Impacts of Integrated Crop-Livestock System on Soil Health Parameters in North Dakota

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Introduction

- Maintaining and improving soil quality are essential for sustaining agricultural production.
- Integrated crop-livestock system (ICLS) is a practice of diversifying a farm for improving its long-term sustainability and profitability.

Objectives

- To access the impacts of cropping sequences and livestock integration on some selected soil properties.

Materials and Methods

- Study site was located at the Dickinson Research Extension Center field, Dunn county, ND
- Randomized complete block design
- Cropping treatments:
  - Continuous spring wheat (CNT : control)
  - Sunflower-spring wheat-cover crop-corn-pea/barely (S1)
  - Spring wheat-cover crop-corn-pea/barely-sunflower (S2)
  - Cover crop-corn-pea/barely-sunflower-spring wheat (S3)
  - Corn-pea/barely-sunflower-spring wheat-cover crop (S4)
  - Pea/barely-sunflower-spring-wheat-cover crop-corn (S5)
- Two grazing treatments:
  - Grazed (G) and un-grazed (UG)

Fig.2. Soils for C analysis

Fig.1. Livestock grazing

- Soil samples were collected in summer of 2016 and 2017 at 0-5, 5-15, 15-30, 30-45, and 45-60 cm
- Soil bulk density, organic carbon, total nitrogen, wet aggregate stability, carbon fractions, water retention, urease and beta-glucosidase activities

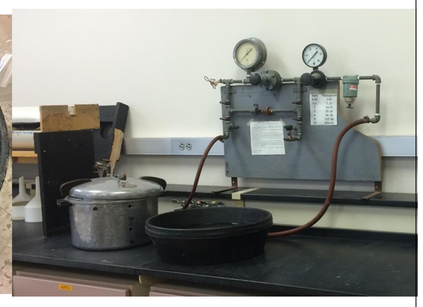

Fig.3. Core samples and ceramic pressure plate for water retention

Results

Table 1. The impacts of cropping sequences and grazing treatments on soil bulk density in 2017

Treatments	0-5 cm	5-15 cm	15-30 cm	30-45 cm	45-60 cm
Sequences (S)	----------Mg m^{-3}----------				
CNT (control)	1.10^{a}	1.43^{a}	1.39^{a}	**1.41^{a}**	1.46^{a}
S1	1.26^{a}	1.50^{a}	1.42^{a}	**1.30^{bc}**	1.34^{a}
S2	1.11^{a}	1.41^{a}	1.33^{a}	**1.42^{a}**	1.40^{a}
S3	1.15^{a}	1.34^{a}	1.32^{a}	**1.37^{ab}**	1.42^{a}
S4	1.21^{a}	1.39^{a}	1.31^{a}	**1.26^{c}**	1.39^{a}
S5	1.22^{a}	1.45^{a}	1.39^{a}	**1.40^{a}**	1.43^{a}
Grazing (G)					
Yes	**1.29^{a}**	1.39^{a}	1.35^{a}	1.35^{a}	1.42^{a}
No	**1.28^{b}**	1.43^{a}	1.35^{a}	1.36^{a}	1.40^{a}
	Analysis of Variance ($P>F$)				
S	0.48	0.17	0.10	**0.001**	0.46
G	**0.003**	0.70	0.49	0.77	0.77
S × G	0.15	0.46	0.88	0.60	0.62

Table 2. The impacts of cropping sequences and grazing treatments on soil organic carbon in 2017

Treatments	0-5 cm	5-15 cm	15-30 cm	30-45 cm	45-60 cm
Sequences (S)	----------g kg^{-1}----------				
CNT (control)	23.5^{a}	15.0^{a}	11.8^{a}	9.76^{a}	11.1^{a}
S1	26.9^{a}	19.7^{a}	15.8^{a}	20.6^{a}	18.7^{a}
S2	25.7^{a}	18.5^{a}	15.8^{a}	12.7^{a}	16.2^{a}
S3	33.8^{a}	26.7^{a}	26.2^{a}	21.6^{a}	18.2^{a}
S4	27.4^{a}	18.0^{a}	17.0^{a}	15.8^{a}	15.1^{a}
S5	22.9^{a}	15.8^{a}	11.2^{a}	8.76^{a}	9.77^{a}
Grazing (G)					
Yes	27.2^{a}	20.0^{a}	17.6^{a}	16.6^{a}	15.9^{a}
No	27.1^{a}	19.0^{a}	16.6^{a}	14.3^{a}	14.1^{a}
	Analysis of Variance ($P>F$)				
S	0.26	0.18	0.19	0.19	0.20
G	0.65	0.94	0.81	0.57	0.33
S × G	0.86	0.94	0.94	0.55	0.15

Table 3. The impacts of cropping sequences and grazing treatments on soil total nitrogen in 2017

Treatments	0-5 cm	5-15 cm	15-30 cm	30-45 cm	45-60 cm
Sequences (S)	----------g kg^{-1}----------				
CNT (control)	2.18^{a}	1.46^{a}	1.13^{a}	0.89^{a}	0.83^{a}
S1	1.90^{a}	1.29^{a}	1.17^{a}	1.05^{a}	0.97^{a}
S2	2.35^{a}	1.73^{a}	1.46^{a}	1.23^{a}	1.14^{a}
S3	2.44^{a}	1.68^{a}	1.22^{a}	0.90^{a}	0.76^{a}
S4	2.49^{a}	1.70^{a}	1.58^{a}	1.36^{a}	1.02^{a}
S5	2.14^{a}	1.48^{a}	1.15^{a}	0.92^{a}	0.89^{a}
Grazing (G)					
Yes	2.26^{a}	1.63^{a}	1.32^{a}	1.03^{a}	0.88^{a}
No	2.30^{a}	1.55^{a}	1.29^{a}	1.07^{a}	0.94^{a}
	Analysis of Variance ($P>F$)				
S	0.62	0.82	0.50	0.22	0.44
G	0.47	0.92	0.99	0.71	0.81
S × G	0.92	0.99	0.96	0.87	0.98

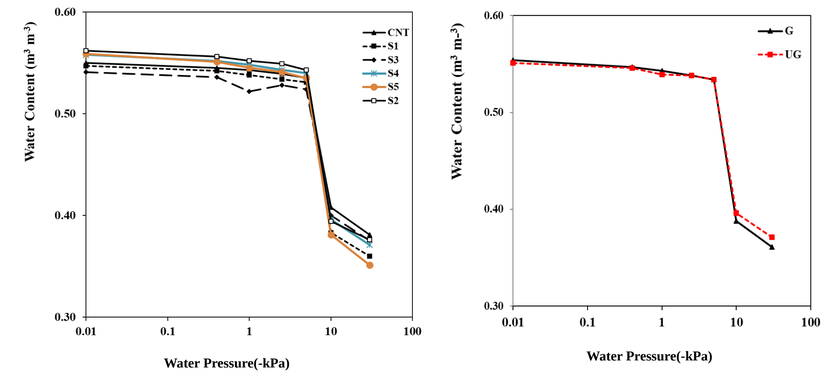

Fig.4. The impacts of cropping sequences and grazing treatments on soil water retention at 0-5 cm depth in 2017

Conclusions

- Data showed that cropping sequences did not significantly impact on soil properties.
- Grazing did increase the soil bulk density only for 0-5 cm depth.
- Grazing did not significant impact on other soil parameters.
- Integrated crop-livestock system might be neutral to beneficial to soil.

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