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Evaluate The Effect Of Common Inputs On Soybean Grain Yield In Enhanced (High-Input) And Traditional (Low-Input) Production Systems

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ABSTRACT

The commodity price of soybean [Glycine max (L.) Merr] grain has grown by over 300% during the year 2000, piqueing farmers' interest in investing in agricultural inputs to boost soybean output. The purpose of this research was to compare enhanced (high-input) and conventional (low-input) production methods for soybeans with regard to the impact of common inputs on grain yield. The ability to select inputs that can boost soybean output on a field-by-field basis relies on an understanding of the elements that may restrict yield.

KEYWORDS Conservation agriculture, soybean grain yield, Soil.

INTRODUCTION

Through the process of industrialisation ushered in by the green revolution, conventional agriculture's stumbling blocks of soil fertility, water, and energy have been removed. Fundamental constraints on soil nutrients, water availability, and human labor were eliminated with the introduction of industrial fertilizers powered by fossil fuels, novel cultivars, and machinery, such as powered pumps. Despite improvements in land efficiency brought about by innovations in the nitrogen fertilizer business, irrigation systems, and other technology, reduced input costs have not materialized. This has resulted in significant environmental repercussions as worldwide agricultural output has quadrupled over the last 50 years.

Organically grown corn (Zea mays L.), soybeans (Glycine max (L.) Merr.), and wheat (Triticum aestivum L.) all command significant premiums, creating an economic incentive for farmers to switch to organic methods. Some farmers are considering making the switch from conventional to organic farming due to the declining prices of corn, soybeans, wheat, and red clover (Trifolium pretense L.). Comparing organic and conventional maize, soybean, or wheat farming, complete survey data showed that organic agriculture resulted in poorer yields and higher production costs per hectare. Therefore, One of the main deterrents for conventional crop producers is the possible loss of large earnings during the changeover to organic farming. Given the recent decline in the value of crops like maize, soybeans, and wheat, it is crucial for farmers to choose the best entry crop and then rotate crops while making the switch to organic farming.

LITERATURE REVIEW

Fabio Stagnari et.al (2017) In the next years, ensuring food security, reducing climate change risks, and managing rising energy demands will become more pressing concerns. This means that sustainable production is taking center stage in the agricultural and food industries. The many benefits provided by legume crops are consistent with sustainability goals and might give them a significant role in this setting. In addition to being an essential global source of high-quality food and feed, legumes play a role in climate change mitigation by releasing 5–7 times less GHG per unit area than other crops, allowing the sequestration of carbon in soils with values estimated from 7.21 g kg1 DM, 23.6 versus 21.8 g C kg1 year, and causing a reduction in fossil energy inputs in the system due to a decrease in nitrogen fertilizer, which is equivalent to 2–3 percent less Incorporating legumes into modern farming systems has been proposed as a way to increase crop diversity while decreasing dependency on non-native materials, as well as because they provide environmental and economical advantages. They do well in low-input and low-yield agricultural systems, including as conservation and intercropping methods, both of which are crucial in poor nations. Soil nutrient and water circulation are both improved by legumes, while atmospheric nitrogen is fixed by the plants. Due to their versatility as both a growing crop and a crop leftover, legumes hold great promise as a conservation agriculture tool.

B.P. Meena et.al (2016) To reduce soil erosion and boost soil fertility and other soil functions, farmers have adopted a set of methods known as conservation agriculture (CA). These activities include rotating crops and covering the soil permanently with crop residues. The CA's goal with CA-based technology is resource conservation, enhancement, and efficiency. Benefits include lower production costs, less wasted time, higher yields thanks to more precise planting, more efficient use of water, greater resilience in the face of climate change, fewer instances of disease and pests thanks to increased biological diversity, smaller ecological footprints, and better soil health. However, unless all the rules are strictly adhered to, weeds constitute a significant biotic interference in CA, offering a substantial challenge towards its success. Herbicide-tolerant crop breeding, using crop leftovers as mulch, and the introduction of post-emergence herbicides all contribute to the reduction of weeds and the maintenance of soil moisture. Increased efficiency in the use of agricultural inputs is another benefit of this kind of farming.

