Mississippi Soybean Promotion Board
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2017 FINAL REPORT

Project Title: Agronomic and Economic Evaluation of Soybean/Corn Rotation with Twin-row Production and Increased Nutrient Management

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EXECUTIVE SUMMARY

Field studies were established at Stoneville, Miss. on a Commerce very find sandy/silt loam site and a Sharkey clay site, and were conducted for 6 years (2012-2017). The studies were designed to evaluate corn and soybean performance when grown in 1 year soybean:1 year corn (1:1) and 2 years soybean:1 year corn (2:1) rotations. Within each study, a standard fertility treatment (220 lb N/acre added to the corn crop and no P and K added to either crop) was compared to a high fertility treatment that consisted of 260 lb N/acre added to corn and 26.2 lb P/acre and 50 lb K/acre added to both crops in the rotation. Both crops on both sites were grown in a twin row pattern on wide beds and were irrigated in all years.

On the Commerce soil site, corn grown in the 1:1 rotation with soybean in both the standard and high fertility treatments yielded slightly more (8-11 bu/acre) than corn grown following a second year of soybeans. In both rotation schemes, yields of corn from the high fertility treatment exceeded those from the standard fertility treatment by 25-28 bu/acre. These yield increases would have been only marginally profitable or unprofitable in the years of this research. Soybean yields following either corn or the second year of soybeans in the rotation were identical in both fertility treatments. Also, soybean yields were not different between the standard and high fertility treatments. Thus, the added P and K applied to soybeans on this site would have been unprofitable.

On the Sharkey clay site, corn yields following either one or two years of soybeans were similar in both the standard and high fertility treatments. The high fertility treatment for corn resulted in a 12-14 bu/acre yield increase, and thus would have been unprofitable in these studies. Soybean yields following either corn or the second year of soybeans in the rotation scheme were nearly identical in both fertility treatments. Also, soybean yields were not different between the standard and high fertility treatments and thus would have resulted in unprofitable returns to the added fertilizer in these studies on this site.

Soil pH declined in all treatments from the beginning to the end of the 6 years of these experiments. However, they were not different between the standard and high fertility treatments at either the beginning or end of the experiments on both sites.

As expected, soil P in the high vs. standard fertility treatments was greater in all years of the experiments on the Commerce soil site. On the Sharkey site, there was no difference in soil P in the final year of the study. Soil K was not different among treatments in any year of the study on both sites.

The rotations and fertility treatments used in these studies had no effect on soil organic matter in any year of the studies. On the Commerce site, the change in organic matter from beginning to end of the experiment was an average -0.06%, while on the Sharkey clay site, the change from beginning to end of the experiment was an average +0.3%.

These results indicate the following.

- Adding fertility in an amount that exceeds that recommended for corn will be only marginally profitable at best, and will be unprofitable for soybeans in rotational systems of the two crops grown on the soils used in these studies.
- On a sandy loam soil site, growing soybeans:corn in a 1:1 vs. a 2:1 rotational scheme will result in slightly more yield from corn, and thus more profit.
- On a clay soil, corn yields will be essentially equal from 1:1 and 2:1 rotations with soybeans.
- Over the six years of these studies, corn yields from the Sharkey clay site were considerably lower than those from the Commerce loam site.
- Soybeans will yield equally well following either corn or soybeans on both soil types used in these studies.

BACKGROUND AND OBJECTIVES

Corn and soybean rotations have been occurring around the country, with the most common rotation being one year soybean followed by one year of corn (1/1). The literature is filled with documentation of the "rotation effect" and the many potential explanations for it.

In the Midsouth and Southeast, less crop rotation was practiced over the last few decades because of cotton's presence on the farm landscape. Many fields were continuously cropped to cotton and cotton production had priority over other crops. In more recent times, corn and soybean replaced cotton, irrigation replaced dryland or rainfed production, and soybean moved from the last crop planted during the growing season to the early soybean production system (ESPS), with planting in March and April rather than May and June.

Bedding remained the choice for most producers in the Delta on both the coarser-textured and clay-textured soils. Getting water off (drainage) and getting water on (irrigation) was the primary concern, especially with desire for early planting of both corn and soybean.

Twin-row (TR) planting systems (two rows planted on the same bed) helped to combine wide- and narrow-row technology into a viable alternative for Midsouth production systems. John Deere's recent introduction of a twin-row planter demonstrates industry's visions for the future as well. Twin-row production allows for more rapid ground cover and yet maintains adequate waterways for surface drainage and irrigation.

On-farm research with corn in the Mississippi Delta has shown significant grain yield increases from increased seeding rates (up to 40,000 plants/acre). Soybean research has also shown advantages to TR production compared to single wide-row systems. Irrigation has led to a decrease in the fluctuation of grain yields from both corn and soybean and has led to increases in state average yields. Yield stability and good prices are keys to successful and prolonged grain production in the Midsouth.

Coupled with increased yield has been increased nutrient uptake and removal. Many producers have felt that fertility has not been an issue in the Mississippi Delta. Unfortunately, that perception has led to nutrient deficiencies in some areas and nutrient levels are expected to continue to decline with continued high yields. Others producers have been convinced that applying fertilizer annually is needed to reach optimum production potential regardless of the crop or system.

Many factors ultimately lead to the yields and yield variation that occurs across the region. The purpose of this research was to combine the technologies coming forward into a management system that can optimize yields and increase profitability. The overall objectives are to determine the agronomic implications of soybean/corn rotations in twin-row planting systems under standard and high management with irrigation, and to evaluate the economic impact of the above systems on whole-farm enterprise profitability. This research was conducted under the premise that a corn/soybean rotation system is agronomically preferred to monocropping of either crop.

ACTIVITY/PROGRESS

Objective 1: Determine the agronomic implications of soybean/corn rotations in twin-row planting systems under standard and high management with irrigation.

Multiple-year field studies were initiated at two locations on the Delta Research and Extension Center near Stoneville, MS to evaluate the agronomic implications of soybean/corn rotations in twin-row planting systems.

The first study (**Exp. No. SB31**) was established on a Commerce soil ranging in texture from very fine sandy loam to silt loam, with a small portion of silty clay loam. The area had previously been maintained as a corn/cotton (1:1) rotation field prior to 2012, with cotton planted in 2011. Since soybean had not been grown in the field, soybean was inoculated with Vault® SP (hopper box treatment) prior to planting the first three years to insure adequate nodulation.

The second site (**Exp. No. SB32**) was established on Sharkey clay previously cropped to soybean (2011). The seed for this area was also inoculated to insure uniformity and to insure that nodualtion was not a confounding factor between the research areas.

Both areas were prepared similarly each year, with beds formed either in the fall or early spring depending on weather patterns and rainfall events. In anticipation of problems with herbicide-resistant weeds, Libery-Link corn and soybean varieties were selected and planted each year. Corn varieties were full-season for the area (120 days) and came from the same family line of Pioneer for five of six years. Mycogen seed was used in 2016 as the previous varieties were not available for purchase. Soybean varieties varied from year-to-year, but generally ranged from Maturity Group 4.5 to 5.0. A complete listing of varieties, planting dates, fertilizer applications, and harvest dates are included in **Table MM1** (sandy loam site) and **Table MM2** (clay site).

Nitrogen applications were made with urea-ammonium nitrate solution (32% N) applied at or near planting (120 lb N/acre) and placed on both sides of the corn rows. Two N rates were established at sidedress with either 100 or 140 lb N/acre applied. Phosphorus and potassium fertilizer was broadcast-applied as a sidedress with simulated aerial application (hand-applied) on the dates shown in **Tables MM1 and MM2**. Rates were set at 26.2 lb P/acre (130 lb 0-46-0/acre) and 50 lb K/acre (100 lb 0-0-60/acre).

