2011 Kansas Fertilizer Research Fund Proposal

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a. Project title: Taking a New Look at P and K Fertilization of Corn and Soybeans

b. Principal Investigators:
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c. Introduction with project justification:

Kansas is a naturally P deficient region. The soils of Kansas contain significant quantities of P, but it is generally present in relatively unavailable or slowly available forms. For example a Smolin silt loam at the Agronomy North Farm with a P soil test level of 25 ppm, has a total mineral P content of 670 ppm.

In the 50 years after original settlement, soil fertility decreased in Kansas and crop yields gradually declined (Figure 1). Early work linked this trend in reduced yield to a decline in soil organic matter and N availability (Swanson, 1915). While the decline of organic matter and N was critically important, the important complimentary role played by P, both P mineralized from soil organic matter and available from mineral sources was yet to be realized. Workers in Iowa later showed that up to 50% of the P supplied to crops by soils came from mineralization of soil OM, especially when soils contained high levels of soil OM, such as common in native Prairie derived soils. As soil OM has decreased, the relative importance of P mineralization has declined, and the role of mineral P and fertilizers has increased.

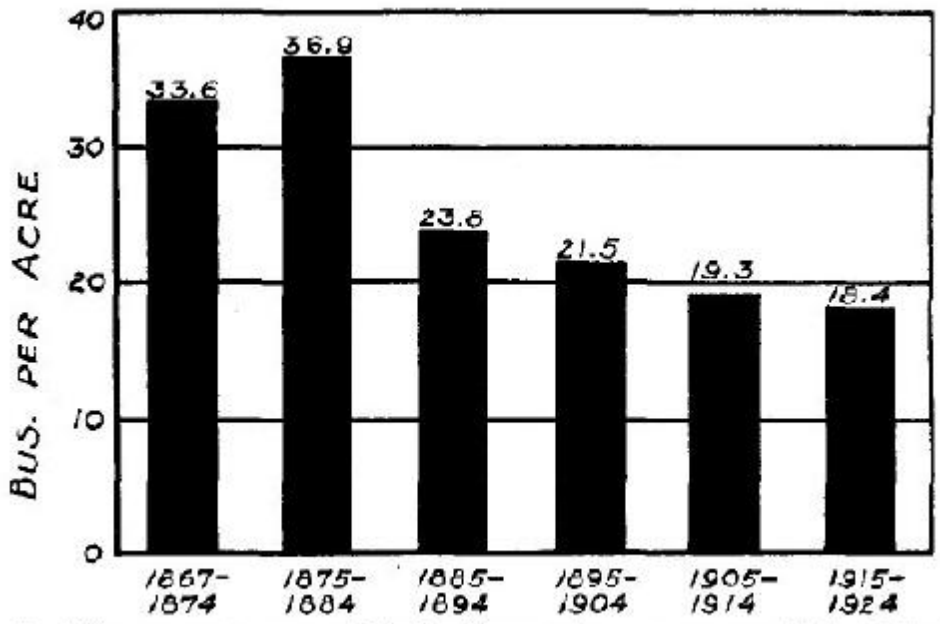

FIG. 5.—The average corn yields in Kansas by ten-year periods, 1865-1924.

Figure 1, Kansas corn yields by decade, 1865–1924. Figure from KS AES Bullet

TABLE I.—DECREASE IN NITROGEN AND ORGANIC MATTER IN KANSAS SOILS DUE TO CULTIVATION. (a)

County and Soil Type.	Cropping system.	Pounds per acre.	
		Nitrogen.	Organic matter.
Russell, Sedgwick clay loam	Native buffalo pasture	4,260	98,400
	Wheat 30 years	2,960	64,400
Allen, Oswego fine sandy loam	Native meadow	3,760	83,600
	Corn and broom corn	2,440	46,400
Butler, Sedgwick clay loam	Native pasture	4,280	106,400
	Corn and forage crops	2,800	66,800
Greenwood, Osage silty clay loam	Native meadow	4,600	113,600
	Corn 30 years	3,400	73,200
Average	Native	4,495	108,050
	Cultivated	3,108	69,500

(a) Swanson, C. O. The loss of nitrogen and organic matter in cultivated Kansas soils and the effect of this loss on the crop-producing power of the soil. Jour. of Indus. and Engin. Chem. 7: 529-532. 1915.

Table1. Abbreviated version of Table 1, KS AES Bulletin 260, 1932

Soil testing as a tool to estimate P availability to crops was first utilized in Kansas in the late 1920's and early 1930's. Initially ST was based from County Extension offices using soil test kits. This process evolved to labs operated in the extension office in many counties, particularly in the eastern 2/3 of Kansas. However in the early 1940's a centralized lab, initially for research staff and counties that did not elect to operate a county lab was started in Waters Hall. This two tiered system of local and state labs remained in place until the last county lab, located in Cherokee County closed.

Fertilizer recommendations were initially developed by the AES in KS and utilized data from throughout the state. The traditional soil test based fertilizer recommendations used in Kansas for the past 75 years have focused on economical crop response to P, and later K and other nutrients, with little concern over the impact of the recommendations on ST levels. In general when followed, they result in ST levels equilibrating at some level below the critical level, or below the level capable of meeting the nutrient needs of a crop. Today 80% of the farmers utilizing the KState Soil Testing lab still request Nutrient Sufficiency recommendations.

