MISSISSIPPI SOYBEAN PROMOTION BOARD

TITLE: Improving dryland soybean yield, profit and health of dominant soils across Mississippi

PROJECT NO: 62-2021

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Rationale/Justification:
Soybean is the most important crop in Mississippi in both acreage and value. In 2018, the Mississippi soybean harvested area was 2.19 million acres and had a total value of $1.104 billion, which surpasses other major crops combined. Because approximately 51% is grown under rainfed conditions, improving non-irrigated soybean yield and reducing production costs will be critical strategies for Mississippi producers to remain profitable. The majority of the annual rainfall in Mississippi occurs in the fallow season in December through April. During the soybean growing season (May to September), insufficient and erratic rain is a major limitation for dryland soybean production often resulting in low and inconsistent grain yield. Researchers have demonstrated that a 1% increase in soil organic matter (SOM) can improve soil water holding capacity by 20%. Thus, any management practice that increases SOM is likely to improve soil water holding capacity and water infiltration rate and conserve more rain water in the soil. The effectiveness of those practices to increase rainfed soybean yield and rain water use efficiency have received little attention and the financial returns and costs of each option are also unknown. Dryland grain yield is a function of the interactive effects of management practices with soil types, weather patterns, and many ecological and geographic variables. Field trials alone are often not sufficient to account for all such interacting variables and determine management options that are optimal for different soils under various growing environments. However, the use of field-calibrated crop simulation models, is considered a powerful tool for integrating the multitude of crop production variables and then selecting ideal management options with a given cropping-system scenario.

Objective 1: Determine cost-effective management practices to stabilize or improve dryland soybean yield and economic return in major soil types and growing environments across Mississippi. This research will determine the effectiveness of cover crop during the fallow season, broiler litter, municipal biosolids and biochar for improving soil health and increasing soil water infiltration, soil water holding capacity and organic matter, and minimizing runoff.

Cover crop and application of poultry litter and biosolids may help dryland grain production by making the soil fluffier (reducing bulk density), increasing organic matter, moisture holding capacity and infiltration rate, and improving aggregate stability and water use efficiency. In order to identify effective management practices for stabilizing or increasing dryland soybean yields, soil health and soybean water productivity. We evaluated management practices of broiler litter, municipal biosolids, and cover crop during the fallow season across north central Mississippi.

1.1 Identify the effectiveness of cover crop, broiler litter and biochar for improving soil health and increasing soil water infiltration, soil water holding capacity and organic matter

The objective was to determine how much more water could be retained by improving soil carbon for different soils, how much soil carbon could be increased, what is the range and maximum value of soil carbon, under what cropping systems/management practices could be improved.

Quarter 1: Activities listed for this quarter

We collected 400 soil samples from either commercial fields or experiment plots receiving organic fertilizer such as poultry litter or inorganic fertilizer at various rates and timing under different cropping systems including cover crops, no-till, minimum and conventional tillage in Coffeeville, Grenada, Choctaw (Neshoba county), Tucker, and Brooksville. We took 176 soil samples at three depths (0-5, 5-10, 10-15 cm) in five private commercial farm fields amended by biochar and chicken litter for 2-10 years in Grenada and Coffeeville. The goal is to find better management practices for improving soil organic matter, stabilizing or increasing rainfed soybean yields and rain water use efficiency. We took 230 soil samples with high organic matter at 0-5 and 5-10 cm depths in three commercial high tunnel farms in Choctaw, Tucker, and Bountiful Harvest Farms. The goal is to determine how much organic matter content in soils starts increasing rain water infiltration and retention in soils for improving water use efficiency of rainfed farmlands, and the maximum infiltration and retention levels could be increased by soil organic matter improved in soil by management practices.

In our lab, currently, we measure bulk density, soil aggregates size and water stable aggregates, soil texture, soil water retention curve, soil saturated hydraulic conductivity, soil water field capacity and plant wilting point water content, pH and EC, total soil carbon and nitrogen, soil chemical elements (P, K, Cu, Mg, Na, Cu, Fe, Mn, Zn) using ICP.

