Profitability analysis of the experimental data -- 2014.
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The purpose of this section is to utilize soybean performance data for the various treatments and locations studied, to represent the costs and returns for production under each of the treatment systems, and to calculate expected profitability of these systems for a commercial scale farm. We accomplished this by first estimating costs and returns for each production system at each of the four locations (Hoytville and Piketon in Ohio; and ARS research sites in Indiana and Alabama).

Receipts are limited to the market value of soybean crops harvested from the plots, expressed on a per acre basis. A soybean price of $10.25/bu was used for 2014 calculations. Production costs are based on soybean crop enterprise budgets developed at each of the state Land Grant universities in the three states studied, all assuming a no-till production system and based on a machinery set appropriate for a farm size of 2,000 cropped acres. For plots receiving gypsum, a cost of $50 per ton of gypsum purchased and applied is charged. For cover crops, the cost of cover crop seed is charged, along with $4.50 per acre for a single pass with a no-till drill is levied. No difference in soybean seed costs were assumed for the high oil seed varieties. A cash rental charge, based on the 2014 USDA cash rental survey, is applied to represent the cost of land.

Table 1 presents a summary the costs of production assumed for each site and production method.

Table 1. Soybean production costs and returns used in profitability analyses[a]

	Ohio-Hoytville	Ohio-Piketon	Indiana	Alabama
	$ / Acre			
Receipts[b]	Yield X Price			
Variable Costs[c]	219	203	231	265
Fixed Costs[d]	281	229	365	152
Total Costs	500	432	596	417
Additional costs for various treatments:				
Gypsum[e]	$50 / ton delivered and applied			
Cover Crop[f]	Cost of cover crop seed + $4.50 per acre for No-Till Seeder pass			
High Oil Variety[g]	No additional costs			

a Production costs are based on a 2,000 acre corn/soybean farm using no-till farming practices. Estimates are published in the Ohio Enterprise Budgets (Ohio State University), 2014 Cost and Returns Guide (Purdue University) and 2013 Enterprise Planning Budget Summary (Auburn University).

b Soybean price is $10.25 / bushel for all sites in 2014. The only source of returns is assumed to be the market value of the crop.

c Variable costs include all costs for seed, fertilizer, agrichemicals, fuel and repair for the base production system. Additional costs for gypsum, cover crops and other treatments are added for applicable treatments.

d Fixed costs include 2 hours per acre of labor ($15/hour), machinery ownership costs, and a cash rental rate for land. 2014 cash rental rates used were 165, 114, 180, and 36.50 per acre for Ohio-Hoytville, Ohio-Piketon, Indiana and Alabama, respectively. The only residual input is management. Hence, our measure of profit is *Return to Management*.

e Transportation costs will vary with distance from gypsum source to farm. We have assumed a cost of $50/ton/acre for the material applied for all study sites.

f Cereal rye is used as the cover crop in Ohio and Indiana. Oil seed radish was used in Alabama

g No additional cost is applied for the high oil variety, nor is there assumed to be a premium price for the soybeans sold..

Results for the 2014 production year

Presented in Table 2 are the average yields and imputed per acre profitability for the four research sites. The year 2014 marked the third year of the study, and the third year of treatment with gypsum. These numbers are averages across all treatment types and replicates. Per acre yields were quite good in Hoytville, Ohio and Indiana, ranging from 54.9 to 56.9 bushel per acre,

but somewhat lower in Piketon, Ohio and Alabama, although the Alabama yields are still in alignment with Alabama state average yields. Per acre profitability ranged from -$139 (loss) per acre in Piketon (due to low yields) to $57.73/acre in Hoytville.

Table 2. Per acre average yields and profitability by test site, 2014

Site	Average Yields (bu/ac)	Average profit ($ / ac)
Alabama	36.41	-85.19
Hoytville, Ohio	56.90	57.73
Indiana	54.94	8.22
Piketon, Ohio	31.14	-138.81

Table 3 provides a breakout of yield performance and profitability by treatment type and state. Averaged across the four test locations, yields decreased slightly, though not significantly (*P=0.10*), with increases of gypsum from zero to 2,000 pounds per acre. Alabama, Indiana and Piketon, OH each saw the largest yields for plots with no gypsum application, but the largest yields at Hoytville were at the 1,000 pound gypsum application rate. However, the yield increases at Hoytville were insufficient to cover the increased costs of gypsum application: The greatest profitability at all four sites were with zero gypsum applied.

The test plots that employed a cover crop produced yields that were not statistically different from sites without a cover crop. Yields for cover cropped plots were larger at two sites: Indiana and Piketon. Calculated profitability was also increased at these two sites with the addition of a cover crop, indicating that the resulting yield increase (valued at the 2014 soybean price of $10.25 per bushel) was more than sufficient to pay the additional costs of establishing a cover crop.