Corn and soybean planting dates (**Tables MM1 & MM2**) depended on weather conditions and rainfall patterns. Corn planting on the sandy loam occurred as early as March 19 and as late as April 17. Previous research at DREC has shown significant yield loss if planting is delayed until late April and beyond. Corn planting on the clay site tended to be later and more subject to soil conditions. Planting occurred as early as March 30 but was delayed to as late as April 28 in 2016. Soybean planting dates ranged from Apr. 9 to June 6 on the loam site and from Apr. 9 to May 5 on the clay site.

Rainfall totals in March 2016 exceeded 18 inches (**Table MM3**), which was almost 14 inches above normal. That type of rainfall was far more likely to impact planting on clay compared to planting on the sandy loam site. A full summary of total rainfall by month and year are shown in Table MM3. In five of the six years of the studies, total annual rainfall was above normal, while 5-7 months each year had below normal rainfall. March and April rainfall were rarely below normal during the duration of the studies and ranged from a low of 3.4 inches in March 2017 to a high of 18.5 inches in March 2016 (**Table MM3**). July-August rainfall was above normal in 2012, 2014, 2016, and 2017, and resulted in little need for irrigation. However, rainfall totals can be a little misleading since some daily rains could exceed 2-3 inches while the rest of the month remains dry.

Harvest for each crop and study site was done by harvesting the center two rows of each plot with appropriate plot combines modified for grain harvest. Grain samples were collected from each plot in order to determine harvest moisture, bushel test weight, and seed index (100-seed weight). Yield, bushel test weight, and seed index were corrected to a standard moisture content of 15.5% for corn and 13.0% for soybeans. The samples were stored in sterile plastic sample bags until processing. Harvest moisture and bushel test weight were determined by Dickey-John Model GAC 2100b moisture meter updated with the latest available constants.

Following soybean harvest, soil samples were collected from each plot in each study. Eight to 10 cores were extracted from 0-6 inches, composited, and then dried without heat. The dried samples were ground, sieved, and mixed prior to shipping to Mississippi State University Soil Testing and Plant Analysis Laboratory in Starkville (2012-2016 samples). The 2017 samples were submitted to the Southern Soil Testing Laboratory. The Southern Soil Testing Laboratory used the same extracting solution and method of analyses as the MSU-ES Laboratory. They also provided an estimate of total sulfur not provided by the other. The results will be discussed later in this report.

Corn and Soybean Yields

State average corn and soybean yields have been on the rise for many years and have set records over the last few years. A summary of state average yields from the National Agricultural Statistics Service is shown in **Table 1.** The highest corn yields were achieved in 2017, largely due to above-normal rainfall during the season that benefitted the dryland corn across the state. Notice that in most years both corn and soybean yields are high. These higher yields tend to be related to available moisture.

Table 1. Summary of Miss. Soybean and Corn Yields for 2012-2017 period.

YEAR	CORN			SOYBEAN		
	Harvested Acres	Yield (bu/acre)	Price Received-$/bu	Harvested Acres	Yield (bu/acre)	Price Received-$/bu
2012	795,000	165	6.94	1,950,000	45	14.50
2013	830,000	176	5.05	1,990,000	46	13.20
2014	485,000	185	4.24	2,190,000	52	11.00
2015	490,000	175	4.01	2,270,000	46	9.72
2016	732,000	166	3.74	2,020,000	48	9.94
2017	500,000	189	3.65	2,170,000	53	9.80

National Agricultural Statistics Service (NASS)

The most corn acreage in Mississippi occurred in the late 1930's, with just over 3.1 million acres harvested and a yield of 16 bu/acre. However, at the time yields rarely were above 20 bu/acre with most used as feed for livestock. Shifts from animal agriculture to machines led to a gradual decline in acreage, with corn production dropping below a million acres in 1961 with farmers producing a record yield for the time of 39 bu/acre. The first state average yield of 100 bu/acre occurred in 1994. Soybean yield reached its peak in 1979 with just over four million acres harvested and an average yield of 29 bu/acre. Since that time, a shift to early planting and irrigation has resulted in a continued increase in yields, with some farmers reporting yields approaching 100 bu/acre.

Corn and soybean yields are summarized in **Table Y1** for the sandy loam site (SB31), with means averaged across four replications and four segments (subsections) within each replication (n=16). The treatments are listed by crop sequence and include both 1:1 and 2:1 (soybean:corn) rotations. The studies were designed so that each crop in rotation sequence is grown each year. The table shows both soybean and corn yields for a given year with the appropriate statistic for each crop each year. The same will be true for subsequent tables presented. Fisher's Protected Least Significant Difference was used at the 5% level of significance. Significant treatment differences for corn were evident in 2013, 2015, 2016, and 2017, with a significant response to additional fertilizer (High vs Standard). Corn yields exceeded the state average in most years but were not consistent from year-to-year even though irrigation was available. Corn yields at the higher fertility levels exceeded 200 bu/acre in most years. The 2015 yields were below expectations due to some periods of water stress.

Soybean yields from the same study are also summarized in **Table Y1.** The highest yield was measured in 2013 from Pioneer 95L01 planted April 30. The only significant fertility effects were observed in 2012, the initial year of the study. The differences were only 1.0 to 2.3 bu/acre, yet were still significant. No differences were observed in any of the other years (Table Y1). As with corn , the lowest soybean yields were observed in 2015 with yields ranging from 47.5 to 49.9 bu/acre.

Corn and soybean yields from the clay soil research area are summarized in **Table Y2.** Overall plot length was shorter for this study but included the same number of replications and sub-sections (n=16). Corn grain yields were expected to be lower on the poorly drained clay soil, with yields exceeding 200 bu/acre only in 2017. Irrigation for this study was supplied from a well rather than a surface source and with continued use has led to higher pH (liming effect) compared to the other location. Soil testing results will be discussed in a subsequent section. The only significant difference for either corn or soybean was measured in 2014 with actual yields below the state average. Grain yields with standard fertility averaged 120 bu/acre compared to the high fertility average of 150 bu/acre. In most years soybean yields were over 50 bu/acre (**Table Y2**), but were over 60 bu/acre in 2013 and 2017. There was no significant response measured for any of the soybean systems. Soil test levels for phosphorus (P) and potassium (K) were well above recommended levels and should not have produced additional yield.

Soybean and Corn - Bushel Test Weight/Seed Index

Bushel test weight and seed index were determined for both corn and soybean samples taken at harvest. These two factors can be influenced by fertility and can affect market value of a given crop and whether or not that crop can be entered into international trade. The standard test weight of corn is 56 lb/bu at 15.5% moisture while the standard weight of soybean is 60 lb/bu at 13.0%. In the Midsouth, corn bushel weight is sometimes higher than the 56 lb/bu, indicating a more dense kernel that is usually related to stress or other factors. A summary of bushel test weight is included in **Table Y3** (SB31) and **Table Y4** (SB32). No differences in either crop was evident in 2012, 2013, or 2014. Corn bushel test weight was significantly different in 2015, 2016, and 2017, with tendency to be higher with added fertility on the sandly loam site (SB31). The bushel test weight for corn was quite low in 2017, with some being in the 47.5 to 50.2 lb/bu range. Grain color was off for this area and seemed to be worse on the upper end of the field. Soybean bushel test weight was significantly different for soybean only in 2017, with the trend toward lower test weight with the additional fertility.

Results from the clay site (SB32) are summarized in **Table Y4.** No significant differences were observed in either corn or soybean test weights in any of the six years. Corn bushel weights were different from year-to-year as were soybean test weights, but that could be related to differences in varieties among years. Also, the amount of available water could also influence the bushel test weight and could have affected grain fill. July and August rainfall were above normal in both 2016 and 2017.