Quarter 2: Activities listed for this quarter

We continuously measure those soil samples for bulk density, soil aggregates size and water stable aggregates, soil texture, soil water retention curve, soil saturated hydraulic conductivity, soil water content at field capacity and plant wilting point, pH, EC, total soil carbon, nitrogen, and other soil chemical elements (P, K, Cu, Mg, Na, Cu, Fe, Mn, Zn).

I worked with extension specialist and editors, and reported our MSPB supported study regarding effect of poultry litter applications on soil physical properties to the soybean growers and general publics. The following articles with hyperlinks to the webpages were written and published:

1) Effect of Poultry Litter Applications on Soil Physical Properties on the website of Mississippi-crops.com, 2021. The work was reported in MSU Extension publication, the newsletter (goes by 1600 emails) of Mississippi Crop Situation and posted on the blog and tweets with 2500 followers, LinkedIn about 700 more exposures.
2) Poultry litter’s efficiency as fertilizer studied | The Western Producer. July 22 issue of Western Producer, 2021.
3) The surprising power of chicken manure” news story on the Agronomy, Crops and Soils web pages: soils.org, agronomy.org and crops.org and CSA news. 2021

In the attached report, the MSPB work and the articles as above were reported by 41 Canadian and American social media, reached over 3.6 million people, and the publicity was worth almost $10K.

1.2 Studies of Cover Crop and Brolier Litter at MSU Pontotoc Experiment Station in Pontotoc County

Quarter 1: Activities listed for this quarter

The Pontotoc field experiment was continued this year, in collaboration with Dr. Mark Shankle. It is an eight acre field which contains 2 types of soils, Atwood and Cascilla silt loam soils. On 10/15/2020, five different cover crop species were planted with three different fertilizer treatments. The five cover crops consisted of: wheat, cereal rye, vetch, mustard/cereal rye, and native vegetation. The three fertilizer treatments were poultry litter, standard pelletized fertilizer, and no fertilizer. These were combined to create 15 different plots, which were replicated four times. The cover crops were terminated on April 19, 2021. Asgrow soybean (AG45×F0) was planted on April 27, 2021 at the seeding rate of 128,000 seeds/ac on 30 inch rows.

From May 14- June 3, we installed 30 tubes of PR2 probe (Dynamax Inc.) required to measure soil moisture at depths of 0-10, 10-20, 20-40, 40-60, 60-90, and 90-100 cm. While installation, we took soil samples at those depths and measured soil gravimetric water content. We also took 45 undisturbed soil core samples at 0-5 and 5-10 cm depth in three plots of each treatment. We will measure bulk density, soil aggregates size and water stable aggregates, soil texture, soil water retention curve, soil saturated hydraulic conductivity, soil water field capacity and plant wilting point water content. Every other week, we went to field and took ground measurements of soil moisture, LAI, biomass, plant height, cover and phenology, chlorophyll content using SPAD meter and stomatal conductance by Licor 600. Meanwhile, we fly drone to take UAV remote sensing images. In this quarter, we have measured soil moisture and plant parameters as above for 4 times on 6/3, 6/17, 7/1, and 7/16.

Quarter 2: Activities listed for this quarter

In this quarter, we measured soil moisture and plant parameters (LAI, biomass, plant height, cover and phenology, chlorophyll content and stomatal conductance) for 4 times on 8/3, 8/17, 9/1, and 9/16. Meanwhile, we flew drone to take UAV remote sensing images on those dates.

It appears soybean was more healthy in the plots where vetch, cereal rye with mustard growed off soybean season (Table 1 & 2). There was no much difference in the chlorophyll index of soybean among different cover crops (Table 4). It indicated cover crop did not make difference in N availability, however, soybeans in the plots received poultry litter had greater chlorophyll index (Table 4), which suggests that poultry provided more N to soybeans than commercial fertilizer. Soybeans in those plots grew much better too (Table 1-3).