Recent surveys of all ST labs working in Kansas, including commercial labs only offering "Build and Maintain" recommendations, show that approximately 55% of the 82,000 soil samples tested each year from KS for P have ST levels below the accepted critical level of 20 ppm, and would be expected to respond to direct applications of P (IPNI, 2010). Rates recommended using todays version of these traditional "Nutrient Sufficiency" recommendations would vary from 0 to 80 pounds P2O5 per acre per year, depending on crop grown, expected yield and ST P level.

While Kansas calls itself the wheat state, in recent years, as many acres of corn, and soybeans, aggregate, are grown as wheat. However, considerably more research data on P and K fertilizer response at different soil test levels is available on wheat than any other crop. With considerably higher revenue per acre and fertilizer use on corn and soybeans as compared to wheat, it raises the question are our current fertilizer recommendations and application practices recommended adequate? Especially since over application of P has potentially negative impacts on surface water quality.

One of the basic, underlying assumptions of a traditional Nutrient Sufficiency recommendation system is that all crops grown will be fertilized each year when soil test levels are below the critical level. Discussions with many Kansas farmers, especially soybean growers, over the past five years have indicated that many growers believe soybeans and potentially grain sorghum will not respond to direct applications of P, especially starter fertilizer, and fertilizer is only applied to the more responsive crops in the rotation such as corn or wheat. Some growers fertilize these responsive crops with the intent of supplying the nutrients needed for the rotation. The soybeans, and some cases sorghum, in the rotation are not fertilized directly, but are expected to benefit from an increase in soil fertility.

Recent work in Kansas would suggest that these widely held beliefs are not correct, and failure to fertilize soybeans and grain sorghum directly at low soil test levels is likely resulting in lower yields for many farmers. An on-going study initiated in 2006 and conducted at three locations in Kansas has addressed this issue of direct vs residual response of soybeans. At the NC KS Experiment Field near Scandia, under supplemental Irrigation, high yielding soybeans grown at low ST P levels, have consistently responded to an annual application of P, in addition to the rotational applications applied to corn the previous year (Table 2). A similar experiment conducted at the ECK Experiment Field near Ottawa though, has shown very different results. At much lower yield levels, but similar soil test levels, no response to the additional P applied to beans has been seen. This suggests that responses are likely to be more soil specific than previously believed.

Treatment	Corn Yield, bu/acre	Soybean yield, bu/acre
No p applied to either crop	227	59
Broadcast 40 lb P2O5 to corn only	258	64
Broadcast 80 lb P2O5 To corn only	263	71
Broadcast 80 to corn Broadcast 40 to beans	268	74

Table 2. Corn and soybean response to applied P, Scandia KS 2009.

A second study conducted on a farmers field in Franklin Co. within two miles of the Ottawa long-term study, was conducted to look at the response of soybeans to starter fertilizer. The results given below in Table 3, show a 6 bushel response to 100 lbs of 7-21-7 per acre applied at planting. The soil test at this site ranged from 4-7 ppm across the plot area.

Lb P2O5 applied as	Soybean yield,

Starter fertilizer	Bu/acre
0 P	31
21 lb P_2O_5	37
LSD alpha 0.1	4

Table 3. Response of soybeans to starter fertilizer at low ST levels, Franklin Co. KS 2008

These experiments clearly suggest that applying all the fertilizer to corn or wheat in a rotation, and not fertilizing soybeans directly, either by broadcasting P or using a starter fertilizer, could be limiting soybean yields in Kansas. However that response is not universal.

Increasing yields, changing genetics, and changes in production systems such as the introduction of new crops, reduced tillage and shifting planting dates all raise questions regarding the accuracy of our current soil test based fertilizer recommendations. Using a small portion of the Fertilizer Check-off dollars to take a second look at some of these issues seems to be a valid use of those funds.

d. Project goals and objectives:

- Take a second look at the correlation and calibration of the P and K soil tests, particularly for soybeans and corn. This would include confirming or adjusting the critical P or K soil test level, and adjusting P or K application rates as impacted by soil test.

- Determine if there is a particular range of soil tests where starter fertilizer applications should be used with corn and/or soybeans. Currently KS has no specific recommendations regarding starter fertilizer use at low soil test levels.

- Determine if there is a particular range of soil test levels where both crops must be directly fertilized rather than relying on residual fertilizers applied to the previous crop. Traditional recommendations assume annual fertilization.

e. Procedures:

This proposal is a request for funding to examine the role of phosphorus and/or potassium fertilization in corn and soybean production in Kansas, particularly how soil test level interacts with fertilization practices such as starter fertilizer use and direct annual fertilization as compared to the more common multiyear or rotational fertilization.

