Impacts of cover cropping system on soybean grain yield, soil health, forage production, and animal performance, 06-2021

Annual Report

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BACKGROUND AND OBJECTIVES

Agriculture is faced with challenges and opportunities that are impacted by a range of societal and ecological concerns about how the world and its people can be sustained. There is a growing awareness that the stability and resiliency of our agricultural landscapes appear to be impaired by enterprise specialization, concentration of operations, and expansion of scale, which can disrupt energy and nutrient cycles beyond natural processes. In Mississippi, opportunities exist to combine crop and livestock enterprises in a manner that imparts major benefits to the environment, while simultaneously generating more revenue for agricultural producers. These integrated crop-livestock systems (ICLS) can potentially increase crop yields, enhance natural resource utilization, exploit natural pest control processes, reduce nutrient concentrations and environmental risk, improve soil health parameters, and provide alternative sources of revenue through livestock marketing.

This project seeks to evaluate the impact of cover cropping and livestock grazing on two distinct soil types to determine the ability for ICLS to be profitable in Mississippi soybean production systems. The objectives of this project are: 1) determine the impact of integrated livestock cover crop systems on soybean growth and grain yield; 2) monitor the change in soil physical, chemical, and biological properties during each phase of production; and 3) assess the economic productivity of each system. Data collection will include soybean grain yield, soil health parameters, cover crop biomass and nutritive value, animal weight gain, and economic comparisons within each system.

Our team, comprised of plant, animal, and economic specialists, combined with ideal locations for testing, is well-positioned to produce quality data that will be of great benefit to both Mississippi soybean growers, and livestock producers throughout the state. Our hypothesis is that the integration of livestock into traditional soybean production systems will increase net economic returns through greater soybean yield and livestock marketing, while simultaneously improving soil health.

REPORT OF PROGRESS/ACTIVITY

Objective 1: Determine the impact of integrated livestock cover crop systems on soybean growth and grain yield.

Forrest Davis was selected as the graduate student assigned to this project. Mr. Davis has a Bachelor of Science degree from the University of North Alabama and began summer coursework and field activities in July 2021. The decision was made to forego soybean planting in the spring of 2021 to prepare replicated paddocks at each site for optimum cover crop planting in the fall of 2021. At Prairie, paddocks were predominantly tall fescue pasture that needed significant vegetation control and tillage to support cover crop planting and subsequent soybean production. All paddocks were sprayed (64 oz ac^{-1} glyphosate) and disked for site preparation. Cover crops were planted on Oct 13 and 18 for the Newton and Prairie locations, respectively. Plots were fertilized with 50 lb N ac^{-1} at planting in Prairie, and on Nov 3 in Newton. Solid

stands were achieved at each location (**Figure 1** and **2**). In Newton, grazing commenced in CG paddocks on Dec 14 and were removed on Jan 14 (31-d). In Prairie, grazing commenced on Jan 19 and ended on Jan 26 (7-d). All GC paddocks at both locations were fertilized with an additional 50 lb N ac^{-1} in preparation for a second grazing cycle. Average daily gain (ADG), gain per acre (GAIN), and animal days (AD) can be found in **Table 1**. Upon completion of the grazing season (approximately Apr 1), all paddocks will be desiccated and prepared for soybean planting.

Objective 2: Monitor the change in soil physical, chemical, and biological properties during each phase of production.

Soil moisture and core samples were collected at Newton and Prairie on Oct 18 and 22, respectively. Samples were submitted to the Cornell Soil Health Laboratory. Soil compaction (PSI), organic matter (OM), available P and K, water holding capacity (WHC), and respiration for each treatment by location can be found in **Table 2**. All samples taken at Prairie followed tillage, seed bed preparation, and cover crop planting. At Newton, however, soil samples were collected from paddocks that were not tilled (no-till planting of cover crop). The next soil sampling date will be at soybean planting for each location.