Seed Index, like bushel test weight, can be directly related to varietal difference, especially with corn where seed size can vary greatly. Some 80-thousand seed bags can weigh less than 45 lb/bag (seed index = 25.52 g/100 seed), while others exceed 60 lb/bag (seed index = 34.02 g/100 seed). Seed index for both corn and soybean are included in **Table Y5** for the sandy loam site (SB31). There were no significant differences measured for either grain crop. Corn seed index in 2017 was lower than any other year but follows the low test weight mentioned earlier. The highest seed index occurred in 2013 with seed weights ranging from 37.82 to 39.50 g/100 seed. Soybean seed index was higher in 2013 and 2014, probably because of different varieties. Grain yields were the highest in 2013 as well, and yielded as much as 15 bu/acre more than in 2014. The clay site data (SB32) can be found in **Table Y6.** Significant differences occurred in 2013 and 2015 for corn, with higher seed index from the high fertility compared to standard fertility. Soybean seed index was significantly different only in 2014, but no pattern was evident.

Soil Testing Results

Soil samples were collected following harvest of each crop to monitor soil nutrient status changes based on treatments (fertilizer additions) over time. Every plot was sampled each year in each study. Each year soil analyses included pH, extractable phosphorus (P) and potassium (K), exchangeable cations (H, K, Ca, Mg, NA), cation exchange capacity (CEC), organic matter (OM), zinc, an estimate of organic sulfur, and sulfate sulfur. The Southern Soil Lab included total sulfur and manganese as well, but did not separate the sulfur fractions. Both labs used the Lancaster method of extraction developed at Mississippi State University.

Of primary interest for these studies are pH, P, K, and OM since P and K are fertilizers that were added. Most N sources are acidic and can lead to lower pH over time; however, well water usually has higher carbonate and can lead to a liming effect. The same change is not present when utilizing surface water for irrigation. The soil test results summarized across years are included in **Tables SB31-pH, SB31-P, SB31-K, and SB31-OM** for the sandy loam site (SB31), and **Tables SB32-pH, SB32-P, SB32-K, and SB32-OM** for the clay soil study site (SB32).

With respect to pH (**Table SB31-pH**), the field average after the first crop was 6.5 at the sandy loam site. Significant differences among treatment systems were observed in 2013, 2014, 2016, and 2017. The biggest differences were found in 2017, where lower pH was observed in the corn plots compared to the soybean plots (Treatments 2, 5, 7, and 10). The same relationship was observed in 2017 for the clay site (SB32), and this was the only year of significant differences. With time and corn in the system, soil pH continued a gradual decline. Soil pH at this site was above 7.0 through the first 5 years, with initial pH of 7.8 after the first cropping year. Following the 2017 crops, soil pH was 7.0 when averaged across all plots (n=160). The only year with significant differences among pH levels was 2017, but there was no clear pattern.

The largest variation in soil test values was observed with extractable P. Six-year summaries for the locations are included in **Tables SB31-P and SB32-P**. The standard P rates for each study were based on soil test P and neither site received supplemental P fertilizer. The high treatments received 26.2 lb P/acre (130 lb 0-46-0/acre = 60 lb P_2O_5/acre) each year of the study at both study sites. Soil P levels in 2012-2014 steadily declined where no P was applied, and values ranged from 92.8 to 76.4 lb P/acre when averaged across treatments. The high fertility areas averaged 110.6 to 94.8 lb P/acre. For the first three years soil test levels were as expected and additions resulted in higher soil test P, but still declined with crop removal. There were no differences in 2015, with soil test P where no P was applied increasing by 25-30%. The 2016 soil test P levels were much higher than in any previous year, even higher than the previous year. However, the difference between applied and non-applied P was 38.2 lb P/acre and this was significant (Table SB31-P). After changing labs in 2017, soil test P was much more in line of where it was in 2012-2014. It is difficult to explain what has happened, but the data have been presented and reported.

Soil test P was much higher for the clay site (SB32), with the means shown in **Table SB32-P**. The levels decreased with time where no fertilizer P was and was not applied. There were significant differences in soil test P observed, but the levels detected had no influence on yield. Soil test P levels for SB32 were much higher in 2016 as was shown with SB31. Shifting labs saw P levels at less than half of what they were the previous year.

Soil test potassium (K) has been summarized in **Tables SB31-K and SB32**-K for the 6 years of the studies. The fertilizer K addition was 50 lb K/acre/year (100 lb 0-0-60/acre). As with soil test P, soil test K gradually decreased with years for 2012-2014 for both the standard and high fertility systems. There were significant differences in 2014 but not in other years. In the final year (2017), average soil test K levels were about 30 lb K/acre higher where fertilizer K was being added annually. This difference was similar for most years. For the clay site (SB32), soil test K levels exceeded the levels where no fertilizer K should have been added. Treatments had no significant impact on soil test K for this site (SB32).

Soil organic matter is thought to be increased with crop rotation, but experience has shown that the process is slow and depends on tillage. In the Midsouth, continued cultivation leads to continued oxidation of organic residues. With high residue crops such as corn, temporary increases in residue are evident. However, without continuing the practice, organic matter will return to the most stable state. A summary of soil organic matter levels is available in **Tables SB31-OM and SB32**-OM. For the sandy loam site (SB31), no significant difference in organic matter levels could be attributed to the rotation and fertility systems. Across years, the field organic matter has ranged from 0.81% in 2016 to 1.10% in 2012 when averaged across all systems and fertility levels, replications, and subplots (n=160) each year. At the clay site (SB32), soil organic matter, averaged across all entities (n=160), ranged from 1.89 in 2016 to a high of 2.29% in 2017 (**Table SB32-OM**). No significant differences were found.

Several other soil test factors have been examined but were not included as input factors should not influence the soil test levels. These factors included Exchangeable cations (H, K, Ca, Mg, Na) and cation exchange capacity, extractable zinc, and sulfur components.

Objective 2: Evaluate the economic impact of the rotation systems and fertilizer management on whole-farm enterprise profitability.

The primary factors that differ from season to season and crop to crop are fertility and the yield of crops being grown. Major fertilizer inputs were urea-ammonium nitrate solution (UAN, 32%N), concentrated super-phosphate (CSP, 0-46-0), and muriate of potash (KCl, 0-0-60) shown in **Table 2**. Prices are based on average March retail price for the local market. Prices in the table are for the fertilizer (local retail delivery) for March-April each year of the study. Fertilizer N, P, and K have dropped in price for the last six years and follow the downward trend of commodity prices. For the standard fertility system for corn, total cost of fertilizer ranged from $137.50 in 2012 to a low of $85.93 in 2017. There was no fertilizer N, P, or K added to soybean.

Grain prices (**Table 4**) used in the summary are average marketing year prices as reported by the National Agricultural Statistics Service (NASS) for Mississippi.

Table 2. Prices for fertilizers used in study.						
Fertilizer	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
UAN Solution (32% N)						
Price/ton	400.00	385.00	365.00	330.00	280.00	250.00
Price/lb (N)	0.6250	0.6016	0.5703	0.5156	0.4375	0.3906
220 lb N/acre	137.50	132.35	125.47	113.43	96.25	85.93
260 lb N/acre	162.50	156.42	148.28	134.06	113.75	101.56
Phosphorus (0-46-0)						
Price/ton	520.00	510.00	480.00	450.00	395.00	360.00
Price/lb (P_2O_5)	0.5652	0.5543	0.5217	0.4891	0.4293	0.3913
Price/lb (P)	1.2951	1.2702	1.1566	1.1208	0.9838	0.8966
26.2 lb P/acre	33.93	33.28	30.30	29.36	25.78	23.49
Potassium (0-0-60)						
Price/ton	560.00	520.00	470.00	440.00	290.00	280.00
Price/lb (K_2O)	0.4667	0.4333	0.3917	0.3667	0.2417	0.2333
Price/lb (K)	0.5622	0.5221	0.4719	0.4418	0.2912	0.2811
50 lb K/acre	28.11	26.10	23.60	22.09	14.56	14.06

Price based on local retail March-April of each year

With the high fertility system and corn, the total fertilizer cost ranged from $224.54 in 2012 to $139.11 in 2017. For the soybean system, the range was $62.04 in 2012 to $37.55 in 2017. At the same time, commodity prices were declining. Corn prices for Mississippi averaged $6.94 in 2012, while soybean averaged $14.50 for the marketing year. By 2017, corn and soybean prices had dropped to $3.65 and $9.80, respectively. A complete list of prices received and state average yields are listed below. Data in tables 2 and 3 can be used to estimate the bushels of each crop needed to cover the cost of the fertilizer materials. The cost of soybean innoculant was not included even though it was used to facilitate nitrogen fixation in soybean for the first three years of the study (SB31).