Table 1. Dry biomass of soybean planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), measured at R6 stage on Aug. 17, 2021.

	CR	**CRm**	**NV**	**VE**	**WH**	**Avg**
Fert	10.16	9.62	8.50	13.47	6.84	**9.72**
None	5.59	6.88	8.77	5.81	2.64	**5.94**
PL	12.46	16.84	10.38	12.31	12.51	**12.90**
Avg	**9.41**	**11.11**	**9.22**	**10.53**	**7.33**	

Table 2. Leaf area index of soybean planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), measured at R6 stage on Aug. 17, 2021.

	CR	**CRm**	**NV**	**VE**	**WH**	**Avg**
Fert	2.69	3.00	2.32	2.54	4.00	**2.91**
None	1.68	1.61	1.94	3.14	1.74	**2.02**
PL	3.06	3.10	3.22	4.27	3.87	**3.50**
Avg	**2.47**	**2.57**	**2.49**	**3.32**	**3.20**	

Table 3. Plant height of soybean planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), measured at R6 stage on Aug. 17, 2021.

	CR	**CRm**	**NV**	**VE**	**WH**	**Avg**
Fert	113.60	102.80	112.00	114.00	116.20	**111.72**
None	76.20	86.80	98.60	93.20	93.80	**89.72**
PL	121.20	122.40	124.40	141.20	115.80	**125.00**

Avg	**103.67**	**104.00**	**111.67**	**116.13**	**108.60**	

Table 4. The chlorophyll index of leaves of soybean planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), measured at R6 stage on Aug. 18, 2021.

	CR	CRm	NV	VE	WH	Avg
Fert	44.0	41.6	39.4	40.3	44.0	**41.9**
None	43.7	39.8	40.1	41.2	40.9	**41.1**
PL	43.0	46.3	42.2	44.8	44.8	**44.2**
Avg	**43.6**	**42.6**	**40.5**	**42.1**	**43.2**	

Quarter 3: Activities listed for this quarter

We took soil samples at the depths of 0-5 cm and 5-10 cm on June 3, then measured saturated soil hydraulic conductivity (Ksat) in late July and early Aug. 2021. The Ksat values shown in Table 5 indicates how fast rain water could get into soil. The Ksat values were identical for all plots grown different cover crops, which indicated that cover crops have not yet been able to change Ksat. Poultry litter increased Ksat by 8% (1.49 vs. 1.38 cm min^{-1}) compared with the soil received commercial fertilizer. In other words, the fields treated with poultry litter could allow more rain water percolate into soil faster, it is in particular critical for intensive rainstorms. Intensive rainfall and intermittent drought frequently occurs in the region. Therefore, more rain water retained in soil help in the mitigation of intermittent drought.

Table 5. The saturated soil hydraulic conductivity (unit: cm min^{-1}) in plots of different fertilizer treatments, receiving Fert (inorganic fertilizer) and PL (poultry litter).

	CR	CRm	NV	VE	WH	Avg
Fert	1.5155	1.3311	1.3986	1.3166	1.3595	**1.3843**
None	1.4166	1.4717	1.4313	1.3727	1.4466	**1.4278**
PL	1.4285	1.4285	1.4940	1.6103	NOT TESTED	**1.4903**
Avg	**1.4535**	**1.4104**	**1.4413**	**1.4332**	**1.4031**	

As averaged soil water content in top soil (0-35 cm) of all plots planted different cover crops for each of fertilizer treatment, we found soil water content was lower than other two treatments in May, probably because poultry litter application produced more cover crop and soybean biomass which consumed more water in soil. Because the lower water content increased soil water storage capacity, in addition, the plots received poultry liter had greater Ksat values (Table 5) which indicate rain water can get into water quickly, therefore, it is beneficial for those plots to store more rain water for meeting soybean water requirement during critical growing stages.

Table 7 shows that soil water content in Vetch plots were lower than other cover crops, also in May before soybean grow up. No much difference in soil water content among the cover crop treatments after June.