Yanfang Xue et.al (2016) Soil sometimes lacks sufficient quantities of the plant nutrients phosphorous (P), iron (Fe), and zinc (Zn). Higher yields and greater grain nutritional quality are good for human health because of intercropping's increased absorption of P, Fe, and Zn. Intercropping enhances plant P, Fe, and Zn availability; understanding this may help you make better use of P fertilizer and implement agronomic Fe and Zn biofortification. This study provides a concise review of the literature on the effects of intercropping legumes with cereals on the absorption of P, Fe, and Zn from soil, as well as on the translocation of nutrients from the root zone to the shoot zone and back again. Companion legumes benefit from increased bioavailability of Fe and Zn from cereals, via direct interspecific facilitation in intercropping. Molecular analysis and isotopic nutrient tracking have shown and substantiated this. Direct interspecific P facilitation requires the same methodological techniques and field research.

Increased P acquisition during intercropping may be attributed to both niche complementarity and interspecific facilitation. An underappreciated factor in the context of increasing Fe and Zn acquisition is the role that niche complementarity may play. Grain P, Fe, and Zn concentrations are determined by a number of processes beyond the interspecific mobilization and absorption facilitation of sparingly soluble P, Fe, and Zn from soil. There are a number of processes, including grain production and nutrient transfer from roots to shoots, that influence the amounts of these components found in grains.

Yingliang Yu, et.al (2014) Due to extensive irrigated rice-wheat agricultural systems, the soil in the Tai Lake region of China has been severely degraded and nitrogen loss has occurred. Since legumes contain nitrogen, using them into rice production might be beneficial. Crop rotation, soil fertility, and nitrogen loss all benefit from legumes, but their impacts are poorly understood. As a result, we studied how five different cycles including rice affected soil nitrogen, rice yields, and water erosion. Rotations included rice with wheat, rape, fallow, beans, and veg. From 2009 to 2012, researchers performed a field study in the Tai Lake area. Chemical fertilizer in rice production was supplemented with crop leftovers from rape, bean, and vetch. The findings show that replacing 9.5-21.4% of mineral nitrogen fertilizer with leftovers has no effect on rice yields in rice-rape, rice-bean, and rice-vetch cycles. In addition, the nitrogen content of rice residue was raised by 9.7-20.5% when legumes were used as a winter crop in rice-bean and rice-vetch combinations. Rice-rape, rice-bean, and rice-vetch reduced nitrogen runoff by 30-60% compared to rice-wheat. The nitrogen content of both soil minerals and microbial biomass increased when leguminous wastes were applied.

Dionys Forster et.al (2013) There has been a lot of renewed interest in the pros and cons of conventional vs organic farming in recent years. To ensure food security, agricultural development efforts throughout the world have so far concentrated on boosting output rather than on sustainable resource management. As a result, it is crucial to create industrial-scale methods of farming that are more environmentally friendly. But there is a lack of data on the efficiency of organic and conventional farming in the tropics and subtropics. This research reports on agronomic and economic findings from the Madhya Pradesh, central India, portion of a farming systems comparison experiment conducted on a Vertisol soil between 2007 and 2010. The results of a cotton-soybean-wheat crop cycle were analyzed using biodynamic, organic, and conventional agricultural practices. When comparing organic and conventional farming methods, we discovered a considerable difference in cotton and wheat yields during the first crop cycle, but by the second crop cycle, conventional yields had dropped to the point where organic and conventional yields were equivalent. Soybeans cultivated organically showed marginally lower yields than conventionally farmed soybeans. Although conventional farming systems had greater gross margins (+29%) on average across all crops in cycle 1, organic farming systems had better gross margins (+25%) in cycle 2 owing to reduced variable production costs and comparable yields. Across all four harvest years, the organic system had a much greater gross margin for soybeans (+11%) than the conventional systems. Based on our findings, smallholder farmers in India's current semi-arid climate may choose to consider organic soybean farming.

METHODS

Site Description and Experimental Design

The research was not done in the same field from 2017 to 2018, despite the fact that seven of the sites were the same. Except for the Clark, Wood, and Wayne County sites, which were performed in OARDC research facilities, all field sites were on farms. Each location had previously grown corn and was no-till in 2017, with the exception of one in Clinton County that had been minimally tilled to a depth of around 2.5 cm. At planting, at least eight soil cores, each 20 centimeters deep, were extracted and homogenized for analysis of chemical and physical characteristics (Table 1). With the exception of the 2017 Delaware site-year, for which the weather station was located one county south in Franklin County, approximately 25 km from the site, average monthly temperature and cumulative monthly precipitation were compiled from May through October using data from National Oceanic and Atmospheric Administration weather stations within the county of interest. Six rows wide and 38 centimeters apart, with the middle four rows plucked for maximum yield. Soybeans with a moisture value of 130 mg kg-1 were harvested using a Massey Ferguson Kincaid 8XP plot combine.