Table 3. Corn and soybean commodity prices used for economic calculations.

	2012	2013	2014	2015	2016	2017
State Average Yield	---------- bu/acre ----------					
Corn	165	176	185	175	166	189
Soybean	45	46	52	46	48	53
Average Price Received	---------- $/bushel----------					
Corn	6.94	5.05	4.24	4.01	3.74	3.65
Soybean	14.50	13.20	11.00	9.72	9.94	9.80

Data obtained from National Agricultural Statistics Service

In order to assess the benefits of additional fertilizer, one must look at the significant response to added fertilizer. Significant corn yield increases were measured in 2013, 2015, 2016, 2017 for the sandy loam site (**SB31, Table Y1**), but only in 2014 for the clay site (**SB32, Table Y2**). To illustrate, the data in **Table 4** below summarizes the value of the corn in the SB31 study based on yield and price received. The same can be done for soybean at each location. In years where differences are not significant, then the increased fertilizer cannot be profitable.

Table 4–SB31 Sandy Loam Site Corn Yields and Crop Value

	2012	2013	2014	2015	2016	2017
CROP YIELD	---------- bu/acre ----------					
Standard Fertility						
1:1 Rotation	196.8	211.0	195.9	139.0	187.6	153.6
2:1 Rotation	196.5	229.9	179.4	179.1	189.4	152.3
High Fertility						
1:1 Rotation	204.9	230.8	212.1	184.1	206.2	196.4
2:1 Rotation	201.1	233.5	205.2	197.1	210.5	198.2
AVERAGE PRICE RECEIVED	---------- $/bushel----------					
Corn	6.94	5.05	4.24	4.01	3.74	3.65
CROP VALUE	---------- $/acre----------					
Standard Fertility						
1:1 Rotation	1365.79	1065.55	830.62	557.39	701.62	560.64
2:1 Rotation	1363.71	1156.45	760.66	718.19	708.36	555.90
High Fertility						
1:1 Rotation	1422.01	1165.54	899.30	738.24	771.19	718.86
2:1 Rotation	1395.63	1179.18	870.05	790.37	787.27	723.43

In situations such as SB32 where soil test levels are high, the probability of getting a response and thus benefit from higher fertilizer inputs is negligible. This points strongly to the benefits of soil testing and knowing the fields that crops are planted into. Buildup of the nutrient pool is good when doing so is warranted. This allows savings when fertilizer costs are high. If soil test nutrient levels are medium to low, the probability of response is much higher.

With higher yields, especially for soybean, nutrient removal is high compared to the time when most correlation/calibration research was completed. Continued high yields are not going to be possible as the soil nutrient pool is depleted. The whole system can be further compromised if something other than grain is removed from the field. When considering residue removal, whether through baling or burning, the pool is diminished more rapidly.

Impacts and Benefits to Mississippi Soybean Producers

With over two million acres of soybean and 500,000 or more acres of corn, it will be preferable to establish a 1/1 soybean:corn rotation on much of the irrigated soybean/corn acreage in Mississippi. The research completed here did not detect any advantage to multiple years of soybean.

Adoption of crop rotation could enable producers to increase soybean yields, increase corn yields, and also increase profitability. The use of rotation could greatly reduce the spread of resistant weeds by offering multiple crops for rotating herbicides.

With fertility management, the key to success lies in soil testing and sound fertility practices. With the high yields that are likely to be harvested from irrigated production systems, removal of N, P, K, and S is great for both corn and soybean compared to cotton. As producers make the shift to grain crops, more pressure will be placed on the soil nutrient reservoir. However, soils with inherently high nutrient levels can be mined with no adverse effect on yield over the short term. The key is to use soil testing and analyses to ensure that this point is not exceeded in time.

The bottom line is know your soils and your soil test nutrient levels, as well as pH and other factors. Using high N fertilizers, most of which are acid-forming, can reduce the soil pH and adversely affect micro-nutrient availability and healthy root development if pH is allowed to drop too low.

Table MM1. SB31 Sandy Loam Site. Factors used in an evaluation of crop rotation with twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

	2012		2013		2014		2015		2016		2017	
Crop Sequence	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**
Cultivar												
Brand	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Mycogen	Hornbeck	Pioneer	Credenz
Number	2088	94L71	2088YH	95L01	2089	45T77L	2089	48T67L	2C797	4653	2089	4748 LL
Planting Date	4/09	4/09	3/19	4/30	4/17	5/02	4/09	6/06	4/08	4/28	3/29	4/20
Fertilizer App. Date												
PPN	4/02	----	3/19	----	4/21	----	4/29	----	5/05	----	4/10	----
SDN	5/11	----	5/27	----	5/27	----	5/13	----	5/24	----	5/10	
Phosphorus	5/14	5/14	5/28	5/28	6/04	6/04	5/12	5/12	5/23	5/23	5/09	5/09
Potassium	5/14	5/14	5/28	5/28	6/04	6/04	5/12	5/12	5/23	5/23	5/09	5/09
Harvest Date	9/04	9/11	9/11	9/23	9/09	9/24	8/27	10/06	9/07	9/21	8/26	10/06

Corn/soybean cultivars are Liberty-Link technology

Fertility Management:
PPN: Preplant nitrogen @ 120 lb N/acre applied as Urea-ammonium nitrate solution
SDN: Sidedress nitrogen @ 100 or 140 lb N/acre
Phosphorus: Applied @ 26.2 lb P/acre = 60 lb P_2O_5/acre = 130 lb 0-46-0/acre
Potassium: Applied @ 50 lb/K/acre = 60 lb K_2O/acre = 100 lb 0-0-60/acre

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Table MM.: SB31 Clay site. Factors used in an evaluation of crop rotation with twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

	2012		2013		2014		2015		2016		2017	
Crop Sequence	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**
Cultivar												
Brand	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Pioneer	Mycogen	Hornbeck	Pioneer	Credenz
Number	2088 YHR	94L71	2088YHR	95L01	2089 YHR	45T77L	2089 YHR	48T67L	2C797	4653	2089 YHR	4748 LL
Planting Date	4/13	4/09	4/20	4/30	4/21	5/05	3/30	4/30	4/28	4/28	3/29	4/20
Fertilizer App. Date												
PPN	4/02	----	3/19	----	4/21	----	4/30	----	5/05	----	4/10	----
SDN	5/15	----	5/27	----	5/27	----	5/13	----	6/10	----	5/11	
Phosphorus	5/15	5/15	5/29	5/29	6/05	6/05	5/13	5/13	5/24	5/24	5/11	5/11
Potassium	5/15	5/15	5/29	5/29	6/05	6/05	5/13	5/13	5/24	5/24	5/11	5/11
Harvest Date	9/06	9/24	9/11	10/23	9/11	9/25	8/27	10/06	9/09	9/23	8/26	9/29

Corn/soybean cultivars are Liberty-Link technology

Fertility Management: PPN: Preplant nitrogen @ 120 lb N/acre applied as Urea-ammonium nitrate solution
SDN: Sidedress nitrogen @ 100 or 140 lb N/acre
Phosphorus: Applied @ 26.2 lb P/acre = 60 lb P_2O_5/acre = 130 lb 0-46-0/acre
Potassium: Applied @ 50 lb/K/acre = 60 lb K_2O/acre = 100 lb 0-0-60/acre

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Table MM3: Six-year summary of rainfall accumulation at the Delta Research and Extension Center, 2012-2017. Negative numbers (red) indicate below-normal rainfall for the month or the year.

