Impacts of Cover Cropping System on Soybean Grain Yield, Soil Health, Forage Production, and Animal Performance, 06-2022

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 (funded graduate student) is currently in his second year of coursework and data collection. Cover crops were planted for the second year of analysis on Oct 5 and 25 for CPBES and PRU, respectively (**Figures 1** and **2**). As of date, grazing is underway at CPBES for the second grazing cycle and has yet to be initiated at PRU for the 2023 growing season. Average daily gain (ADG), gain per acre (GAIN), animal days (AD), and stocking density (SD) can be found in **Table 1** from data collected in 2022. Data collection for grazing in 2023 is underway. Soybeans were planted on Apr 25 and Jun 6, 2022 at CPBES and PRU, respectively. For 2022, each paddock was fertilized with respective fertilizer applications based on soil test recommendations for soybean production. At CPBES, all paddocks received 120 lb K_2O ac^{-1} in a split application (emergence and V3), while PRU paddocks received 60 lb P_2O_5 ac^{-1} and 90 lb K_2O ac_{-1} in a

single application at planting. Soybeans were planted at CPBES on 30" row spacings and twin-row 38" rows at PRU; both with a no-till planter equipped with row cleaners, double-disk openers, and spiked-tooth press wheels. Soybeans were harvested on Sep 22 and Oct 19 at CPBES and PRU, respectively. Soybean yield for each treatment x location combination can be found in **Figure 3**. Soybean planting for the 2023 season is anticipated for late April at CPBES and mid-May for PRU.

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

Soil moisture and core samples have been collected at Newton and Prairie across 3 sampling dates (fall 2021, spring 2022, and fall 2022). All samples have been analyzed by the Cornell Soil Health Laboratory. Soil biological (OM – organic matter and soil respiration), physical (AS – aggregate stability and WHC – water holding capacity), and chemical (TC – total carbon, TN – total nitrogen, P, and K) characteristics for each treatment x location combination can be found in **Table 2**. The next soil sampling date will be at soybean planting for each location in spring of 2023.

Objective 3: Assess the economic productivity throughout each phase of production.

No economic analysis has been conducted thus far in the project. However, costs incurred for each site (i.e., spraying, tillage, labor, seed, herbicide, etc.) are being noted which will be used in final analysis. Also, data collection for historical cattle and soybean prices are being gathered for future risk analysis.

*The data collected thus far in the project is preliminary and is not intended for final use by producers.

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.

Davis, F. and **B. Rushing.** 2023. Integrated crop-livestock systems in Mississippi. Beef Cattle Field Day. Coastal Plains Branch Experiment Station. Newton, MS. 30, Mar.

Rushing, B. 2023. Integrated crop-livestock systems and grazing management. Cool-season forage and grazing management Field Day. H.H. Leveck Research Farm. Mississippi State, MS. 17, Mar.

Davis, F., **B. Rushing**, K. Harvey, J. Maples, and J.C. Lyles. 2023. The effects of grazing cover crops and soybean production on soil health parameters. NMREC Producer Advisory Meeting. 16, Feb.

Rushing, B., F. Davis, K. Harvey, J. Maples, and J.C. Lyles. 2023. The effects of grazing cover crops on animal performance and soybean production. NMREC Producer Advisory Meeting. 16, Feb.

Davis, F., **B. Rushing**, K. Harvey, J. Maples, and J.C. Lyles. 2023. The effects of grazing cover crops and soybean production on soil health parameters. Southern Cover Crops Council. Baton Rouge, LA. 14-15, Feb.

Rushing, B., F. Davis, K. Harvey, J. Maples, and J.C. Lyles. 2023. The effects of grazing cover crops on animal performance and soybean production. Southern Cover Crops Council. Baton Rouge, LA. 14-15, Feb.

Rushing, B. Forage Management in Mississippi. Marshall County Cattlemen's Association. Holly Springs, MS. 19, Jan.

Davis, F.E. **B. Rushing**, K. Harvey, J. Maples, and J.C. Lyles. 2023. Utilizing cover crops as winter forage in an integrated crop-livestock system. American Forage and Grassland Council Annual Conference. Winston-Salem, NC. 8-11, Jan.

Rushing, J.B. B. Bass**,** and J.C. Lyles. 2023. The effects of grazing cover crops on animal performance and soybean production. American Forage and Grassland Council Annual Conference. Winston-Salem, NC. 8-11, Jan.

Rushing, B. 2022. Forage Management in Mississippi. Mississippi Cattlemen's Association Annual Convention. Jackson, MS. 2-3, Dec.

Rushing, B. 2022. Forage Management in Mississippi. Walthall County Cattlemen's Association. Tylertown, MS. 13, Sep.

Rushing, B. 2022. Forage Management in Mississippi. Attala County Cattlemen's Association. Kosciusko, MS. 22, Aug.

Rushing, B. 2022. Forage Management in Mississippi. Leake County Cattlemen's Association. Carthage, MS. 18, Aug.

Rushing, B. 2022. Forage Management in Mississippi. Smith County Cattlemen's Association. Raleigh, MS. 16, Aug.

Rushing, B. 2022. Integrated crop-livestock systems in the southeastern U.S. Southern Forage and Pasture Crop Improvement Conference. Asheville, NC. 26-28, July.