Table 6. The soil volumetric water content of top soil (0-35 cm) in plots receiving Fert (inorganic fertilizer), PL (poultry litter) and nothing (None) on different dates (Month/Day).

Treatment	5/14	5/18	5/19	5/20	5/24	5/26	5/27	6/3	6/17	7/1	7/16	8/3	8/17	9/1	9/16
Fert	0.36	0.30	0.35	0.36	0.36	0.35	0.36	0.35	0.36	0.35	0.34	0.33	0.32	0.37	0.39
None	0.36	0.33	0.35	0.34	0.34	0.35	0.36	0.34	0.34	0.34	0.34	0.33	0.32	0.37	0.38

PL	0.22	0.27	0.29	0.31	0.32	0.33	0.33	0.34	0.35	0.33	0.32	0.32	0.31	0.36	0.37

Table 7. The soil volumetric water content of top soil (0-35 cm) in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), measured on different dates (Month/Day).

Treatment	5/14	5/18	5/19	5/20	5/24	5/26	5/27	6/3	6/17	7/1	7/16	8/3	8/17	9/1	9/16
CR				0.37	0.36	0.37	0.34	0.34	0.34	0.34	0.33	0.31	0.30	0.36	0.37
CRm			0.35	0.34	0.34	0.33	0.33	0.33	0.34	0.33	0.33	0.32	0.31	0.36	0.35
NV		0.33	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.34	0.34	0.34	0.33	0.38	0.40
VE	**0.17**	**0.22**	**0.29**	**0.29**	**0.29**	**0.32**	**0.33**	**0.33**	**0.35**	**0.32**	**0.32**	**0.30**	**0.30**	**0.35**	**0.38**
WH	0.33	0.35	0.35	0.34	0.36	0.36	0.36	0.37	0.36	0.36	0.35	0.35	0.33	0.38	0.38

Quarter 4: Activities listed for this quarter

We randomly sampled 5 plants in each of all plots, then oven dried at 65ºC for 2 days, weighted and calculated grain yield based on the plant numbers we counted in 1 m long row at 30 in row space. The yield data in Table 8 might be greater than the data from combine harvested soybeans. Table 8 clearly shows that the plots amended with poultry litter had the greatest yield compared with the plots without fertilization (82 vs. 50 bu/ac) or the plots applied with commercial inorganic fertilizer (82 vs. 69 bu/ac). As we averaged data for each cover crop across fertilizer treatments, the lowes yield was observed in native vegetation plots, which suggest that cover crop did play a role in soybean production. The great yield was found in plots with vetch and winter wheat, followed by cereak rye and cereal rye with mustard. Thos yield data are consistent with the total biomass data shown in Table 9, which indicate PL produced large and healthy plants. More number of pods (Table 12) instead of the number of seeds (Table 11) and weight of seeds (Table 10) contributed to the greater yield in PL plots. It is different for the impact of cover crop, the low yields in plots with native vegetation and cereal rye with mustard resulted from both leass number of seed and pods of their plants. No much difference in seed weight was found among either fertilizer treatments or cover crop treatments.

Table 8. Grain yield (by/ac) based on dry weight at 65ºC of 5 plants and the plant numbers in 1 m long row, soybean was planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), sampled on Sept. 16, 2021.

	CR	CRm	NV	VE	WH	Avg
Fert	79.37	83.03	57.26	74.54	83.51	68.46
None	45.64	51.19	41.46	60.58	50.51	49.88
PL	85.19	64.92	75.10	91.97	90.81	81.60
Avg	70.07	66.38	57.94	75.69	73.87	

Table 8b, Grain yield (kg/m^2)

	CR	CRm	NV	VE	WH	Avg
Fert	0.53	0.56	0.38	0.50	0.56	0.46
None	0.31	0.34	0.28	0.41	0.34	0.34
PL	0.57	0.44	0.50	0.62	0.61	0.55
Avg	0.47	0.45	0.39	0.51	0.50	

Table 9. Dry total biomass (kg/m^2)at 65ºC of 5 plants and the plant numbers in 1 m long row, soybean was planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), sampled on Sept. 16, 2021.