The majority of the field trials will be conducted on cooperating farmer fields in the eastern 2/3 of Kansas. The focus will be to address the basic questions outlined in the Objectives above. Our proposed research plan for the 2012 and 2013 crop years is to:

Identify a number of potential cooperating farm sites (5-7) located in the primary corn and soybean producing areas in Kansas. At each of these sites a multiyear (2-3 years) P and/or K study will be established. These sites will be characterized by a range of soil test levels, though the majority will be in the medium, low and very low ranges (approximately 5-20 ppm P, 50 to 80 ppm K). In addition to low soil test (ST) P, preferred sites would be characterized by high yield potential and regular crop rotation including corn/soybean and corn/wheat dc soybean or corn/soybean/wheat rotations.

Where possible, paired fields on similar soils with similar ST levels using similar management practices would be established at each site so that all crops in the rotation used could be present each year to remove weather as a major variable when looking at multi-year or rotational fertilization. Since low ST P levels are common across the state, these experiments will be conducted across the major soybean producing areas in Kansas. When both P and K ST levels are low, the response to both nutrients will be examined.

Specific treatments to be applied will be a series of P and/or K rates applied annually to establish a basic response curve or function to that nutrient, for the specific crop at that specific ST level. Additional treatments will include multiple year applications at several rates applied before each of the crops in rotation to determine if specific crops respond best to direct versus residual fertilization. A third variable will be to determine if the crops will respond to starter fertilizer, alone or in combination with broadcast P or K. Starter fertilizer placement used will be surface banding of liquid ammoniated poly phosphate approximately 2 inches to the side of the seed row. Total number of treatments applied at a site will be approximately 16.

Traditional small plot field experiments will be laid out in the identified fields. The project will soil test the proposed plot area during the site selection process to determine the approximate ST level. In addition, soil tests will be taken by individual plot prior to applying treatments in the spring of 2012, to quantify soil variability. The farmer will plant the field as normal to the variety of his/her choice. The farmer will be responsible for normal cultural practices (weed control, insect or disease control etc). Individual plot size will vary to account for differences in the cooperating farmers planting equipment. For example, if a farmer has a 6, 12 or 24 row planter, plot size will be 6 rows, 50 foot long. However if he has 8, 16 or 32 row equipment, plot size will be 8 rows wide by 50 foot long.

Once planted all fertilizer treatments and sampling will be applied/done by the project team. Measurements made to determine treatment effects will include: Soil test levels before treatment application; early season (4-5 leaf stage on corn, 3rd trifoliate stage on soybeans) growth and nutrient content; leaf N, P and K level at pod set and late pod fill

in soybeans and silking in corn; grain yield; grain nutrient content to calculate removal values; grain moisture; test weight; and final soil test levels.

The residual effects of multiyear treatments will be measured by determining the effects of those multi-year treatments on the rotational crops, and soil test levels. No additional P or K applications will be made to the multi-year broadcast treatment plots. However additional P or K fertilizer will be applied to the annual application treatments.

In the second year, the plots established in year 1 will be rotated to corn or soybeans. The annual applications will be reapplied, while the rotation crops will be grown on residual fertility from the multiyear application rates. As in the first year, measurements made will include: intial ST levels; early season growth and nutrient content; crop yield; grain moisture at harvest as an indication of crop growth rate; and final soil test level.

There will be a planned technology transfer component of the project:

- Each year a report from each site will be included in the Kansas Fertilizer Research Report.
- Eupdates will be developed as appropriate
- Reports will be made at CCA training and ANR Agent Agronomy Updates.
- The data will become part of the permanent data record used for reviewing fertilizer recommendations
- Extension bulletins will be written as warranted.
- Sites and PI's will be available for local field days or other extension activities.

f. Duration of the project:

Two crop years, 2012 and 2013

g. Expected Outputs and Outcomes:

- Updated soil test based phosphorus and potassium fertilizer recommendations for corn and soybeans in Kansas.

- A better understanding of how frequently crops must be fertilized (every year or every other year in rotation) as a function of soil test level, especially when using the traditional KSU Nutrient Sufficiency Recommendations.

- A better understanding of at what soil test levels starter fertilizers will enhance early growth and how that relates to subsequent crop yield.

h. Project Budget

Proposed Budget Summary	Year 1	Year 2	Total
A. Salaries and Wages: Total [1]	$2,000	$2,000	$4,000
Principal Investigator(s)	$0	$0	$0
Other Professional(s):	$0	$0	$0
Pre-baccalaureate Student(s)	$2,000	$2,000	$4,000

B. Fringe Benefits [2]	$26	$26	$52
C. Expendable Materials and Supplies Soil Testing, plant analysis fertilizer, tractor fuel, equipment repairs, flags, bags, stakes etc	$4,000	$4,000	$8,000
D. Travel [3] Travel to plot locations and to regional soil fertility meetings	$3,974	$3,974	$7,948
E. Subcontracts	0	0	0
F. All Other Direct Costs	0	0	0
G. Total Amount of Request	$10,000	$10,000	$20,000
Capital Equipment	0	0	0

[1] Based on current student labor at $8/hr

[2] Current fringe benefit rates are 1.3% on undergraduate students.

[3] Travel costs based on a minimum of 6 trips to each site each year using departmental assigned vehicle ($0.35 per mile plus fuel) or reimbursed personal vehicle use @$0.51. Hotel and per diem charges may also be included.