# Tillage Systems for Summer Crops Following Winter Grazing

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## Introduction

Wisely managed conservation-tillage systems arc Iow-input production systems that help maintain soil productivity and reduce environmental pollution by decreasing soil erosion and water runoff. During the past decade. research efforts have been directed towards matching the most economical conservation-tillage system with specific soils and crops. The different tillage requirements among crops and soils are related to the compactability of the soil and sensitivity of the crop to compacted soils.

Although research has been conducted to determine tillage needs for specific crops in mulitple-cropping systems and rotations. this research has not been designed to identify tillage needs for summer crops following winter grazing. Throughout the Southeast, winter grazing is an integral part of most diversified farming systems. In Alabama alone, over 400,000 acres of summer row-crop land are grazed during the winter months. Since the compaction potential due to winter grazing is high, and since the need or lack of a need for tillage is highly correlated with compaction, this research is being conducted to determine the effects of animal traffic on compaction and tillage needs for summer crops following winter grazing.

## Materials and Methods

The information presented in this paper is from the first year of a 3-year test. This study is being conducted at Auburn University's Sand Mountain Substation in northeast Alaba-

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ma. The soil is a Hartsel sandy loam, which is typical of soils located along the Appalachian Plateau in northern Alabama. Although compaction problems have been identified in these soils, the problems are generally not as severe as those which exist in the sandy Coastal Plain soils of south Alabama.

Treatments consist of grazed and nongrazed rye during the winter months, and tillage prior to planting the summer crop. Summer crop tillage treatments are: 1) no tillage, 2) no tillage with in-row subsoiling at planting, 3) disk only, 4) chisel plow-disk, 5) paraplow, and 6) moldboard plow - disk. Cows were taken off the winter grazed plots 3 weeks prior to the target planting date for corn, and the grazed and nongrazed rye was killed with Roundup. All preplant tillage operations were one week after the rye was killed. The corn, 'Pioneer 3165', was planted in 30-inch row widths on 8 April 1988, which was 3 weeks after the rye was killed. Recommended production practices were followed for fertilizer and pesticide use .

One month after planting, soil compaction-related data were collected. These date included penetrometer readings at 2.8-inch increments down to the 20-inch depth, both in the row and in the tire-track middles; soil moisture at 5-inch increments down to 20-inch depth; and bulk density in the upper 4 inches of soil. Ear leaf samples were taken during midsilk so that nutrient uptake could be evaluated. Grain yields were taken at maturity. The spring and summer period of 1988 was exceptionally dry and not a typical growing season. The corn was not imgated. As with any data collected during the single growing season, extreme care should be exercised when these date are used to make major management decisions.

## Results

As a result of the extremely dry growing season, corn grain yields (Table 1) were 30 to 40 bu/acre lower that normally expected for the Sand Mountain region. There was, however, a strong relationship between yield and treatments. When averaged across all tillage treatments, winter grazing resulted in a 14 bu/acre yield reduction. Without grazing, no tillage and no tillage with in-row subsoiling resulted in the highest yields, 82 and 87 bu/acre, respectively. Yields with the other treatments ranged between 69 and 73 bu/acre. Lower yield with than without tillage is not uncommon in the

Table 1. Tillage effects on yield of corn following grazed and nongrazed rye.

| Rye grazed | Tillage for corn | | | | | |
|---|---|---|---|---|---|---|
| | No-till | No-till* | Disk | Chisel | Turn | Paraplow |
| | bu/acre | | | | | |
| Yes | 57 | 65 | 46 | 60 | 66 | 77 |
| No | 82 | 87 | 69 | 72 | 71 | 73 |

* Indicates no tillage with in-row subsoiling.

Sand Mountain region. When corn followed grazed rye, there was definitely a need for deep tillage. Highest yields obtained with deep tillage occurred with the paraplow, but even these yields were 10 bu/acre lower than those obtained with the highest yielding treatment when corn followed nongrazed rye. Although yields obtained with deep tillage in the grazed area were less than the highest yields in the nongrazed area, yields with both the paraplow and moldboard plow were approximately equal for the grazed and nongrazed area.

