



Personnel:

Drs. María Villamil and Emerson Nafziger (PIs)

Dr. Carmen Ugarte (Research Specialist)

Project Objectives:

The goal of this project is to work with producers and retailers to improve N, P, and K fertilizer recommendations for Illinois. Specifically, we seek to modernize P and K removal rates by analyzing P and K concentrations in corn, soybean, and wheat grain samples collected from producers across Illinois. This information is essential for nutrient replacement plans and optimal crop management.

Summary of Progress and Preliminary Results (Period 01/01/2014 to 02/15/15):

Sample collection is underway and will continue through the year. We solicited grain samples from producers – one pound per sample per crop with yield specifications– through the Bulletin website <http://bulletin.ipm.illinois.edu/>. We also reached out to certified crop advisers and extension educators, who actively participated on identifying and collecting samples from producers across the state. Additionally, we partnered with staff from Centrec Consulting Group, LLC to obtain additional corn and soybean samples of known yield. A summary of the number of samples collected and analyzed to this date is detailed in **Table 1**. Average yields for corn, soybean, and wheat were 240, 63, and 90 bushels/acre respectively and were notably higher than the state average for 2013 and 2014. State yield averages for 2014 were 200, 56, and 67 bushels/acre for corn, soybean, and winter wheat (USDA-NASS, 2015). Successfully, we were able to collect samples from all nine Cropping Reporting Districts (CRD) with a greater sampling intensity for CRDs 1, 4, and 5 for corn while soybean samples were more evenly distributed across all CRDs (**Table 2**).

Figure 1 shows the relationships between corn and soybean yield (bushels/acre) and P and K concentrations in grain (expressed as pounds P₂O₅, and K₂O/bushel) in samples collected in 2014. Grain yield for both crops was not related to P₂O₅, and K₂O concentrations in harvested grain as revealed by the low values of the Pearson correlation coefficients and their non-statistically significant levels. Although preliminary, these values of nutrient removal along with appropriate soil testing can guide soil management for optimal nutrient budgeting.

Estimates of P₂O₅ and K₂O per bushel of corn and soybean in this study were lower than the benchmark values suggested in the Illinois Agronomy Handbook (Fernandez and Hoefl, 2009) (**Table 3**). Similarly, our results revealed lower concentrations than those suggested in neighboring states like Mallarino et al. (2011) in Iowa and Houx III et al. (2014) in Missouri soils although the magnitude of differences was much narrower than differences associated with the Illinois expected values.

We further compared our results to those of other surveys in Illinois. Mean estimates of P₂O₅ removal in harvested corn and soybean for were higher than those reported by Fernandez (2012) while estimates of K₂O removal were higher for corn, but lower for soybeans. Our nutrient content values for corn were comparable to those of Bender et al. (2013) in research conducted at the University of Illinois Research



Centers in Urbana and Dekalb. By studying the behavior of our data set through visual evaluations of variability and histogram plots (**Figure 2**) we estimate that about 97% of corn samples removed less than the expected P₂O₅ value for Illinois (0.43 lb P₂O₅/bu) while all the corn samples tested below the expected removal value of 0.28 lb P₂O₅/bu. Similarly, for soybean, 99% of the samples removed less than the expected 0.85 lb P₂O₅/bu and 1.30 lb K₂O/bu respectively. Moreover, the range of our data set encompassed those values reported in other locations of the North Central Region (Bender et al., 2013; Clover and Mallarino, 2013; Fernandez, 2012; Houx III et al., 2014; Mallarino et al., 2011) validating current estimates of nutrient removal from corn and soybean fields. The geographical sampling distribution in the current data collection effort represents actual nutrient removal rates in commercial crop producing fields in Illinois and we will further validate these results with new data collected on a second data collection campaign.

Preliminary data - Not for distribution.

Table 1. Summary of samples collected across grain producing counties in Illinois during the 2014 cropping period.