			2012		2013		2014		2015		2016		2017	
	MONTH	**NORMAL**	**Actual**	**Diff.**	**Actual**	**Diff.**	**Actual**	**Diff.**	**Actual**	**Diff.**	**Actual**	**Diff.**	**ActualCR**	**Diff.**
		(Inches)	(Inches)		(Inches)		(Inches)		(Inches)		(Inches)		(Inches)	
1	January	4.92	2.77	-2.15	10.27	5.35	1.15	-3.77	5.69	0.77	3.39	-1.53	6.88	1.96
2	February	4.81	3.13	-1.68	5.24	0.43	3.96	-0.85	4.72	-0.09	4.50	-0.31	5.03	0.22
3	March	4.54	5.94	1.40	3.83	-0.71	6.36	1.82	7.31	2.77	18.47	13.93	3.40	-1.14
4	April	4.81	4.19	-0.62	6.59	1.78	9.82	5.01	6.33	1.52	4.31	-0.50	6.63	1.82
5	May	4.80	2.03	-2.77	5.70	0.90	6.22	1.42	6.96	2.16	3.26	-1.54	4.88	0.08
6	June	3.69	6.39	2.70	3.65	-0.04	5.74	2.05	2.57	-1.12	5.06	1.37	7.59	3.90
7	July	3.65	4.57	0.92	1.91	-1.74	4.81	1.16	3.17	-0.48	6.53	2.88	4.31	0.66
8	August	2.49	4.29	1.80	1.99	-0.50	3.03	0.54	0.73	-1.76	5.48	2.99	10.74	8.25
9	September	3.72	3.26	-0.46	5.12	1.40	1.03	-2.69	0.79	-2.93	0.34	-3.38	1.69	-2.03
10	October	4.16	5.78	1.62	7.12	2.96	6.69	2.53	5.49	1.33	0.20	-3.96	1.88	-2.28
11	November	5.01	0.95	-4.06	4.76	-0.25	2.90	-2.11	9.59	4.58	5.29	0.28	2.14	-2.87
12	December	5.88	4.92	-0.96	3.96	-1.92	4.77	-1.11	4.75	-1.13	3.98	-1.90	2.98	-2.90
			48.22	-4.26	60.14	7.66	56.48	4.00	58.1	5.62	60.81	8.33	58.15	5.67
	NORMAL	52.48	52.48		52.48		52.48		52.48		52.48		52.48	

Data provided by Delta Agricultural Weather Center, Mississippi State University, Delta Research and Extension Center, Stoneville, Mississippi.

Table Y1. Summary of corn and soybean yields from an evaluation of crop rotation with twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

			2012		2013		2014		2015		2016		2017	
	Crop Sequence	Fertility	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean
			(bu/acre)		(bu/acre)		(bu/acre)		(bu/acre)		(bu/acre)		(bu/acre)	
1	CR-SB-CR-SB-CR-SB	STD	196.8	-----	-----	75.8	195.9	-----	-----	49.3	187.6	-----	-----	61.1
2	SB-CR-SB-CR-SB-CR	STD	----	52.0	211.0	-----	-----	58.5	139.0	-----	-----	56.2	153.6	-----
3	CR-SB-SB-CR-SB-SB	STD	196.5	-----	----	73.5	-----	61.0	179.1	-----	-----	58.7	-----	60.1
4	SB-CR-SB-SB-CR-SB	STD	-----	52.8	229.9	-----	-----	60.0	-----	48.6	189.4	-----		60.8
5	SB-SB-CR-SB-SB-CR	STD	-----	53.6	-----	78.5	179.4	-----	-----	47.5	-----	56.1	152.3	-----
6	CR-SB-CR-SB-CR-SB	HIGH	204.9	-----	-----	74.7	212.1	-----	-----	49.9	206.2	-----	-----	61.9
7	SB-CR-SB-CR-SB-CR	HIGH	-----	54.3	230.8	-----	-----	61.7	184.1	-----	-----	60.6	196.4	-----
8	CR-SB-SB-CR-SB-SB	HIGH	201.1	-----	-----	75.4	-----	61.0	197.1	-----	-----	60.4	-----	60.0
9	SB-CR-SB-SB-CR-SB	HIGH	-----	53.8	233.5	-----	-----	60.0	-----	49.0	210.5	-----	-----	62.9
10	SB-SB-CR-SB-SB-CR	HIGH	-----	54.6	-----	78.2	205.2	-----	-----	49.3	-----	59.4	198.2	-----
	LSD (0.05)		7.8	1.7	9.9	4.0	31.7	2.6	35.0	4.3	14.4	4.1	18.4	3.4
	Prob > F		0.1056	0.0394	0.0022	0.1160	0.1801	0.1823	0.0232	0.8877	0.0116	0.1207	0.0003	0.4640
	C. V. (%)		6.42	3.82	5.74	4.40	7.91	6.15	9.59	8.43	6.37	5.18	6.70	4.57

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment].

Table Y2. Summary of corn and soybean yields from an evaluation of crop rotation with twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

			2012		2013		2014		2015		2016		2017	
	Crop Sequence	**Fertility**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**
			(bu/acre)		(bu/acre)		(bu/acre)		(bu/acre)		(bu/acre)		(bu/acre)	
1	CR-SB-CR-SB-CR-SB	STD	178.4	-----	-----	63.6	121.5	-----	-----	50.7	155.1	-----	-----	62.4
2	SB-CR-SB-CR-SB-CR	STD	----	57.0	142.3	-----	-----	50.9	173.9	-----	-----	55.7	199.3	-----
3	CR-SB-SB-CR-SB-SB	STD	180.5	-----	----	65.5	-----	48.3	166.4	-----	-----	56.4	-----	60.4
4	SB-CR-SB-SB-CR-SB	STD	-----	57.6	144.6	-----	-----	51.9	-----	53.4	156.3	-----		60.5
5	SB-SB-CR-SB-SB-CR	STD	-----	56.8	-----	58.7	119.7	-----	-----	52.2	-----	56.1	204.4	-----
6	CR-SB-CR-SB-CR-SB	HIGH	189.6	-----	-----	63.6	149.9	-----	-----	53.2	163.1	-----	-----	60.3
7	SB-CR-SB-CR-SB-CR	HIGH	-----	57.5	155.9	-----	-----	51.1	184.8	-----	-----	56.0	207.3	-----
8	CR-SB-SB-CR-SB-SB	HIGH	195.9	-----	-----	61.9	-----	48.7	175.1	-----	-----	53.2	-----	58.6
9	SB-CR-SB-SB-CR-SB	HIGH	-----	58.1	164.5	-----	-----	50.3	-----	53.5	161.2	-----	-----	60.0
10	SB-SB-CR-SB-SB-CR	HIGH	-----	56.7	-----	59.5	149.7	-----	-----	52.6	-----	57.2	207.9	-----
	LSD (0.05)		17.7	4.7	35.9	5.6	21.4	4.6	13.4	4.6	11.9	5.1	9.1	3.4
	Prob > F		0.1615	0.9825	0.4575	0.1440	0.0132	0.5150	0.0741	0.4836	0.4107	0.6701	0.2042	0.3895
	C. V. (%)		4.48	4.68	16.07	4.42	11.59	4.62	10.20	10.71	6.65	7.22	3.88	4.51

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment].