Soil compaction data (Table 2) taken 4 weeks after planting (7 weeks after removing cattle) suggest that the effect of animal traffic on compaction is not limited to the surface few inches of soil. Compaction effects were measurable at the 20-inch depth. The values listed in table 2 are in bars, which is a measure of resistance, and the higher the number the more compact the soil. Disking appeared to eliminate compaction caused by grazing down to the 2.8-inch depth, but in the nongrazed plots, it appeared to have created a disk pan between the 5.5- and 8.3-inch depths. All of the deep tillage implements appeared to have eliminated the compaction caused by grazing down to depth of tillage, which was approximately 8, 11, 11, and 17 inches for the chisel plow, in-row subsoiler, moldboard plow, and paraplow, respectively. The paraplow was most effective in loosening the soil, and it was the only deep tillage implement that appeared to have tilled as deep as the animal traffic compacted the soil.

Interrow traffic from planting and postplant cultivation can also cause compaction problems, which can adversely effect yields by restricting root growth into the row middles. Date in Table 3 show the effects of planting traffic on soil compaction. Compaction cause by planting traffic appeared to be an additive effect to grazing. Within the strict no-tillage plots, additional compaction occurred only in the upper 2.8 inches of soil, and difference between the grazed and nongrazed plots was the same (4 to 5 bars) as within the row (Table 2). Within all tillage plots, the planting traffic essentially eliminated the beneficial effects of tillage, and compaction depth was identifiable at the 16-inch depth. It appears that soils tilled with the chisel plow are least susceptible to recompaction in the surface few inches of soil, but those tilled with the paraplow are least susceptible to recompaction at depths of 11 to 16 inches.

When compared to no grazing, winter grazing resulted in lower concentrations of P, K, Ca, and Mg in the earleaf during midsilk (Table 4). Tillage, however, did not improve leaf nutrient concentrations in the grazed plots. In the nongrazed area, deep tillage greatly increased the K concentration in the ear leaf. There is no explanation for the tillage effect on leaf K when corn followed nongrazed rye but not grazed rye.

Table 2. Soil cornpaction in the row as affected by animal traffic and tillage after grazing.

| Soil depth | Tillage after grazing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No-till | | Disk | | No-till$ | | Chisel | | Para-plow | | Moldboard plow | |
| | Yes† | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
| inches | soil resistance, bars§ | | | | | | | | | | | |
| 2.8 | 20 | 16 | 4 | 9 | 5 | 5 | 5 | 7 | **8** | 10 | 5 | 6 |
| 5.5 | 25 | 24 | 24 | 25 | 2 | 3 | 14 | 16 | 11 | 11 | 11 | 10 |
| 8.3 | 24 | 20 | 22 | 22 | 8 | 4 | 15 | 17 | 9 | 7 | 14 | 10 |
| 11.0 | 19 | 15 | 19 | 15 | 17 | 12 | 20 | 17 | **8** | 6 | 18 | 12 |
| 13.8 | 16 | 14 | 17 | 14 | 19 | 12 | 18 | 12 | 7 | 6 | 16 | 12 |
| 16.5 | 18 | 15 | 18 | 16 | 21 | 12 | 21 | 14 | 9 | 9 | 18 | 18 |
| 19.6 | 20 | 17 | 20 | 20 | 24 | 13 | 24 | 19 | 18 | 17 | 20 | 22 |

†Yes indicates that plots were winter grazed and No indicates no winter grazing.
‡Indicatcs no tillage with in-row subsoiling
§the highcr the numbcr the more compact the soil. 25 bar is the measurable maximum.