Crop	Samples to date (N)	Samples analyzed (N)	Counties sampled (N)	Yield (bu/acre)
Corn	692	589	81	240
Soybean	432	279	80	63
Wheat	19	15	9	90

Table 2. Geographical distribution (%) of samples collected by Cropping Reporting District (CRD) in Illinois.

	CRD1	CRD2	CRD3	CRD4	CRD5	CRD6	CRD7	CRD8
	-----Percentage (%)-----							
Corn	28	5	10	15	14	10	4	7
Soybean	15	11	12	13	15	11	11	8
Wheat	0	5	0	11	26	11	21	5



Table 3. Preliminary summary of P and K removal through crop harvest in the 2014 growing season. Values represent mean P and K content expressed as pounds of P₂O₅ and K₂O per bushel (dry matter basis) of harvested grain. For comparison, values from three additional sources are provided.

Crop	This study	IL Agronomy Handbook (Fernandez & Hoef, 2009)	IL Survey (Fernandez, 2012)	IA (Mallarino et al., 2011)
-----lb P ₂ O ₅ /bu-----				
Corn	0.35	0.43	0.27	0.37
Soybean	0.72	0.85	0.69	0.79
Wheat	0.54	0.90	--	--
-----lb K ₂ O/bu-----				
Corn	0.21	0.28	0.19	0.24
Soybean	1.13	1.30	1.17	1.42
Wheat	0.31	0.30	--	--

Figure 1. Grain yield in relation to P₂O₅ and K₂O in harvested grain in corn and soybean samples collected across Illinois in 2014.