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Table Y3: Summary of corn and soybean bushel test weight estimates from an evaluation of crop rotation with twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

			2012		2013		2014		2015		2016		2017	
	Crop Sequence	Fertility	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean
			-----lb/bu-----											
1	CR-SB-CR-SB-CR-SB	STD	55.8	-----	-----	55.3	53.5	-----	-----	59.3	54.2	-----	-----	55.5
2	SB-CR-SB-CR-SB-CR	STD	----	53.6	57.80	-----	-----	58.4	52.3	-----	-----	59.7	48.3	-----
3	CR-SB-SB-CR-SB-SB	STD	56.0	-----	----	55.6	-----	58.6	53.7	-----	-----	59.6	-----	55.8
4	SB-CR-SB-SB-CR-SB	STD	-----	53.6	57.9	-----	-----	58.3	-----	59.2	54.6	-----		55.7
5	SB-SB-CR-SB-SB-CR	STD	-----	53.6	-----	55.4	52.0	-----	-----	59.5	-----	59.9	47.5	-----
6	CR-SB-CR-SB-CR-SB	HIGH	56.1	-----	-----	55.7	53.7	-----	-----	59.6	55.5	-----	-----	54.1
7	SB-CR-SB-CR-SB-CR	HIGH	-----	53.4	58.0	-----	-----	58.6	53.8	-----	-----	59.9	50.2	-----
8	CR-SB-SB-CR-SB-SB	HIGH	56.1	-----	-----	55.6	-----	58.5	54.0	-----	-----	60.0	-----	55.2
9	SB-CR-SB-SB-CR-SB	HIGH	-----	53.6	58.2	-----	-----	58.4	-----	59.5	55.4	-----	-----	54.3
10	SB-SB-CR-SB-SB-CR	HIGH	-----	53.7	-----	55.7	52.6	-----	-----	59.6	-----	60.0	50.9	-----
	LSD (0.05)		1.0	0.4	0.8	0.4	1.8	0.5	1.1	0.5	1.0	0.3	2.1	1.0
	Prob > F		0.8776	0.7607	0.6493	0.2942	0.1776	0.7550	0.0200	0.5456	0.0373	0.0782	0.0180	0.0065
	C. V. (%)		1.45	1.24	1.33	1.04	2.58	0.55	2.25	0.75	1.52	0.76	4.22	1.64

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]

Table Y4: Summary of corn and soybean bushel test weight from an evaluation of crop rotation with twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

			2012		2013		2014		2015		2016		2017	
	Crop Sequence	Fertility	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean
			----------	----------	----------	----------	----------	-----lb/bu-----	----------	----------	----------	----------	----------	----------
1	CR-SB-CR-SB-CR-SB	STD	56.0	-----	-----	53.9	53.5	-----	-----	57.7	56.2	-----	-----	57.6
2	SB-CR-SB-CR-SB-CR	STD	----	55.4	58.4	-----	-----	56.6	55.3	-----	-----	60.6	52.9	-----
3	CR-SB-SB-CR-SB-SB	STD	56.3	-----	----	54.2	-----	56.9	54.8	-----	-----	60.4	-----	57.8
4	SB-CR-SB-SB-CR-SB	STD	-----	55.3	57.9	-----	-----	56.3	-----	57.8	56.0	-----		58.0
5	SB-SB-CR-SB-SB-CR	STD	-----	55.6	-----	53.9	53.4	-----	-----	57.9	-----	60.5	53.6	-----
6	CR-SB-CR-SB-CR-SB	HIGH	56.8	-----	-----	53.9	53.5	-----	-----	57.8	56.2	-----	-----	57.5
7	SB-CR-SB-CR-SB-CR	HIGH	-----	56.0	57.9	-----	-----	56.6	55.2	-----	-----	60.5	53.8	-----
8	CR-SB-SB-CR-SB-SB	HIGH	56.7	-----	-----	54.3	-----	56.6	55.1	-----	-----	60.6	-----	57.8
9	SB-CR-SB-SB-CR-SB	HIGH	-----	55.1	57.8	-----	-----	56.3	-----	57.9	56.6	-----	-----	57.9
10	SB-SB-CR-SB-SB-CR	HIGH	-----	55.9	-----	54.1	53.7	-----	-----	58.1	-----	60.5	53.0	-----
	LSD (0.05)		0.8	1.0	1.1	0.4	1.3	0.6	1.4	0.6	0.8	0.3	0.8	0.5
	Prob > F		0.1627	0.4838	0.6374	0.1618	0.1776	0.2470	0.8682	0.5973	0.5212	0.4136	0.1263	0.2685
	C. V. (%)		1.03	1.09	1.47	1.10	2.58	0.64	1.65	0.58	1.12	0.67	1.91	0.68

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]

Table Y5: Summary of corn and soybean Seed index (100-seed weight) from an evaluation of crop rotation with twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

			2012		2013		2014		2015		2016		2017	
	Crop Sequence	Fertility	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean	Corn	Soybean
			---g/100 seed---											
1	CR-SB-CR-SB-CR-SB	STD	30.386	-----	-----	18.203	33.788	-----	-----	15.757	30.953	-----	-----	14.306
2	SB-CR-SB-CR-SB-CR	STD	----	15.680	37.820	-----	-----	18.181	31.918	-----	-----	12.644	29.536	-----
3	CR-SB-SB-CR-SB-SB	STD	30.468	-----	----	17.944	-----	18.310	33.632	-----	-----	12.818	-----	14.340
4	SB-CR-SB-SB-CR-SB	STD	-----	15.267	38.212	-----	-----	18.323	-----	15.614	30.586	-----		14.339
5	SB-SB-CR-SB-SB-CR	STD	-----	15.345	-----	18.455	31.923	-----	-----	15.542	-----	12.640	29.353	-----
6	CR-SB-CR-SB-CR-SB	HIGH	31.067	-----	-----	18.124	33.596	-----	-----	15.495	31.764	-----	-----	14.045
7	SB-CR-SB-CR-SB-CR	HIGH	-----	15.511	39.501	-----	-----	18.365	33.663	-----	-----	12.691	31.327	-----
8	CR-SB-SB-CR-SB-SB	HIGH	31.121	-----	-----	18.447	-----	18.285	34.656	-----	-----	12.854	-----	13.842
9	SB-CR-SB-SB-CR-SB	HIGH	-----	15.351	38.547	-----	-----	18.530	-----	15.483	31.588	-----	-----	13.972
10	SB-SB-CR-SB-SB-CR	HIGH	-----	15.297	-----	18.485	33.376	-----	-----	15.307	-----	12.760	32.004	-----
	LSD (0.05)		0.830	0.343	1.520	0.634	2.520	0.452	2.023	0.547	1.312	0.212	2.425	0.655
	Prob > F		0.8301	0.1518	0.1475	0.3995	0.3769	0.7098	0.0749	0.4501	0.2182	0.9589	0.0874	0.4571
	C. V. (%)		4.12	2.95	5.71	4.60	6.94	3.97	3.72	5.13	3.23	2.49	5.25	4.75

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment].