IMPACTS AND BENEFITS TO MISSISSIPPI SOYBEAN PRODUCERS

Small grains are excellent choices for use as cover crops in protecting soil from erosion, nutrient scavenging, increasing organic matter, and enhancing soil structure in no-till settings. However, costs associated with planting cover crops often out-weighs potential benefits. Utilizing livestock may help account for these costs, and aid in nutrient cycling by returning undigested nutrients back into the soil profile through urine and manure. Partnering row crop and beef cattle enterprises has the potential to increase soybean acreage across the state, while simultaneously providing additional revenue outlets for soybean and cattle producers.

END PRODUCTS – COMPLETED OR FORTHCOMING

Davis, F., B. Rushing, J. McCoy, K. Harvey, and J. Maples. 2023. (Thesis). Impacts of cover cropping system on soybean grain yield, soil health, forage production, and animal performance. Mississippi State University. Mississippi State, MS 39762.

Rushing, B., J. White, B. Karisch, K. Harvey, and F. Davis. 2022. Impacts of cover cropping system on soybean grain yield, soil health, forage production, and animal performance. Beef Cattle Field Day. Newton, MS. 31, Mar.

Davis, F. and B. Rushing. 2022. Grazing and tillage effect on cover crop and soybean performance in an integrated crop-livestock system. American Society of Agronomy Southern Branch. New Orleans, LA. 11-14, Feb.

Rushing, B., J.C. Lyles, B. Bass, K. Waddell, and F. Davis. 2022. Impacts of grazing cover crops on animal performance, crop production, and soil health in east-central Mississippi. American Forage and Grassland Council Annual Conference. Wichita, KS. 10-12, Jan.

Harvey, K., C. Rutherford, B. Rushing, L. Durst, D. Shaw, J. McCool, and I. Jumper. 2021. Impacts of cover cropping system on soybean grain yield, soil health, forage production, and animal performance. Fall Beef Cattle Field Day. Prairie, MS. 19, Nov.

Remaining outputs include successful completion of master's thesis by Mr. Forrest Davis in the fall of 2023, presentations at local (field days and county meetings), regional (Southern Pasture and Forage Crop Improvement Conference, American Society of Agronomy – Southern Branch), national (American Forage and Grassland Council), and international (International Grassland Conference) meetings.

GRAPHICS/TABLES

Figure 1. Six of the nine replicated 2-ac paddocks located at the Coastal Plain Branch Experiment Station (CPBES) in Newton, MS.

Figure 2. Replicated paddocks (5-ac) from the Prairie Research Unit (PRU) in Prairie, MS.

Table 1. Animal performance data, 2021-2022; Prairie Research Unit (PRU) and Coastal Plain Branch Experiment Station (CPBES).

Location	ADG (lb hd^{-1} d^{-1})†	GAIN (lb ac^{-1}) †	AD (d ac^{-1}) †	SD (lb ac^{-1}) †
CPBES	2.69	166.7	62	1509
PRU	3.89	98.1	25	1821

†ADG – average daily gain; GAIN – gain per acre; AD – animal days; SD – stocking density.

Table 2. Selected soil characteristics taken from samples collected in the fall of 2021; Prairie Research Unit (PRU) and Coastal Plain Branch Experiment Station (CPBES).

Variable	Compaction	OM †	P †	K †	Total C	WHC †	Respiration
	PSI	%	lb ac^{-1}	lb ac^{-1}	lb ac^{-1}	g g^{-1}	mg CO_2 g^{-1}
CPBES							
UG †	305	2.1	23.9	50.3	4.2	0.21	0.17
GC †	350	1.8	47.1	30.6	4.1	0.21	0.24
CS †	304	1.9	92.8	26.3	4.5	0.23	0.26
PRU							
UG	166	5.0	2.2	195.7	9.4	0.25	0.77
GC	148	4.8	2.1	247.4	9.3	0.24	0.76
CS	179	4.7	1.9	189.7	8.8	0.25	0.80

†OM – organic matter; P – phosphorus; K – potassium; WHC – water holding capacity; UG – un-grazed cover crop; GC – grazed cover crop; CS – conventional soybean.