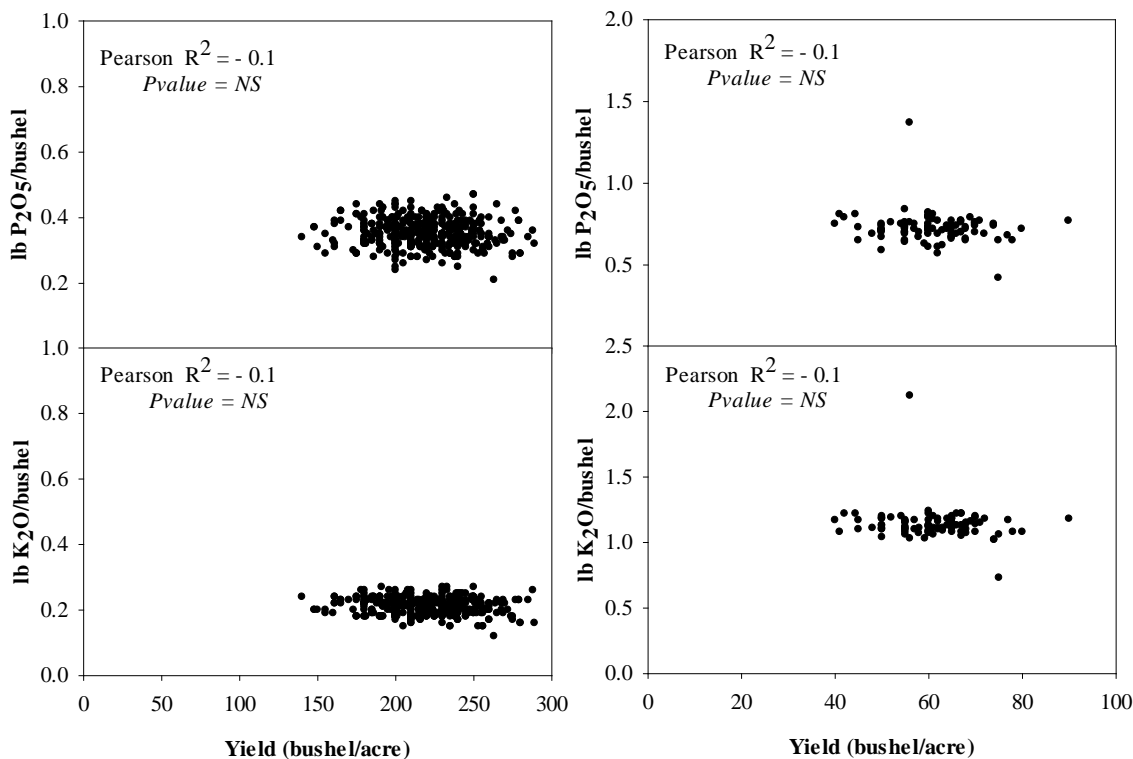
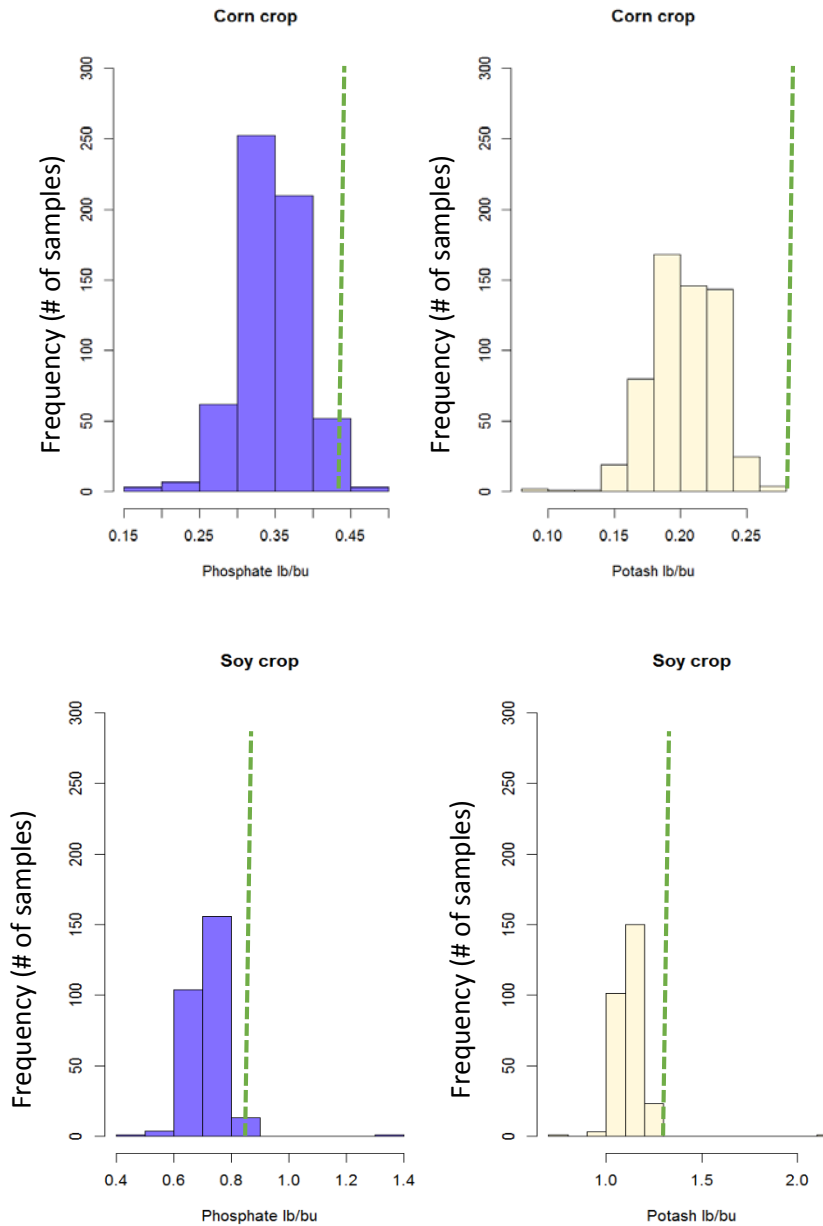




Figure 2. Data distribution for nutrient concentration (as pounds of P_2O_5 and K_2O /bushel) in corn and soybean harvested grain in samples collected across Illinois in 2004. Dashed green line in each histogram represents the recommended values in the Illinois Agronomy Handbook.