Table Y6: Summary of corn and soybean seed index (100-seed weight) from an evaluation of crop rotation with twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

			2012		2013		2014		2015		2016		2017	
	Crop Sequence	**Fertility**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**	**Corn**	**Soybean**
			---g/100 seed---											
1	CR-SB-CR-SB-CR-SB	STD	28.331	-----	-----	15.295	26.764	-----	-----	15.062	28.714	-----	-----	13.903
2	SB-CR-SB-CR-SB-CR	STD	----	14.763	33.585	-----	-----	14.718	31.909	-----	-----	13.831	32.968	-----
3	CR-SB-SB-CR-SB-SB	STD	28.968	-----	----	15.479	-----	14.341	32.204	-----	-----	14.037	-----	13.848
4	SB-CR-SB-SB-CR-SB	STD	-----	14.761	32.690	-----	-----	15.071	-----	15.345	28.242	-----		13.495
5	SB-SB-CR-SB-SB-CR	STD	-----	14.773	-----	14.795	27.456	-----	-----	15.079	-----	13.758	32.480	-----
6	CR-SB-CR-SB-CR-SB	HIGH	29.384	-----	-----	15.189	28.862	-----	-----	15.182	29.571	-----	-----	13.754
7	SB-CR-SB-CR-SB-CR	HIGH	-----	14.948	34.329	-----	-----	14.8122	33.566	-----	-----	13.788	33.517	-----
8	CR-SB-SB-CR-SB-SB	HIGH	29.218	-----	-----	15.106	-----	14.5522	33.489	-----	-----	13.801	-----	13.922
9	SB-CR-SB-SB-CR-SB	HIGH	-----	14.835	35.040	-----	-----	15.685	-----	15.466	29.056	-----	-----	13.269
10	SB-SB-CR-SB-SB-CR	HIGH	-----	14.783	-----	14.920	28.342	-----	-----	15.230	-----	13.646	33.469	-----
	LSD (0.05)		1.422	0.452	1.276	0.629	1.124	0.4243	1.264	0.424	1.326	0.444	1.495	0.663
	Prob > F		0.4050	0.9414	0.0189	0.2729	0.3769	0.0074	0.0304	0.1291	0.2126	0.7429	0.1263	0.2733
	C. V. (%)		3.16	2.45	3.16	3.74	6.94	3.97	3.96	1.44	3.01	3.52	3.28	2.46

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment].

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Table SB31-pH. Summary of soil pH as affected by crop rotation and fertility differences in twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			Soil pH					
1	CR-SB-CR-SB-CR-SB	STD	6.42	6.56 abc	6.26 ab	6.34	5.74 e	6.21 b
2	SB-CR-SB-CR-SB-CR	STD	6.46	6.36 bcd	6.28 ab	6.32	6.14 abc	5.73 d
3	CR-SB-SB-CR-SB-SB	STD	6.55	6.52 abc	6.41 a	6.28	6.18 ab	6.47 a
4	SB-CR-SB-SB-CR-SB	STD	6.52	6.33 cd	6.33 ab	6.25	5.79 de	6.36 ab
5	SB-SB-CR-SB-SB-CR	STD	6.52	6.68 a	6.14 bcd	6.28	6.30 a	5.96 c
6	CR-SB-CR-SB-CR-SB	HIGH	6.38	6.36 bcd	5.96 d	6.36	6.00 bcd	6.19 b
7	SB-CR-SB-CR-SB-CR	HIGH	6.43	6.36 bcd	6.26 ab	6.35	6.11 abc	5.76 cd
8	CR-SB-SB-CR-SB-SB	HIGH	6.31	6.35 cd	6.18 bc	6.29	5.95 cde	6.33 ab
9	SB-CR-SB-SB-CR-SB	HIGH	6.44	6.20 d	6.24 ab	6.24	5.82 de	6.25 b
10	SB-SB-CR-SB-SB-CR	HIGH	6.52	6.59 ab	6.02 cd	6.28	6.14 abc	5.87 cd
	LSD (0.05)		0.17	0.24	0.19	0.09	0.23	0.20
	Prob > F		0.1430 ns	0.0110	0.0024	0.0757 ns	0.0002	<0.0001
	C. V. (%)		4.00	4.06	5.23	3.49	4.53	5.21

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

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Table SB32-pH: **Summary of soil pH as affected by crop rotation and fertility differences in twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).**

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			---------- Soil pH ----------					
1	CR-SB-CR-SB-CR-SB	STD	7.79	7.72	7.39	7.29	7.26	6.99 ab
2	SB-CR-SB-CR-SB-CR	STD	7.79	7.66	7.33	7.31	7.25	6.86 b
3	CR-SB-SB-CR-SB-SB	STD	7.77	7.70	7.32	7.36	7.22	7.10 a
4	SB-CR-SB-SB-CR-SB	STD	7.76	7.64	7.31	7.29	7.20	7.04 a
5	SB-SB-CR-SB-SB-CR	STD	7.81	7.68	7.38	7.34	7.24	7.00 ab
6	CR-SB-CR-SB-CR-SB	HIGH	7.82	7.68	7.44	7.22	7.22	7.03 a
7	SB-CR-SB-CR-SB-CR	HIGH	7.79	7.74	7.41	7.19	7.28	6.99 ab
8	CR-SB-SB-CR-SB-SB	HIGH	7.81	7.73	7.45	7.35	7.26	7.12 a
9	SB-CR-SB-SB-CR-SB	HIGH	7.70	7.59	7.37	7.26	7.19	7.06 a
10	SB-SB-CR-SB-SB-CR	HIGH	7.80	7.70	7.41	7.39	7.30	6.85 b
	LSD (0.05)		0.07	0.11	0.11	0.15	0.09	0.15
	Prob > F		0.0817 ns	0.2492 ns	0.1530 ns	0.2060 ns	0.4184 ns	0.0104
	C. V. (%)		1.19	2.05	2.27	2.90	2.26	4.13

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

Table SB31-P. Summary of soil phosphorus as affected by crop rotation and fertility differences in twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			---------- Soil Phosphorus–lb P/acre ----------					
1	CR-SB-CR-SB-CR-SB	STD	94 cd	84 d	78 cd	108	132 bc	59 b
2	SB-CR-SB-CR-SB-CR	STD	94 cd	87 d	77 d	105	129 bc	61 b
3	CR-SB-SB-CR-SB-SB	STD	91 d	84 d	75 d	113	126 bc	56 b
4	SB-CR-SB-SB-CR-SB	STD	98 bcd	91 cd	80 cd	112	140 b	60 b
5	SB-SB-CR-SB-SB-CR	STD	87 d	82 d	72 d	104	119 c	58 b
6	CR-SB-CR-SB-CR-SB	HIGH	117 a	122 a	94 b	107	169 a	75 a
7	SB-CR-SB-CR-SB-CR	HIGH	108 ab	107 b	94 b	106	162 a	72 a
8	CR-SB-SB-CR-SB-SB	HIGH	105 abc	111 ab	93 b	105	163 a	71 a
9	SB-CR-SB-SB-CR-SB	HIGH	117 a	110 b	106 a	109	177 a	77 a
10	SB-SB-CR-SB-SB-CR	HIGH	106 abc	103 bc	87 bc	102	166 a	75 a
	LSD (0.05)		13	13	10	8	17	8
	Prob > F		0.0003	<0.0001	<0.0001	0.2204 ns	<0.0001	<0.0001
	C. V. (%)		11.70	19.22	13.10	20.54	16.36	15.06