For the average of yields at all four test sites, plots that were in soybeans following a 2013 corn crop resulted in higher soybeans yields (2.85 bu/acre) than did the continuous soybean plots. However, this difference was not statistically significant at the *P=0.10* level. Only Hoytville displayed a larger soybean yield for the continuous soybean rotation. Hoytville also showed an increase in profitability with continuous soybeans due to the small additional yield and somewhat lower fixed costs of machinery for the continuous soybean scenario.

Two soybean varieties were grown at each of the Ohio and Alabama sites: a high oil variety and a variety with traditional oil levels.[1] Across the three sites, the high oil variety yielded an average of 3.8 bushel per acre more per acre, although the means for high oil and traditional soybeans were not statistically different (*P=0.10*). The mean profitability was $38.53/acre greater for the high oil variety, but again this difference was not statistically different from zero at *P=0.10.*

[1] The Indiana site did not grow high oil soybeans in 2014.

Table 3. Per acre average yields and profitability by treatment for four test sites, 2014.

	All sites									
	Average Yields	Average profit	AverageYields (bu/ac)				Average Profits ($/ac)			
Treatment	(bu/ac)	($ / ac)	Alabama	Hoytville	Indiana	Piketon	Alabama	Hoytville	Indiana	Piketon
Gypsum=0 lbs/acre	44.05	-14.76	37.07	56.61	55.76	32.61	-53.47	79.73	41.60	-98.73
Gypsum=1,000 lbs/acre	43.28	-47.60	36.32	57.23	55.42	30.23	-86.18	61.10	13.12	-148.10
Gypsum=2,000 lbs/acre	42.89	-76.64	35.85	56.86	53.65	30.57	-115.93	32.36	-30.08	-169.62
Covercrop=no	43.04	-38.84	36.51	58.08	52.58	29.78	-62.09	76.09	-6.90	-146.49
Covercrop=yes	43.77	-53.82	36.31	55.72	57.31	32.50	-108.29	39.37	23.34	-131.13
Continuous Soybeans=no	44.83	-37.03	39.12	56.64	58.51	31.89	-62.72	49.75	39.51	-136.38
Continuous Soybeans=yes	41.98	-55.64	33.70	57.16	51.37	30.38	-107.66	65.71	-23.08	-141.25
High oil variety=no	39.60	-74.69	32.22	55.80		30.80	-128.19	46.42		-142.29
High oil variety=yes	43.36	-36.16	40.61	58.00	NA	31.48	-42.19	69.04	NA	-135.33

NA – The Indiana site did grow high oil soybeans in 2014.

The previous analyses do not adequately sort out the impacts of each of the treatments. That is, the averages in Table 3 look only at a single treatment regime. To sort out the individual impacts of treatments, and to apply tests of significance to these differences, a regression model is estimated for the combined yield and profitability results across the four production sites. Table 4 provides results for the soybean yield data. The model adjusted R-Square coefficient is 0.88, suggesting that about 88 percent of the variation in soybean yield is explained by this simple model. The model F-statistic is significant at the 0.01 probability level, suggesting that at least one of the estimated coefficients is significantly different than zero.

In order to control for differences in productivity and/or growing conditions across the four sites, three binary variables are included to represent the Alabama, Piketon and Indiana sites. The Hoytville, OH site is the excluded (comparison) location. The regression coefficient for Alabama was significant ($P<0.01$), indicating that, with all other treatments held constant, yields at that location were 20.5 bushel per acre lower than for the Hoytville site. Yields at the Piketon site were also significantly ($P<0.01$) lower (25.76 bu/ac) than for the Hoytville site. Indiana yields were not significantly different ($P=0.10$) from the Hoytville site.

The estimated coefficient for gypsum application level was -0.001, but was not statistically different zero ($P=0.10$). That is, with location, the presence of a cover crop, crop rotation, and the presence of a high oil variety all controlled, gypsum applications did not impact yield in 2014.

The estimated regression coefficient for the presence of a cover crop was 0.72, but was not statistically different from zero at $P=0.10$. Thus, in 2014, plots with cover crops displayed no difference in yields as compared to plots without cover crops, again with location and other treatment levels held constant.

The regression coefficient for high oil variety was 3.76 and was statistically significant ($P\leq0.01$). This suggests that will all other treatments and location effects held constant, the high oil soybean variety yielded 3.76 bushels more than the conventional oil variety soybeans.

Finally, two rotations were studied: a continuous soybean rotation and soybeans following corn. The estimated coefficient for continuous soybeans was -2.85 and was statistically significant at $P\leq0.01$. Thus, in 2014, soybean yields on continuous soybean plots (with all else controlled) averaged 2.85 bushels per acre less than for soybeans following corn.