Davis, F. and **B. Rushing**. 2022. Utilizing cover crops as winter forage in an integrated crop-livestock system. Southern Forage and Pasture Crop Improvement Conference. Asheville, NC. 26-28, July.

Rushing, B. 2022. Grazing cover crops. Cool-Season Forage Field Day. H.H. Leveck Animal Research Farm. Mississippi State, MS. 4, 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, J.B. and B.S. Bass. 2022. Impact of grazing on soil health in integrated crop-livestock systems. American Society of Agronomy Southern Branch. New Orleans, LA. 11-14, Feb.

Rushing, J.B., J.C. Lyles, B.S. Bass, K.R. Waddell, and F.E. 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.

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.

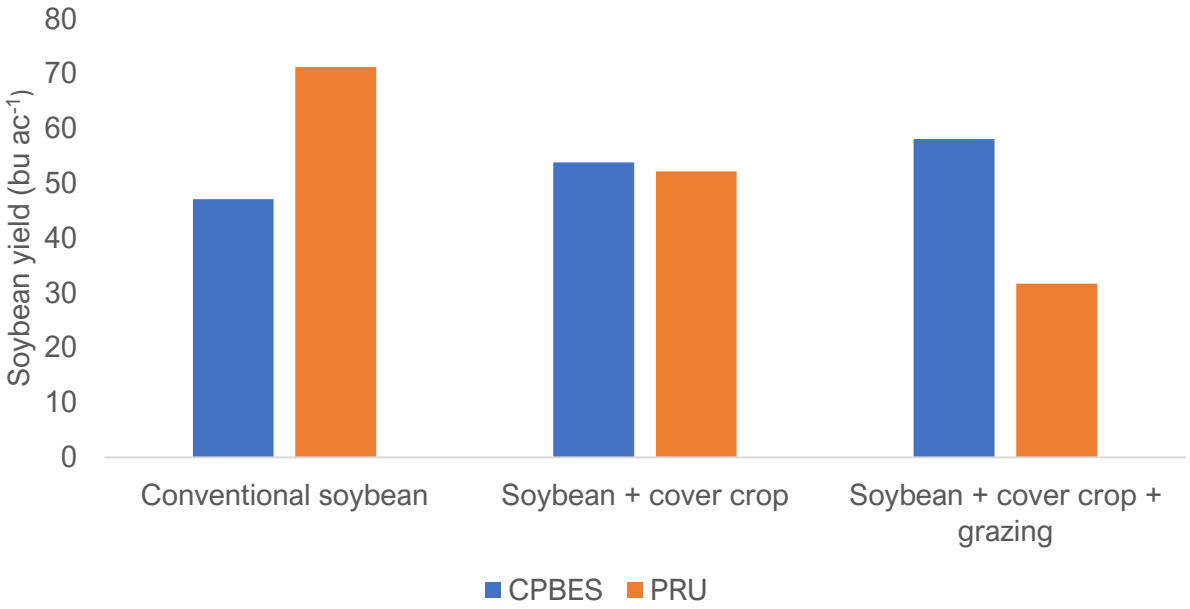

Figure 3. Soybean yield data, 2022; Prairie Research Unit (PRU) and Coastal Plain Branch Experiment Station (CPBES).

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

Variable	Location	
	CPBES	**PRU**
Cover crop		
FM† (lb ac^{-1})	5,996	2,117
CP† (%)	25	15
TDN† (%)	56	57
Animal		
ADG† (lb hd^{-1} d^{-1})	2.69	3.89
GAIN† (lb ac^{-1})	166	98
AD† (d ac^{-1})	62	25
SD† (lb ac^{-1})	1,509	1,821

†FM – cumulative forage mass; CP – crude protein; TDN – total digestible nutrients; ADG – average daily gain; GAIN – gain per acre; AD – animal days; SD – stocking density.

Table 2. Selected soil characteristics taken from samples collected from three sampling dates (fall 2021, spring 2022, and fall 2022); Prairie Research Unit (PRU) and Coastal Plain Branch Experiment Station (CPBES).

Variable	Biological		Physical		Chemical			
	OM† (%)	**Respiration mg CO_2/g soil**	**AS† (%)**	**WHC† (%)**	**TC† ppm**	**TN† ppm**	**P† ppm**	**K† ppm**
CPBES								
CS†	2.84	0.49	12.07	0.23	1.87	0.16	16.42	40.91
CC†	3.35	0.52	16.59	0.22	2.12	0.18	5.25	45.95
GC†	2.86	0.50	15.44	0.22	2.01	0.17	10.44	37.83
PRU								
CS	5.38	0.66	65.19	0.25	2.63	0.22	1.37	59.99
CC	5.70	0.77	65.75	0.25	2.85	0.23	1.96	59.58
GC	5.45	0.76	65.59	0.24	2.81	0.22	1.86	84.16

†OM – organic matter; AS – aggregate stability; WHC – water holding capacity; TC – total carbon; TN – total nitrogen; P – phosphorus; K – potassium; CS – conventional soybean; CC – cereal rye + no-till soybean; GC – grazed cereal rye + no-till soybean.