# Impact of Spring Corn Residue Grazing on Soil Physical Properties and Crop Yield

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## Summary with Implications

*The effects of stocking density for spring corn residue grazing on soil physical properties and soybean yield were evaluated in an experiment with three treatments: no grazing, normal density, and high density. Normal density was stocked at 3 calves/acre and grazed 45 days starting in mid-February. High-density was stocked at 9 calves/acre and grazed 15 days starting in mid-March. Increased stocking density decreased residue cover and increased surface roughness. Bulk density and penetration resistance were increased for normal density compared to no graze, with no difference between grazed treatments, illustrating that grazing may cause minor compaction, regardless of stocking density. However, these values were below the threshold that would be expected to cause issues with plant growth. Soybean emergence did not differ among treatments and soybean yield was increased by grazing. Spring grazing may cause minor compaction, and increase surface roughness, but improves subsequent soybean yields in an irrigated, no till, high yielding field.*

## Introduction

The University of Nebraska–Lincoln has conducted extensive research in the area of corn residue grazing, as it is an effective way to integrate crop and livestock production. Unfortunately, it is still an under-utilized forage resource in much of the Midwest. It is well known that corn residue can be a low-cost feed resource for cattle producers. Despite this, not all farmers are comfortable with grazing corn residue due to concerns about compaction. In a survey of Nebraska farmers, of those who chose not to graze or allow grazing of corn residue, 47% thought soil compaction was a major issue (*2017 Nebraska Beef Cattle Report*, pp. 112–115). Studies have shown this to not be the case, with there being little impact on soil physical properties under normal grazing conditions during the winter months (*2015 Nebraska Beef Cattle Report*, pp. 53–55; *2017 Nebraska Beef Cattle Report*, pp. 50–52). However, minimal research has evaluated spring residue grazing, especially when applying heavier stocking densities; thus, this study investigated these factors and the effects on soil physical properties and subsequent soybean yield.

## Procedure

A corn residue grazing experiment was conducted during the spring of 2019 and 2020 at the Eastern Nebraska Research and Extension Center of the University of Nebraska–Lincoln located near Mead, Nebraska to evaluate the effect of high stocking density on soil physical properties and its influence on soybean emergence and yield. The 160-ac field was irrigated, under no-till management and in a corn-soybean rotation. Approximately, one-half of the field was in corn each year. The soil is mainly Tomek silt loam and Yutan silty clay loam. The treatments were: (i) no grazing (NG) (negative control), (ii) normal stocking density (NSD) (positive control), and (iii) high stocking density (HSD). The study utilized 128 calves each year (609 ± 9.6 lb) assigned to either a NSD treatment (3 calves/ acre) with a target grazing period of 45 days or HSD treatment (9 calves/ acre) with a target grazing period of 15 days. This resulted in an equal number of head days for the two grazing treatments (135 head days/acre). There were 4 groups of calves (replicates) for each grazing treatment each year with eight calves per group in NSD and 24 calves per group in HSD. The corn yield in this field was 233 bu/ac and the target grazing rate was based on the estimate of 16 lb of leaf and husk produced per bushel of corn grain, 50% of leaf and husk available for grazing, and an intake of 10 lb (dry matter basis) per calf per day which is 15% of the total residue (cornstalks, cobs, leaves, and husks) in the field. Calves were provided a dry distillers grain supplement daily at 5.4 lb DM/hd/d. Calves in NSD began grazing in mid-February with the HSD calves beginning to graze in early March. The objective of the high intensity group was to create a worst-case scenario to evaluate the effects on the soil; thus, the HSD groups were put on their plots after a rain event occurred. Until then, the HSD cattle grazed corn residue in an adjoining field at normal stocking rate. Calves were taken off treatments by March 27, 2019, and March 31, 2020, with soil measurements taken 21- and 49-days post removal of calves. Three measurements were taken on the soil: bulk density, soil penetration resistance, and surface roughness. Residue cover was measured only in the second year of the study, 21 days post-removal of calves. Soybean planting occurred on May 2, 2019, and April 29, 2020, and crop emergence was evaluated 30 days post-planting. For all measures, 4 rows were sampled in each plot with 3 sample sites per row, resulting in 12 sample sites per plot. Data were analyzed using Proc Mixed of SAS with treatment considered significant at $P \leq 0.05$. Experimental unit was treatment plot.