	CR	CRm	NV	VE	WH	Avg
Fert	1.02	1.06	0.76	0.95	0.99	0.63
None	0.57	0.65	0.54	0.76	0.64	0.63
PL	1.14	0.98	1.01	1.18	1.14	1.09
Avg	0.91	0.89	0.77	0.96	0.92	

Table 10. Dry weight of 1000 seeds 5 plants at 65ºC (kg) and the plant numbers in 1 m long row, soybean was planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), sampled on Sept. 16, 2021.

	CR	CRm	NV	VE	WH	Avg
Fert	109.93	111.95	98.05	111.90	121.24	110.00
None	109.08	107.79	106.37	107.32	114.56	109.02
PL	107.13	76.49	110.61	116.26	119.29	105.96
Avg	108.72	98.75	105.01	111.83	118.00	

Table 11. Number seeds per pod based on 5 plants, soybean was planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), sampled on Sept. 16, 2021.

	CR	CRm	NV	VE	WH	Avg
Fert	3	3	3	3	3	3
None	2	2	2	2	3	2
PL	3	3	2	2	3	3
Avg	2	3	2	3	3	

Table 12. Number pods per plant based on 5 plants, soybean was planted on mid-May in plots of different cover crops (CR: cereal rye; CRm: cereal rye with mustard; NV: native vegetation; VE: vetch; WH: wheat) off growing season, receiving Fert (inorganic fertilizer) and PL (poultry litter), sampled on Sept. 16, 2021.

	CR	CRm	NV	VE	WH	Avg
Fert	86	93	64	83	83	82
None	49	57	45	61	57	54
PL	91	90	77	94	81	86
Avg	75	80	62	79	72	

1.3 Greenhouse Study on soybean water relations in soils amended with biosolid in Oktibbeha County

Quarter 1: Activities listed for this quarter

Intact soil cores were collected by driving a PVC tube (7.7 cm i.d. x 30 cm length) into the ground with a hammer from field plots that received either no fertilization (control) or pelleted biosolids at a single, high rate of 37 Mg ha^{-1} (1,500 kg ha^{-1} total N and 10,180 kg ha^{-1} total C). The tubes are arranged as a RCB, with 2 treatments (1 biosolid amendement and 2 non-biosolid amended soils), and 6 replicates in the Crop Science Research Lab greenhouse. Soybean (MG IV - Pioneer 'P53A67X', MG 5.3) is grown in the intact soil cores. After emergence the 12 plants were watered regularly with tap water using drip lines attached to an automatic timer. Responses of leaf stomatal conductance, psychrometric leaf water potential at predawn and midday, days of visible wilting, and volumetric soil water content are recorded.

Quarter 2-4: Activities listed Activities listed in these quarters
The experiment was terminated at the end of July. We took 36 samples at depths of 0-5, 5-10, 10-15 cm for measurement of nutrients, 36 samples for aggregates size and stability, 36 samples for soil water retention curve including field capacity, wilting point water content and plant available water content. In this quarter, we measure soil nutrients (organic matter, N, P, K, Cu, Mg, Na, Cu, Fe, Mn, Zn).

Objective 2: Apply agroecosystem models, in conjunction with field trials in Objective 1, to determine optimal management options for consistent dryland soybean yield across typical Mississippi weather conditions and in each of 16 dominant soil types based on 100-year daily weather records and on predicted daily weather in future 50 years.

Quarter 1: Activities listed for this quarter
RZWQM2 is being applied to determine the response of soil health scores to various management practices, including cover crop, no-till and minimum tillage, manure amendments, rotations, and climate change senarios. The objective is to identify the effective measures for improving soil health and sustainability of soybean production system in long-term.