Statistical Analysis

The data were analyzed using SAS ANOVA and MIXED procedures at a = 0.05 significance level, with treatment as the fixed variable and replication as the random effect. Contrasts with one degree of freedom were used to determine differences in means. After removing a treatment factor from the enhanced production system and comparing it to the enhanced production system with all treatment factors present, we compared the traditional production system with the addition of the treatment factor to the traditional production system with no treatment factors present to determine the treatment effects. Due to treatment by year interactions, data from each location and year had to be evaluated independently.

DATA ANALYSIS

Growing conditions

Both experimental years' monthly average temperatures (Table 1) were within two degrees of the 30-year average. The deviation of the average monthly rainfall from the 30-year average varied from site year to site year. Precipitation totals were up to 16.9 centimeters more than normal in July 2017 and 7.7 centimeters higher than normal in June 2018. Heavy rain on July 9 led to 24 hours of standing water at the 2017 Delaware and Erie locations.

Table 1. Average monthly temperature and cumulative monthly precipitation for 2017 and 2018.

		Average temperature						Cumulative precipitation					
Site	Year	May	June	July	Aug.	Sept.	Oct.	May	June	July	Aug.	Sept.	Oct.
Clark	30 yr avg.	15.78	21.00	22.83	22.00	18.00	11.44	11.89	10.64	11.63	8.46	7.98	7.04
	2017	+1.44	-0.22	-0.72	-1.22	+0.11	+0.28	-7.72	+1.63	+1.45	-3.45	+0.03	+4.72

	2018	+0.50	+0.28	-3.11	-0.72	-1.28	-0.17	+2.44	+7.21	-2.18	-4.09	-6.07	-2.67
Clinton	30 yr avg.	16.22	21.22	22.94	22.00	18.22	12.11	13.44	9.78	10.72	7.70	7.24	7.70
	2017	+1.67	+0.06	-0.33	-0.72	+0.39	+0.17	-4.85	+7.54	+8.48	-2.51	+1.14	+1.27
	2018	+0.78	+0.56	-2.33	-0.11	-0.44	+0.28	-2.13	+3.23	+1.60	-2.16	-1.45	+2.18
Delaware	30 yr avg.	16.22	21.22	23.39	22.50	18.44	12.00	11.20	11.40	11.10	8.61	7.42	6.35
	2017	+2.67	+1.28	+0.50	+0.72	+1.33	+1.61	-7.09	-0.08	+6.35	-1.37	-1.02	+8.66
Erie	30 yr avg.	15.06	20.39	22.56	21.67	17.83	11.44	9.65	10.69	9.91	9.25	8.53	7.01
	2017	+2.56	+0.61	+0.22	-0.56	+0.39	+0.44	-5.16	+3.73	+16.94	-2.74	-2.84	+1.70
Henry	30 yr avg.	15.44	21.06	23.17	22.06	18.11	11.39	10.06	9.25	10.39	7.67	8.26	7.49
	2017	+2.44	+0.22	-0.56 +0.61	-0.67		+0.61	-3.56	+5.99	+3.30	-4.04	-4.52	-1.63
Mercer	30 yr avg.	16.50	21.44	23.11	22.17	18.61	12.28	10.11	10.34	12.22	9.02	6.60	6.73
	2017	+2.00	-0.44	-0.83	-0.44	+0.67	+0.22	-5.11	+2.31	-4.19	-5.69	-0.18	-0.61
	2018	+0.72	+0.83	-2.39	-0.28	-1.00	-0.28	+2.51	+7.70	-3.71	-1.27	+0.30	-1.12
Preble	30 yr avg.	16.28	21.39	23.28	22.56	18.72	11.83	12.95	10.54	11.00	7.44	7.11	7.65
	2017	+1.22	-0.17	-1.06	-1.06	+0.50	-0.33	-2.90	+2.74	+4.55	-3.68	+0.33	+5.89
	2018	+0.44	+0.72	-2.78	-0.56	-1.00	-0.06	-3.56	+4.90	-1.35	+3.76	-2.74	-0.56
Sandusky	30 yr avg.	15.50	21.06	23.17	22.11	18.06	11.39	10.06	10.34	8.99	8.00	7.90	7.32
	2018	+0.72	+0.83	-2.06	-0.33	-0.17	+0.00	-4.39	+1.50	-2.67	-4.78	+4.93	-2.41
Wayne	30 yr avg.	15.28	20.17	22.11	20.78	17.00	10.94	9.32	9.58	10.87	8.59	8.53	7.06
	2017	+1.11	-0.39	-0.39	-1.28	-0.78	+0.67	-4.75	+6.05	+3.07	-1.85	-1.37	+0.79
	2018	+0.44	+0.72	-1.89	-0.28	-0.39	+0.83	+1.30	+6.10	-6.73	+2.18	-5.03	-1.19
Wood	30 yr avg.	16.28	21.56	23.56	22.56	18.56	12.00	10.52	10.62	9.93	9.25	6.88	6.76
	2017	+1.61	-0.28	-0.83	-1.28	-0.17	+0.28	-6.55	+1.12	+14.02	-1.02	-0.13	+4.17
	2018	+0.33	+0.44	-2.83	-0.44	-0.78	-1.72	-5.77	+1.04	-4.78	-2.74	+4.65	-5.44