Activities Planned for 2015

We continue collecting and analyzing stored grain samples from producers. We have collected 200 grain samples with specified yields from each corn, soybean, and wheat from the variety testing (VT) program at the University of Illinois to test N, P and K content. These VT samples will allow us to see if variety has an effect on nutrient removal. We are working on several strategies to expand our sample collection efforts by contacting additional stakeholder groups and visiting grain elevators around the state of IL.

We expect to present summary data at appropriate producer venues as well as scientific conferences.

Budget Report See attached document.

References

- Bender, R.R., J.W. Haegerle, M.L. Ruffo, and F.E. Below. 2013. Nutrient Uptake, Partitioning, and Remobilization in Modern, Transgenic Insect-Protected Maize Hybrids. *Agron. J.* 105: 161–170.
- Clover, M.W., and A.P. Mallarino. 2013. Corn and Soybean Tissue Potassium Content Responses to Potassium Fertilization and Relationships with Grain Yield. *Soil Sci. Soc. Am. J.* 77: 630–642.
- Fernández, F.G., and R.G. Hoefl. 2009. Managing soil pH and crop nutrients. p. 91–112. In *Illinois Agronomy Handbook*. 24th Editi. University of Illinois, Urbana, IL. Available at:
<https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf>.
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- Houx III, J.H., W.J. Wiebold, and F.B. Fritsch. 2014. Rotation and tillage affect soybean grain composition, yield, and nutrient removal. *F. Crop. Res.* 164: 12–21.
- Mallarino, A.P., R.R. Oltmans, J.R. Prater, C.X. Villavicencio, and L.B. Thompson. 2011. Nutrient uptake by corn and soybean, removal, and recycling with crop residue. 2011 Integrated Crop Management Conference. Iowa State University. Available at: <http://www.agronext.iastate.edu/soilfertility/info/mallarino-2.pdf>.
- USDA-NASS. 2014. Illinois crop production: 2014 Summary. Available at:
http://www.nass.usda.gov/Statistics_by_State/Illinois/Publications/Current_News_Release/20150112-IL_Annual_Crop_Production.pdf.

NUTRIENT RESEARCH AND EDUCATION COUNCIL
"Updating P and K Responses and Crop Removal Numbers for Illinois"
Award Period: January 1, 2014 - December 31, 2014
Current Reporting Period: May 1, 2014 - December 31, 2014
INTERIM FINANCIAL REPORT

INVESTIGATOR: Maria B. Villamil

EXPENDITURES:	PRIOR PERIOD EXPENSES	CURRENT PERIOD EXPENSES	CUMMULATIVE EXPENSES
Salaries & Wages	\$0.00	\$19,132.44	\$19,132.44
Fringe Benefits	\$0.00	\$7,165.71	\$7,165.71
Material & Supplies	\$0.00	\$1,615.10	\$1,615.10
Travel	\$0.00	\$862.04	\$862.04
Services	\$0.00	\$2,146.36	\$2,146.36
 Total Direct	 \$0.00	 \$30,921.65	 \$30,921.65
Indirect	\$0.00	\$3,432.31	\$3,432.31
Total	<u>\$0.00</u>	<u>\$34,353.96</u>	<u>\$34,353.96</u>

AWARD:	
1/1/14-12/31/14	\$96,822.00
Interest Accrued to date	<u>\$2.29</u>
	\$96,824.29
Less Expenditures	<u>\$34,353.96</u>
BALANCE	<u>\$62,470.33</u>

This report was prepared from
 financial records of the
 UNIVERSITY OF ILLINOIS
 GRANTS AND CONTRACTS OFFICE

Sandra Moulton

Sandra Moulton, Senior Director
 Post-Award Administration