Quarter 2-4: Activities listed in these quarters
The unique advantage of modeling research is that models are capable of investigating the long-term effects of integrated management practices under diverse weather conditions. In this quarter, we conducted simulation study to determine long-term effect of integrated cover-crop, poultry litter, and tillage on soil organic carbon under rainfed conditions. Our results revealed the continuous tillage system improved soil organic matter more than the no-till system as 18,000 kg ha^{-1} poultry litter was applied in each spring in this humid region characterized by hot summer and mild winter.

Objective 3: Conduct economic analysis using results of field trials (Objective 1) and simulation studies (Objective 2) to compare the cost and return of using soil organic amendments or/and cover crop in comparison with conventional management practices. The goal is to help non-irrigated soybean growers in different Mississippi environments determine the long-term profit-maximizing management practices for a soil type, topography, precipitation pattern, and other climate condition found on their farm.

Quarter 1: Activities listed for this quarter
The RZWQM2 simulated data will be incorporated with the soybean price and cover crop cost information to build a soybean profit function, and solve for the profitability maximization problem using mathematic programming techniques under various constraints (budget, water capacity, *etc*.). The final output will be an interactive budget table, giving the specific cover crop recommendations under different soils, water costs, and soybean sale prices. The soybean profit functions and the budget table can provide guidelines for producers to determine the economically cover crop and nutrients management options under various weather and market conditions. Those results allow the producers to accurately weigh returns from increased yields against potential management costs on their specific fields. That provides a tool to more precisely manage their farm and improve profitability in soybean production.

Quarter 2-4: Activities listed in these quarters
We run the RZWQM2 model and obtained data for assessment of soil health and economic return.

End Products after the project was funded since 2020 (Authors in bold are PI/CoPIs):

<u>*Presentations and Published Abstracts:*</u>

(1) **Feng, G**. 2021. Invited oral presentation: Effectiveness of Organic Agriculture Practices in Improving Soil Organic Matter and Soil Health**.** International symposium entitled "Soil Organic Matter Dynamics and Soil Health: Honoring the Contributions of Dr. Cynthia Cambardella" at the ASA-SSSA-CSSA Annual Meeting, Salt Lake City, UT. Nov. 8, 2021.

(2) **Feng, G**. 2021. Invited oral presentation: Biochar Use Strategies for Sustainable Cotton Production and Soil Health. International symposium entitled "Biochar for Sustainable Soil Health: Perspectives and Opportunities" at the ASA-SSSA-CSSA Annual Meeting, Salt Lake City, UT. Nov. 10, 2021.

(3) Chang, T., **G. Feng**, **A. Adeli**, V. Paul, **D. Reginelli**, and J. **Jenkins**. 2021. Soil health as affected by long-term application of poultry litter and cropping patterns under humid subtropical climates. Agronomy Abstract. the ASA-SSSA-CSSA Annual Meeting, Salt Lake City, UT. Nov. 7-11, 2021.

(4) Zhang, Y., **G. Feng**, **G. Bi**, S. Yu, **D. Reginelli**, and **J. Jenkins**. 2021. Sustainable organic farming system for improving soil nutrients management and soil chemical health. Agronomy Abstract. the ASA-SSSA-CSSA Annual Meeting, Salt Lake City, UT. Nov. 7-11, 2021.

(5) Chang, T., **G. Feng**, **A. Adeli**, V. Paul, **D. Reginelli**, and J. **Jenkins**. 2021. Soil health as affected by long-term wheat cover crop in no-till and conventional tillage systems. Agronomy Abstract. the ASA-SSSA-CSSA Annual Meeting, Salt Lake City, UT. Nov. 7-11, 2021.

(6) Zhang, Y., **G. Feng**, **G. Bi**, S. Yu, **D. Reginelli**, and **J. Jenkins**. 2021. Effects of Organic Farming Systems on Soil Health. Agronomy Abstract. the ASA-SSSA-CSSA Annual Meeting, Salt Lake City, UT. Nov. 7-11, 2021.

(7) Chang, T., **G. Feng**, A. Adeli, V. Paul, **D. Reginelli, and J. Jenkins**. Spatial variability of soil chemical properties following long-term poultry litter application. ASA Southern Branch Annual Virtual Meeting. Jan. 30, 2021.

