fate of P	1:20-1:40
	Discussion	1:40-2:10

Southern CIG-P Working Group Meeting

Athens, Georgia. June 12th – 13th, 2018

June 12th

1:30 *Background and Introduction, including discussion on need for soil test validation and regionalized interpretations* – Deanna Osmond

2:30 *Philosophies of soil test interpretations* – Robert Florence

3:00 *Networking*

3:30 *Round Robin on state soil test methods and nutrient recommendation philosophy*

4:30 *Comparison of LGU soil test recommendations for corn and soybean – Brad Joern*

6:00 Dinner

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Southern CIG-P Working Group Meeting

Athens, Georgia. June 12th – 13th, 2018

June 13th

8:00 *Summary of day one* – Deanna Osmond

8:30 *Soil test interpretations for hay and other crops* – Tony Proven, Deanna Osmond, Leticia Sonon, Hailing Zhang

9:30 *Networking*

10:00 *Sub-regionalization for soil test recommendations – Deanna Osmond*

11:00 I*mproving current soil test methods and calibrations: How do we proceed?* – Deanna Osmond, Haiying Zhang

12:00 Adjourn

“…it can in fact be done provided the will exists.”

Paul Fixen

Effective leadership is essential.

Thank you, Deanna and Nathan!

Question or comments?