Table 3. Soil compaction in the row middles (tire tracks created at planting) as affected by animal traffic and tillage after grazing.

| Soil depth | Tillage after grazing | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No-till | | Disk | | No-till$ | | Chisel | | Para-plow | | Moldboard plow | |
| | Yes† | No | Yes | No | Yes | No | Yes | No | Yes | No | Yes | No |
| inches | soil resistance, bars$ | | | | | | | | | | | |
| 2.8 | 25 | 20 | 20 | 20 | 21 | 19 | 16 | 15 | 18 | 18 | 18 | 17 |
| 5.5 | 25 | 22 | 25 | 24 | 23 | 24 | 21 | 19 | 14 | 18 | 17 | 15 |
| 8.3 | 24 | 18 | 25 | 22 | 23 | 19 | 22 | 19 | 22 | 12 | 20 | 13 |
| 11.0 | 24 | 15 | 25 | 18 | 21 | 14 | 22 | 16 | 9 | 9 | 19 | 16 |
| 13.8 | 18 | 16 | 17 | 16 | 20 | 25 | 17 | 25 | 10 | 10 | 19 | 15 |
| 16.5 | 21 | 19 | 18 | 18 | 25 | 14 | 21 | 15 | 13 | 14 | 20 | 21 |
| 19.6 | 23 | 21 | 23 | 23 | 25 | 16 | 25 | 20 | 21 | 20 | 22 | 25 |

†Yes indicatcs that plots were winter grazed and No indicates no winter grazing.
‡Indicatcs no tillage with in-row subsoiling
§the higher the numbcr the more compact the soil. 25 bar is the measurable maximum.

**Table 4. Nutrient concentration in corn ear leaf during mid silk as affected by winter grazing and tillage prior to planting corn.**

| Tillage | Winter grazed | N | P | K | Ca | Mg | Mn | Zn | B |
|---|---|---|---|---|---|---|---|---|---|
| | | % | | | | | ppm | | |
| No-till | Yes | 2.30 | .19 | 1.13 | .36 | .14 | 66 | 31 | 30 |
| | No | 2.32 | .23 | 1.34 | .51 | .23 | 52 | 28 | 30 |
| Disk | Yes | 2.09 | .18 | 1.33 | .31 | .14 | 43 | 31 | 34 |
| | No | 2.12 | .22 | 1.37 | .51 | .23 | 38 | 28 | 33 |
| No-till‡ | Yes | 2.30 | .19 | 1.24 | .41 | .16 | 26 | 27 | 25 |
| | No | 2.29 | .22 | 1.36 | .51 | .21 | 52 | 26 | 35 |
| Chisel | Yes | 2.08 | .18 | 1.19 | .38 | .16 | 37 | 24 | 28 |
| | No | 2.15 | 32 | 1.50 | .47 | .21 | 32 | 25 | 51 |
| Paraplow | Yes | 2.04 | .17 | 1.14 | .43 | .16 | 44 | 34 | 29 |
| | No | 2.12 | .21 | 1.50 | .46 | .20 | 57 | 31 | 28 |
| Turn | Yes | 2.04 | .18 | 1.20 | .42 | .17 | 38 | 21 | 28 |
| | No | 2.07 | .24 | 1.60 | .46 | .22 | 30 | 24 | 23 |
| Average | Yes | 2.14 | .18 | 1.20 | .39 | .16 | 42 | 28 | 29 |
| | No | 2.18 | .22 | 1.44 | .49 | .21 | 44 | 32 | 34 |

‡No-till* is no tillage with in-row subsoiling.


## Summary

The results from this one year of data suggest that compaction created by animal traffic during winter grazing is not restricted to the surface few inches of soil. In addition, it appears that compaction created by animal grazing may be as much as 10 inches deeper than compaction created by tractor tires during planting. Yield of corn following grazed and nongrazed rye suggests that grazing can have a severe adverse effect on grain yield. Deep tillage following grazing can partially but not completely eliminate this adverse effect. It also appears that deep penetrating tillage implements, such as the paraplow, are much more effective in eliminating this adverse effect than an in-row subsoiler or a chisel plow. There were also indications that grazing or the compaction created by grazing interfered with uptake of P, K, Ca, and Mg but not N, Cu, Mn, Zn, and B. These studies will have to be continued for several years to determine if there is a strong relationship between climatic conditions and winter grazing on yield of the following summer crops.