Table 4. Multivariate regression model of soybean yields for four sites and all treatments, 2014.

Regression Statistics	
Multiple R	0.94
R Square	0.89
Adjusted R Square	0.88
Standard Error	4.28
Observations	84

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	11,209	1,601	87.44	0.00
Residual	76	1,392	18		
Total	83	12,601			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	56.66	1.33	42.47	0.00
Gypsum application level[a]	0.00	0.00	-1.01	0.31
Cover Crop (1=yes)	0.72	0.93	0.77	0.44
High oil variety (1=yes)	3.76	1.01	3.73	0.00
Continuous soybeans (1=yes)[b]	-2.85	0.93	-3.05	0.00
Alabama=1[c]	-20.49	1.24	-16.58	0.00
Indiana=1[c]	-0.08	1.59	-0.05	0.96
Pike=1[c]	-25.76	1.24	-20.85	0.00

a Gypsum application levels were 0, 1,000 and 2,000 pounds per acre

b Corn/Soybean rotation is the excluded category (=0)

c The Hoytville, OH site is the excluded location (=0)

A similar regression model was estimated with per acre profitability as the dependent variable. These results are presented in Table 5. Again, the model was highly significant ($P<0.01$), as determined by the model F-Statistic. The regression model explained about 79 percent of the variation in soybean profitability.

The site location variable again determines the difference in profitability that is attributable primarily to location of these test site. The estimated coefficient for Alabama was -$142.92, suggesting that profits per acre were about $143 per acre lower than for Hoytville. This is primarily due to the significantly lower soybean yields at that site, even though total production

costs were lower than for Hoytville. The regression coefficient for Indiana also was significantly lower ($P<0.10$) than for Hoytville, suggesting profits were about $30 per acre lower in Indiana. This was due to somewhat higher production costs in Indiana, principally a cash rental rate for land that was $15 per acre higher than for Hoytville, Ohio. Piketon, Ohio also had significantly ($P<0.01$) lower profitability ($197/acre) than the Hoytville site. This was due to the large differential in soybean yields between the two sites, even though Pike faced lower production and land costs relative to Hoytville.

The regression coefficient for gypsum application was $-0.03 and was statistically significant ($P<0.01$). Thus, for 2014, each additional pound of gypsum applied resulted in a $0.03 reduction in per acre profitability, with location and all other treatment levels held constant. The estimated coefficient for cover crop was not significant at $P=0.10$, suggesting that use of a cover crop did not impact profitability in 2014. The estimated coefficient for the high oil variety was 38.53 (significant at $P<0.01$), indicating an average increase in per acre profitability of $38 per acre for the high oil variety used in this study relative to traditional soybean variety tested. Finally, the regression coefficient for continuous soybeans was -18.62 (significant at $P<0.10$), suggesting that continuous soybean plots earned nearly $19/acre lower profits than did soybeans following corn in 2014.

These results represent the combined experiences of the four test sites in 2014. It should be underscored that this represents only the third year experience with each of these treatments. One must be careful to draw conclusions from this short-term set of results. For instance, a survey of gypsum-using farmers conducted in 2014 by Batte and Forster (2014)[2] found that these farmers observed yield increases for gypsum use on a number of crops, and that the magnitude of yield premium increased for farmers who had applied gypsum for four or more years. This may suggest that the gypsum use may display positive impacts in our own study as we continue the study over time. Likewise, we may see changes in magnitudes of other treatments (especially cover crops and continuous soybeans) as we track these over an extended study period.

[2] Batte, Marvin T., and D. Lynn Forster. 2014. "Economic Impact of Gypsum: A Study of Midwestern Crop Growers". January 14, 2014.

Table 5. Multivariate regression model of soybean profitability for four sites and all treatments, 2014.

Regression Statistics	
Multiple R	0.90
R Square	0.81
Adjusted R Square	0.79
Standard Error	44.79
Observations	84

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	7	629,407	89,915	44.83	0.00
Residual	76	152,436	2,006		
Total	83	781,842			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	86.20	13.96	6.17	0.00
Gypsum application level[a]	-0.03	0.01	-5.17	0.00
Cover Crop (1=yes)	-14.98	9.77	-1.53	0.13
High oil variety (1=yes)	38.53	10.56	3.65	0.00
Continuous soybeans (1=yes)[b]	-18.62	9.77	-1.90	0.06
Alabama=1[c]	-142.92	12.93	-11.05	0.00
Indiana=1[c]	-30.25	16.69	-1.81	0.07
Pike=1[c]	-196.54	12.93	-15.20	0.00

a Gypsum application levels were 0, 1,000 and 2,000 pounds per acre

b Corn/Soybean rotation is the excluded category (=0)

c The Hoytville, OH site is the excluded location (=0)