(8) Chang, T., **G. Feng**, V. Paul, **D. Reginelli, and J. Jenkins**. Effects of cover crops on soil health and sustainability of corn-soybean cropping system under future climate change scenarios. ASABE Annual International Virtual Meeting. July 11-14, 2021.

(9) Zhang, Y. **G. Feng**, **G. Bi**, S. Yu, **D. Reginelli, and J. Jenkins**. Measuring soil hydraulic conductivity, aggregates and other hydraulic properties and evaluating the sustainability of agricultural land use. ASABE Annual International Virtual Meeting. July 11-14, 2021.

(10) Zhang, Y. **G. Feng**, **G. Bi**, S. Yu, **D. Reginelli, and J. Jenkins**. Sustainable organic farming system for improving soil aggregates, infiltration and water retention capacity to minimize effects of drought and flood. ASABE Annual International Virtual Meeting. July 11-14, 2021.

(11) Chang, T., **G. Feng**, V. Paul, **D. Reginelli, and J. Jenkins**. Soil health as affected by long-term no-till wheat cover crop, corn, and soybean rotations in the Southeast United States. ASABE Annual International Virtual Meeting. July 11-14, 2021.

(12) **Feng, G.**, H. **Tewelde, A. Adeli**, and **D. Reginelli**. 2020. Invited oral presentation: advances in 4Rs research on manure application to row crops for improving soil health in the Southeastern USA. International symposium entitled "Emerging Needs in 4Rs Nutrients Research" at the ASA-SSSA-CSSA virtual international meeting, Nov. 9, 2019.

(13) *Chang, T*., V. Paul, **G. Feng**, **A. Adeli**, and **J. Brooks**. 2020. Determining a minimum data set for assessing soil health in Mississippi. Agronomy Abstract. ASA, CSSA & SSSA Virtual International Annual Meeting, Nov. 9-13, 2020.

(14) Paul, V., T. Chang, **G. Feng**, and **A. Adeli**. 2020. Soil health assessment methods: a comparative study. Agronomy Abstract. ASA, CSSA & SSSA Virtual International Annual Meeting, Nov. 9-13, 2020.

(15) *Zhang, Y*. **G. Feng**, **G. Bi**, and S. Yu. 2020. Effects of cover crops on soil physical health in South American organic farming systems. Agronomy Abstract. ASA, CSSA & SSSA Virtual International Annual Meeting, Nov. 9-13, 2020.

(16) *Li, Y*. **G. Feng**, and **H. Tewolde**. 2020. Measuring and assessing soil physical health in long-term boiler ash application: an on-field study in Mississippi State. Agronomy Abstract. ASA, CSSA & SSSA Virtual International Annual Meeting, Nov. 9-13, 2020.

(17) *Gao, F*. **G. Feng**. 2020. Impact of climate change and cropping systems on groundwater recharge in a humid region. Agronomy Abstract. ASA, CSSA & SSSA Virtual International Annual Meeting, Nov. 9-13, 2020.

(18) *Li, Y*. **G. Feng**, and **H. Tewolde**. 2020. Long-term effects of biochar on fertility, physical and hydrological properties and corn yield of dissimilar soils in Mississippi state. Agronomy Abstract. ASA, CSSA & SSSA Virtual International Annual Meeting, Nov. 9-13, 2020.

Publications and Manuscripts:

(1) *Chang, T*., **G. Feng**, V. Paul, **A. Adeli**, and **J. Brooks**. 2022. Soil health assessment methods: progress, application and comparison. *Advances in Agronomy*. 172: 129-200.

(2) **Feng, G** and S. Anapalli. 2022. Integrating models with field experiments to enhance research: cover crop, manure, tillage, and climate change impacts on crops in a humid Climate. In ASA, CSSA, SSSA Books, editors: Ole Wendroth, Kurt Christian Kersebaum, and Laj Ahuja, Volume 10 of the Advances in Agr Systems Modeling on Modeling Soil-Plant-Climate-Management Processes and Their Interactions in Cropping Systems, Challenges for the 21st Century.