Enhanced vs. traditional production system

The upgraded production system with all inputs produced a smaller yield increase than the conventional production system with none of the inputs. Tables 2 and 3 show that the upgraded system only significantly increased yield in two of the sixteen site-years studied. The upgraded production system at the 2017 Wood County site and the 2018 Mercer County site generated 5.5% and 10.8% more, respectively, than the standard production method. The overall lack of reaction to inputs probably caused the limited yield impacts. The field locations were generally quite fruitful in both years. All fields were planted with a corn-soybean rotation, and most had only mild infestations of insects and diseases. Since yield-limiting variables were low, the absence of observed yield responses may be attributed to a confluence of these factors.

Table 2. Soybean grain yield in 2017.

Treatment	Site								
	Clark	Clinton	Delaware	Erie	Henry	Mercer	Preble	Wayne	Wood
Enhanced (E)	4.72	5.00	3.20	2.48	4.07	3.75	4.33	4.03	4.21
E – inoculant†	-0.13	-0.24	-0.52	-0.36	-0.04	+0.29	+0.14	+0.08	-0.07
E – gypsum	+0.53*	-0.11	+0.46	+0.39	+0.06	+0.06	+0.16	-0.04	-0.13
E – fungicide	-0.12	-0.79*	+0.13	+0.32	-0.35*	+0.05	+0.39	-0.11	-0.21*
E – insecticide	+0.05	-0.27	-0.55	-0.20	-0.01	+0.50*	+0.24	-0.01	-0.14
E –Mn	+0.03	+0.13	-0.28	+0.01	-0.05	+0.17	+0.25	+0.06	-0.16
Traditional (T)	4.78	4.76	2.72	2.57	3.88	3.92	4.58	3.87	3.98
T + inoculant‡	-0.47	+0.06	-0.35	-0.32	+0.08	-0.14	-0.02	+0.11	-0.01
T + gypsum	-0.08	-0.57*	+0.21	-0.41	-0.23	-0.26	+0.12	+0.10	+0.00
T + fungicide	+0.10	-0.14	+1.01	+0.43	+0.19	+0.07	-0.27	+0.16	+0.07
T + insecticide	-0.50	+0.00	-0.01	+0.37	-0.06	-0.14	+0.01	-0.09	+0.08
T + Mn	+0.19	+0.08	-0.21	+0.20	-0.09	-0.37	+0.06	-0.19	-0.01
E vs T	ns	ns	ns	ns	ns	ns	ns	ns	*

Table 3. Soybean grain yield in 2018.