## Results

### *Soil cover and compaction parameters*

The amount of residue cover at the end of grazing differed ($P < 0.01$) among treatments, with NG having greater ($P < 0.01$) cover than NSD and NSD having greater ($P < 0.01$) residue cover than HSD (Table 1). Indeed, the high stocking treatment visually had more bare ground than the other treatments. The decreased residue cover in the high stocking density treatment is thought to be primarily due to increased trampling losses as the intake between NSD and HSD

**Table 1. Percentage of residue cover and surface roughness present after corn residue was not grazed (NG), grazed in the spring at a normal stocking density (NSD) or spring grazed using a high stocking density (HSD).**

| | NG | NSD | HSD | SEM | NG vs NSD | NSD vs HSD |
|---|---|---|---|---|---|---|
| **Residue cover[1], %** | 87.9 | 37.7 | 17.7 | 2.8 | <0.01 | <0.01 |
| **Surface roughness[2], %** | 1.6 | 9.5 | 14.9 | 0.78 | <0.01 | <0.01 |

[1] Residue cover measured in year 2, 21-days post removal of calves.

[2] Surface roughness was measured using a 20-foot-long chain which decreased in length with increased surface roughness. It is expressed as the percent change in chain length.

**Table 2. Soil parameters measured[1] after corn residue was either not grazed (NG), grazed in early spring at a normal stocking density (NSD) with 3 steers/acre for 45 days or at a high stocking density (HSD) with 9 calves/acre for 15 days.**

| | | | | | *P*-value | |
|---|---|---|---|---|---|---|
| Item | NG | NSD | HSD | SEM | NG vs NSD | NSD vs HSD |
| **Bulk density, g/cm³** | | | | | | |
| 21 days | | | | | | |
| 0–2 in | 0.85 | 1.02 | 0.99 | 0.041 | <0.01 | 0.45 |
| 2–4 in | 1.16 | 1.25 | 1.25 | 0.028 | <0.01 | 0.92 |
| 49 days | | | | | | |
| 0–2 in | 0.88 | 1.01 | 1.02 | 0.036 | <0.01 | 0.80 |
| 2–4 in | 1.18 | 1.27 | 1.27 | 0.016 | <0.01 | 0.86 |
| **Penetration resistance, MPa** | | | | | | |
| 21 days | | | | | | |
| 0–2 in | 0.50 | 1.53 | 1.64 | 0.12 | <0.01 | 0.29 |
| 2–4 in | 0.71 | 1.36 | 1.58 | 0.07 | <0.01 | 0.02 |
| 49 days | | | | | | |
| 0–2 in | 0.52 | 1.67 | 1.76 | 0.11 | <0.01 | 0.37 |
| 2–4 in | 0.73 | 1.45 | 1.64 | 0.12 | <0.01 | 0.08 |
| **Moisture content, %** | | | | | | |
| 21 days | | | | | | |
| 0–2 in | 23.8 | 19.7 | 17.1 | 0.89 | <0.01 | <0.01 |
| 2–4 in | 23.0 | 22.2 | 22.0 | 0.59 | 0.35 | 0.81 |
| 49 days | | | | | | |
| 0–2 in | 25.2 | 19.5 | 18.0 | 0.86 | <0.01 | 0.20 |
| 2–4 in | 24.1 | 22.0 | 21.9 | 0.37 | <0.01 | 0.78 |

[1] Cattle were pulled off treatments at the end of March. Soil samples were taken 21- and 49-days post removal of calves and were taken in rows in which no equipment had travelled.

cattle would be expected to be similar. Similarly, across both years, surface roughness at the end of grazing (Table 1) differed ($P < 0.01$) among treatments with NG having less ($P < 0.01$) roughness than NSD and NSD having less ($P < 0.01$) roughness than HSD. Again, these data suggest increased trampling in HSD.