(3) Effect of Poultry Litter Applications on Soil Physical Properties on the website of Mississippi-crops.com, 2021. The work was reported in MSU Extension publication, the newsletter (goes by 1600 emails) of Mississippi Crop Situation and posted on the blog and tweets with 2500 followers, LinkedIn about 700 more exposures.

(4) Poultry litter's efficiency as fertilizer studied | The Western Producer. July 22 issue of Western Producer, 2021.

(5) The surprising power of chicken manure" news story on the Agronomy, Crops and Soils web pages: soils.org, agronomy.org and crops.org and CSA news (May, 2021). The MSPB work and the articles as above were reported by 41 Canadian and American social media, reached to ~3.6 million readers, and the publicity was worth almost $10K.

(6) **Feng, G.**, **H. Tewolde**, B. Zhang, N. Buehring, **A. Adeli**. 2021. Soil physical and hydrological properties as affected by a five-year history of *broiler litter* applied to a cotton-corn-soybean rotation system. *Soil Science Society of American Journal*.1-14.

(7) *Li, Y*. D. Tian, **G. Feng**, W. Yang and L. Feng. 2021. Climate change and cover crop effects on water use efficiency of a corn-soybean rotation system. *Agricultural Water Management* 255 (2021) 107042. https://doi.org/10.1016/j.agwat.2021.107042.

(8) Li, Y., **G. Feng**, **H. Tewolde**, F. Zhang, C. Yang, and M. Yang. 2021. Soil aggregation and water

holding capacity of soil amended with agro-industrial byproducts and poultry litter. *Journal of Soils and Sediments*, 21: 1127-1135. https://doi.org/10.1007/s11368-020-02837-3.

(9) *Yang, W*., **G. Feng**, **A. Adeli, H. Tewolde**, and Z. Qu. 2021. Simulated long-term effect of wheat cover crop on soil nitrogen losses from no-till corn-soybean rotation under different rainfall patterns. *Journal of Cleaner Production* 280: 124255. https://doi.org/10.1016/j.jclepro.2020.124255.

(10) *Li, Y*., **H. Tewolde, D. Miles**, **J. Munyon, J. Brooks**, **G. Feng**, M. Yang, F. Zhang. 2021. Decomposition of Poultry Litter Organic Matter Co-applied with Industrial and Agricultural Products/Byproducts. *J. Environ. Qual*. 50: 364-374. doi: 10.1002/jeq2.20189.

(11) *Yang, W*., **Feng**, **G.**, **Read, J.**, Ouyang, Y., and Li, P. 2020. Impact of cover crop on corn-soybean productivity and soil water dynamics under different seasonal rainfall patterns. *Agronomy Journal*, 112: 1-15. DOI: 10.1002/agj2.20110.

(12) *Li, Y*., **G. Feng**, **H. Tewolde**, F. Zhang, and M. Yang. 2020. Soil aggregation and water holding capacity of soil amended with agro-industrial byproducts and poultry litter. *Journal of Soils and Sediments*, 21: 1127-1135. 10.1007/s11368-020-02837-3.

(13) *Li, X*., **G. Feng**, **H. Tewolde, A. Adeli, and J. Jenkins**. 2020. Effect of improved soil organic matter using poultry litter on field water holding capacity of silt loam soils. *Land Degradation and Development* (internal review).

(14) **Feng, G**., and R. Sui. 2020. Evaluation and calibration of soil moisture sensors in undisturbed soils. *Transactions of the ASABE*. 2020. 62(2): 1-11. https://doi.org/10.13031/trans.13428

(15) *Yang, W*., **G. Feng**, **A. Adeli, H. Tewolde,** and Z. Qu. 2020. Simulation of long-term impact of wheat cover crop on soil nitrogen losses from corn-soybean rotation in southeastern United. *Journal of Cleaner Production*, https://doi.org/10.1016/j.jclepro.2020.124255