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

Table SB32-P. Summary of soil phosphorus as affected by crop rotation and fertility differences in twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			---------- Soil Phosphorus–lb P/acre ----------					
1	CR-SB-CR-SB-CR-SB	STD	185 d	190 a	167 bcd	161 cde	230	112
2	SB-CR-SB-CR-SB-CR	STD	195 bcd	166 c	162 d	148 de	235	108
3	CR-SB-SB-CR-SB-SB	STD	190 cd	182 abc	165 cd	147 e	231	112
4	SB-CR-SB-SB-CR-SB	STD	193 bcd	174 bc	154 d	174 abc	215	102
5	SB-SB-CR-SB-SB-CR	STD	193 bcd	183 ab	165 cd	172 bc	231	112
6	CR-SB-CR-SB-CR-SB	HIGH	194 bcd	190 ab	195 a	183 abc	235	119
7	SB-CR-SB-CR-SB-CR	HIGH	201 abc	182 ab	187 ab	160 cde	264	109
8	CR-SB-SB-CR-SB-SB	HIGH	206 ab	191 a	168 bcd	184 ab	239	126
9	SB-CR-SB-SB-CR-SB	HIGH	205 ab	184 ab	186 abc	196 a	241	126
10	SB-SB-CR-SB-SB-CR	HIGH	214 a	192 a	190 a	170 bcd	241	118
	LSD (0.05)		13	16	21	23	31	19
	Prob > F		0.0051	0.0536	0.0045	0.0024	0.2795 ns	0.2368 ns
	C. V. (%)		16.11	14.69	15.87	23.42	15.16	15.06

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

Table SB31-K. Summary of soil potassium as affected by crop rotation and fertility differences in twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			Soil Potassium–lb K/acre					
1	CR-SB-CR-SB-CR-SB	STD	383	319	282 bc	417	301	337
2	SB-CR-SB-CR-SB-CR	STD	349	275	284 bc	381	330	309
3	CR-SB-SB-CR-SB-SB	STD	414	348	334 ab	401	366	353
4	SB-CR-SB-SB-CR-SB	STD	376	304	314 ab	400	307	365
5	SB-SB-CR-SB-SB-CR	STD	350	275	250 c	392	293	286
6	CR-SB-CR-SB-CR-SB	HIGH	415	359	292 bc	394	378	386
7	SB-CR-SB-CR-SB-CR	HIGH	404	325	328 ab	398	404	355
8	CR-SB-SB-CR-SB-SB	HIGH	392	357	286 bc	388	349	327
9	SB-CR-SB-SB-CR-SB	HIGH	410	309	362 a	398	360	400
10	SB-SB-CR-SB-SB-CR	HIGH	390	319	275 bc	375	330	329
	LSD (0.05)		58	63	63	26	80	82
	Prob > F		0.2184 ns	0.0903 ns	0.0431	0.1537 ns	0.1326 ns	0.1949 ns
	C. V. (%)		15.90	19.22	21.63	12.22	25.84	22.41

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

Table SB32-K. Summary of soil potassium as affected by crop rotation and fertility differences in twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			---------- Soil Potassium–lb K/acre ----------					
1	CR-SB-CR-SB-CR-SB	STD	663	619	756	707	656	814
2	SB-CR-SB-CR-SB-CR	STD	644	597	725	680	668	775
3	CR-SB-SB-CR-SB-SB	STD	653	613	741	662	686	795
4	SB-CR-SB-SB-CR-SB	STD	657	639	740	725	644	760
5	SB-SB-CR-SB-SB-CR	STD	658	602	726	687	682	802
6	CR-SB-CR-SB-CR-SB	HIGH	660	608	771	710	664	804
7	SB-CR-SB-CR-SB-CR	HIGH	665	601	793	719	674	774
8	CR-SB-SB-CR-SB-SB	HIGH	662	607	737	737	670	801
9	SB-CR-SB-SB-CR-SB	HIGH	672	620	761	708	664	805
10	SB-SB-CR-SB-SB-CR	HIGH	686	621	771	685	664	751
	LSD (0.05)		58	37	71	68	38	85
	Prob > F		0.2024 ns	0.4777 ns	0.5991 ns	0.4911 ns	0.5827 ns	0.8346 ns
	C. V. (%)		5.46	8.39	10.46	15.18	9.07	12.85

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

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Table SB31-OM. Summary of organic matter levels as affected by crop rotation and fertility differences in twin-row production systems on sandy loam soil [SB31] at the Delta Research and Extension Center, 2012-2017 (DREC Field 12 E).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			Soil Organic Matter–%					
1	CR-SB-CR-SB-CR-SB	STD	1.12	0.93	0.89	0.96	0.80	1.03
2	SB-CR-SB-CR-SB-CR	STD	1.07	0.87	0.92	0.92	0.81	1.04
3	CR-SB-SB-CR-SB-SB	STD	1.13	0.93	0.90	0.99	0.84	1.06
4	SB-CR-SB-SB-CR-SB	STD	1.06	0.87	0.88	0.93	0.80	1.06
5	SB-SB-CR-SB-SB-CR	STD	1.11	0.88	0.95	0.96	0.84	1.02
6	CR-SB-CR-SB-CR-SB	HIGH	1.14	0.90	0.96	0.92	0.79	1.04
7	SB-CR-SB-CR-SB-CR	HIGH	1.11	0.89	0.93	0.91	0.88	1.09
8	CR-SB-SB-CR-SB-SB	HIGH	1.04	0.91	0.87	0.96	0.81	1.04
9	SB-CR-SB-SB-CR-SB	HIGH	1.08	0.84	0.91	0.95	0.78	1.03
10	SB-SB-CR-SB-SB-CR	HIGH	1.18	0.90	0.91	0.99	0.77	1.07
	LSD (0.05)		0.13	0.11	0.10	0.06	0.09	0.07
	Prob > F		0.6157 ns	0.8080 ns	0.7135 ns	0.1098 ns	0.5021 ns	0.6972 ns
	C. V. (%)		13.18	12.85	13.19	11.40	11.91	11.37

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)

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Table SB32-OM. Summary of organic matter levels as affected by crop rotation and fertility differences in twin-row production systems on clay soil [SB32] at the Delta Research and Extension Center, 2012-2017 (DREC Field 17 AA).

	Crop Sequence	Fertility	2012	2013	2014	2015	2016	2017
			------ Soil Organic Matter–% ------					
1	CR-SB-CR-SB-CR-SB	STD	1.94	1.86	2.13	2.11	1.89	2.26
2	SB-CR-SB-CR-SB-CR	STD	2.02	1.91	2.36	2.16	1.95	2.38
3	CR-SB-SB-CR-SB-SB	STD	1.95	1.92	2.13	1.95	2.02	2.25
4	SB-CR-SB-SB-CR-SB	STD	1.97	1.93	2.23	2.15	1.85	2.41
5	SB-SB-CR-SB-SB-CR	STD	2.04	1.90	2.24	2.16	1.89	2.26
6	CR-SB-CR-SB-CR-SB	HIGH	1.87	1.90	2.14	2.16	1.85	2.31
7	SB-CR-SB-CR-SB-CR	HIGH	2.06	1.96	2.32	2.32	1.91	2.34
8	CR-SB-SB-CR-SB-SB	HIGH	1.90	1.91	2.14	2.19	1.90	2.29
9	SB-CR-SB-SB-CR-SB	HIGH	1.98	1.96	2.20	2.18	1.89	2.17
10	SB-SB-CR-SB-SB-CR	HIGH	2.14	1.95	2.28	2.00	1.77	2.22
	LSD (0.05)		0.13	0.21	0.22	0.34	0.18	0.26
	Prob > F		0.1595 ns	0.9957 ns	0.3536 ns	0.6656 ns	0.4319 ns	0.7420 ns
	C. V. (%)		11.51	11.01	13.03	13.17	13.01	12.05

Crop Sequence: a) 1:1 (SB:CR) Rotation Sequence - CR/SB or SB/CR; b) 2:1 (SB-SB-CR) Rotation Sequence - CR-SB-SB, SB-CR-SB, or SB-SB-CR.
Fertility: STD = Standard Fertility (220 lb N/acre + Recommended P and K (None); HIGH = High Fertility (260 lb N/acre + 26.2 lb P/acre + 50 lb K/acre)
Values are means across four (4) subplots and four (4) replications [n=16 observations per treatment]
Soil sample analyses completed by Soil Testing and Plant Analysis Laboratory at MSU-ES (2012-2016) and Southern Soils Laboratory (2017)