	Site						
	Clark	Clinton	Mercer	Preble	Sandusky	Wayne	Wood
Treatment							
Enhanced (E)	3.51	4.57	4.06	5.50	4.16	4.13	3.42
E – inoculant†	-0.04	-0.04	-0.03	-0.11	-0.09	-0.13	+0.26
E – gypsum	-0.02	+0.21	+0.05	-0.16	-0.21	+0.10	+0.03
E – fungicide	+0.03	-0.71*	-0.21	-0.09	-0.36	-0.36*	+0.09
E – insecticide	+0.12	-0.33	-0.22	-0.04	-0.46	-0.32*	-0.01
E –Mn	-0.03	+0.16	-0.06	+0.04	-0.54*	-0.06	-0.01
Traditional (T)	3.49	4.32	3.62	5.55	3.73	4.09	3.21
T + inoculant‡	+0.01	+0.06	+0.30	-0.19	+0.30	-0.27	-0.20
T + gypsum	+0.08	-0.26	+0.03	-0.50*	+0.02	-0.31*	-0.06
T + fungicide	+0.08	+0.22	+0.47*	+0.13	+0.25	-0.05	+0.22
T + insecticide	+0.07	+0.06	+0.24	+0.05	-0.07	-0.30	+0.25
T + Mn	+0.05	+0.14	+0.05	-0.19	+0.01	-0.24	+0.13
E vs T	ns	ns	*	ns	ns	ns	ns

A 0.45 Mg ha-1 average yield improvement as compared to the conventional production method was achieved in three of the sixteen site-years (Tables 4 and 5). The upgraded production method increased yield by 0.06 Mg ha-1 on average throughout the other 13 site-years as compared to the conventional system.

Table 4. Omission trial design, treatment names, and list of inputs applied in 2017 and 2018.

Trt	Treatment			Inputs		
#	name	Inoculant†	Gypsum‡	Fungicide∫	Insecticide§	Mn^{2+}ℓ
1	Enhanced (E)	Yes	Yes	Yes	Yes	Yes
2	E – inoculant	No	Yes	Yes	Yes	Yes
3	E – gypsum	Yes	No	Yes	Yes	Yes
4	E – fungicide	Yes	Yes	No	Yes	Yes
5	E – insecticide	Yes	Yes	Yes	No	Yes
6	E – Mn	Yes	Yes	Yes	Yes	No
7	Traditional (T)	No	No	No	No	No
8	T + inoculant	Yes	No	No	No	No
9	T + gypsum	No	Yes	No	No	No
10	T + fungicide	No	No	Yes	No	No
11	T + insecticide	No	No	No	Yes	No
12	T + Mn	No	No	No	No	Yes

Table 5. Dates field activities were performed including planting date, gypsum application date, chemical application date at R3 of the fungicide, insecticide, and manganese (Mn) foliar fertilizer, and harvest date for all site-years.

Year	Site	Planting	Gypsum	Chemical	Harvest
		--------------------		date------------------------	
2017	Clark	21 May	29 May	30 July	11 Oct.
2017	Clinton	22 May	3 June	29 July	27 Oct.
2017	Delaware	20 May	5 June	5 Aug.	28 Oct
2017	Erie	29 May	11 June	5 Aug.	30 Oct.
2017	Henry	16 May	31 May	30 July	14 Oct.
2017	Mercer	17 May	29 May	31 July	15 Oct.
2017	Preble	15 May	24 May	30 July	21 Oct.
2017	Wayne	21 May	11 June	2 Aug.	5 Nov.
2017	Wood	16 May	4 June	1 Aug.	2 Oct.
2018	Clark	31 May	19 June	5 Aug.	4 Nov.
2018	Clinton	28 May	10 June	5 Aug.	30 Oct.
2018	Mercer	25 May	9 June	4 Aug.	25 Oct.
2018	Preble	22 May	29 May	4 Aug.	3 Nov.
2018	Sandusky	30 May	18 June	6 Aug.	27 Oct.

2018	Wayne	3 June	29 June	7 Aug.	11 Nov.
2018	Wood	29 May	18 June	6 Aug.	10 Nov.

CONCLUSION

In areas that had been growing corn and soybeans in a rotation for many years, there were no Mn or S deficits and pest pressure was low, thus the foliar application of Mn did not significantly affect grain output. The severity of frogeye leaf spot and brown leaf spot diseases was significantly reduced when pyraclostrobin fungicide was applied. These results indicate that the disease-reducing effects of the fungicide pyraclostrobin are likely responsible for the positive yield responses seen in high-yielding systems.

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