Bulk density and penetration resistance (Table 2) were measurements taken to determine compaction at two depths and two timepoints after grazing. At the end of grazing, both bulk density and penetration resistance differed ($P < 0.01$) among treatments. At both timepoints and depths, NG had less ($P < 0.01$) bulk density compared to NSD. No difference ($P \geq 0.45$) between the grazed treatments (NSD and HSD) were observed for bulk density. These data indicate that grazing resulted in minor compaction but stocking density did not affect compaction. Penetration resistance at the shallow depth followed the same pattern as bulk density. Not grazing had less ($P < 0.01$) penetration resistance than NSD at both timepoints, but there was no difference ($P = 0.29$) among the grazed treatments. Penetration resistance at the deeper depth shows a little different result. At both timepoints, NG had less ($P < 0.01$) penetration resistance than NSD. At 21 days post-removal of calves, NSD had less ($P = 0.02$) penetration resistance than HSD. At the second timepoint, 49 days, there tended to be a difference ($P < 0.08$) between the grazed treatments. While bulk density and penetration resistance were increased by grazing, it is important to understand that these changes were very minor and likely of little biological significance. A penetration resistance value greater than 2 MPa could result in restricted root growth. A bulk density value of 1.65 g/cm³ or more could also restrict root growth. Thus, it is unlikely that the increase in penetration resistance and bulk density would be considered detrimental as penetration resistance values were ≤ 1.76 MPa and bulk density values were ≤ 1.27 g/cm³ across all treatments at both depths and timepoints.

Moisture content (Table 2) differed ($P < 0.01$) among treatments at both timepoints within the shallow depth with NG being greater ($P < 0.01$) than NSD. Moisture content was also greater for NSD ($P < 0.01$) than HSD at 21 days post removal, but there was no difference ($P = 0.20$) between grazed treatments at 49 days. The only significant difference for moisture content at the deeper depth was at the 49-day timepoint, with NG being greater ($P < 0.01$) than NSD. Penetration resistance was not adjusted for moisture content and the wetter the soil, the easier it is to penetrate. With less residue cover, there appeared to be more evaporative loss, resulting in dryer soil, especially within the first two inches of the HSD treatment. Differences in moisture content may explain why more change is observed with penetration resistance com-

**Table 3. Soybean emergence and yield when planted after corn residue was either not grazed (NG), grazed in early spring prior to soybean planting[1] at a normal stocking density (NSD) with 3 steers/acre for 45 days or at a high stocking density (HSD) with 9 calves/acre for 15 days.**

| Item | NG | NSD | HSD | SEM | NG vs NSD | NSD vs HSD |
|---|---|---|---|---|---|---|
| **Emergence[2], plants/ac** | 102,311 | 107,340 | 109,267 | 3,754 | 0.34 | 0.70 |
| **Soybean yield, bu/ac** | 72.9 | 75.7 | 77.4 | 0.61 | <0.01 | 0.06 |

[1] Cattle were pulled off treatments at the end of March and soybeans were planted approximately 30 days later.

[2]Emergence counts were taken 30 days post-planting.

pared to bulk density and why bulk density is usually considered a better estimate of compaction.

### *Soybean emergence and yield*

There were no differences ($P \geq 0.34$) in emergence, but yield differed among treatments (Table 3). Soybean yield was less ($P < 0.01$) for NG (72.9 bu/ac) than NSD (75.7 bu/ac) and NSD tended to be less ($P = 0.06$) than HSD (77.4 bu/ac). The greater yields in the grazing treatments may be due to warmer soil temperatures, because of less residue cover, or potentially increased microbial activity in the soil which may speed up nutrient cycling (*2017 Nebraska Beef Cattle Report*, pp. 50–52).

## Conclusion

When stocking at the recommended rate, stocking density does not have major impacts on soil physical properties and subsequent crop yield. The results indicate that, regardless of stocking density, grazing corn residue in the spring may cause minor compaction; however, it is below the threshold to reduce the subsequent soybean yield. This study was conducted to create a worst-case scenario (grazing in muddy conditions) and yet there was still soybean yield improvement with grazing. Thus, producers should not be concerned about grazing cattle on residue in the spring causing compaction. However, winter grazing would still be considered ideal as there is less surface roughness to contend with at planting and less trampling loss of residue.

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