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Corn Residue Use by Livestock in the United States

Marty R. Schmer,* Rachael M. Brown, Virginia L. Jin, Robert B. Mitchell, and Daren D. Redfearn

Core Ideas

- USDA-ERS surveyed 2250 producers from 19 states on corn residue grazing and mechanical harvests in 2010.
- Approximately 4.06 million ha was grazed by 11.7 million head of livestock.
- Approximately 0.81 million ha of corn residue was mechanically harvested in 2010.
- Corn residue is a significant resource for integrated crop–livestock systems in the western Corn Belt.

Abstract: Corn (*Zea mays* L.) residue grazing or harvest provides a simple and economical practice to integrate crops and livestock, but limited information is available on how widespread corn residue utilization is practiced by US producers. In 2010, the USDA Economic Research Service surveyed producers from 19 states on corn grain and residue management practices. Total corn residue grazed or harvested was 4.87 million ha. Approximately 4.06 million ha was grazed by 11.7 million livestock (primarily cattle) in 2010. The majority of grazed corn residue occurred in Nebraska (1.91 million ha), Iowa (385,000 ha), South Dakota (361,000 ha), and Kansas (344,000 ha). Average grazing days ranged from 10 to 73 d (mean = 40 d). Corn residue harvests predominantly occurred in the central and northern Corn Belt, with an estimated 2.9 Tg of corn residue harvested across the 19 states. This survey highlights the importance of corn residue for US livestock, particularly in the western Corn Belt.

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CORN RESIDUE or stover has been used for decades for grazing, livestock bedding, or harvested as supplemental feed for beef and non-lactating dairy cattle (Shinners et al., 2007; Ward, 1978). Baled corn residue, supplemented with corn grain ethanol by-products (wet or dry distiller's grains), is increasing in feedlot and backgrounding rations (Klopfenstein et al., 2013). Grazing and harvesting corn residues are considered to be widely practiced in the western Corn Belt (Sulc and Franzluebbers, 2014). However, limited information is available as to the extent to which US producers have used this resource.

There are multiple advantages to utilizing corn residue, including managing residue quantity in high-production fields, supplemental revenue, and a simple, cost-effective method of integrating crop–livestock systems. Improved corn hybrids and management practices have increased US corn grain yields by 50% since the early 1980s with an equivalent increase in nongrain biomass (USDA-NASS, 2016). Producers who use continuous corn rotations can have high residue accumulation especially under conservation tillage practices.

Partial corn residue removal can ameliorate potential yield reductions where high residue accumulation can interfere with planting operations, uniform stand emergence, and increased disease incidence on reduced tillage and continuous corn fields (Sindelar et al., 2013; Verma et al., 2005). A 3-yr rotation of corn–corn–soybean [*Glycine max* (L.) Merr.] is widespread in the US Corn Belt, particularly in central Nebraska, northern Iowa, and northern Illinois (Sindelar et al., 2015). In addition to its use for the livestock industry, corn residue is the primary feedstock for the fledgling cellulosic bioenergy industry (Mitchell et al., 2016). Here we report on the 2010 USDA Agricultural Resource Management Survey (ARMS) corn production practices and cost report conducted by the USDA Economic Research Service and USDA National Agricultural Statistics

Abbreviations: ARMS, Agricultural Resource Management Survey.

Service that surveyed producers from 19 states on corn residue harvesting and grazing. Specifically, study objectives were to determine where and to what degree corn residue utilization occurred in major corn-growing states, as well as producer's responses in utilizing corn residue.

Procedures

The commodity versions of ARMS surveys are conducted on a rotation basis every 4 to 8 yr to obtain commodity cost and return estimates. The 2010 ARMS corn survey was collected in 19 states (Fig. 1A) that represent 93% of planted corn acreage in the United States. The ARMS corn survey has three phases: ARMS I—screening to determine a farm's operating status and whether a producer grew corn in 2010; ARMS II—data collection on acreage, production practices, input use, and costs related to a randomly selected corn field within the previously identified farms; and ARMS III—collected data on whole farm finance and operation characteristics for a calendar year. A probability-weighting method is

applied to the ARMS II survey so that the sum of the surveyed corn fields across farms equals the corn acres planted reported by the USDA National Agricultural Statistics Service. Data from the ARMS II survey were from 2250 corn producers located in the 19 surveyed states (Foreman, 2014). In 2010, questions addressing corn residue management were included in the ARMS II corn production practices and costs report survey (pp. 7–8; questions 22–25) field characteristics section (USDA, 2010). Specific questions on corn residue harvest or grazing included the following:

- Were the stalks/stover harvested from the field?
- How many acres of corn stalks/stover were harvested from this corn field?
- Did any livestock graze this corn field after harvest of the 2010 corn crop?
- What type of livestock—cattle (*Bos taurus*), sheep (*Ovis aries*), or other—grazed this corn field after harvest of the 2010 corn crop?

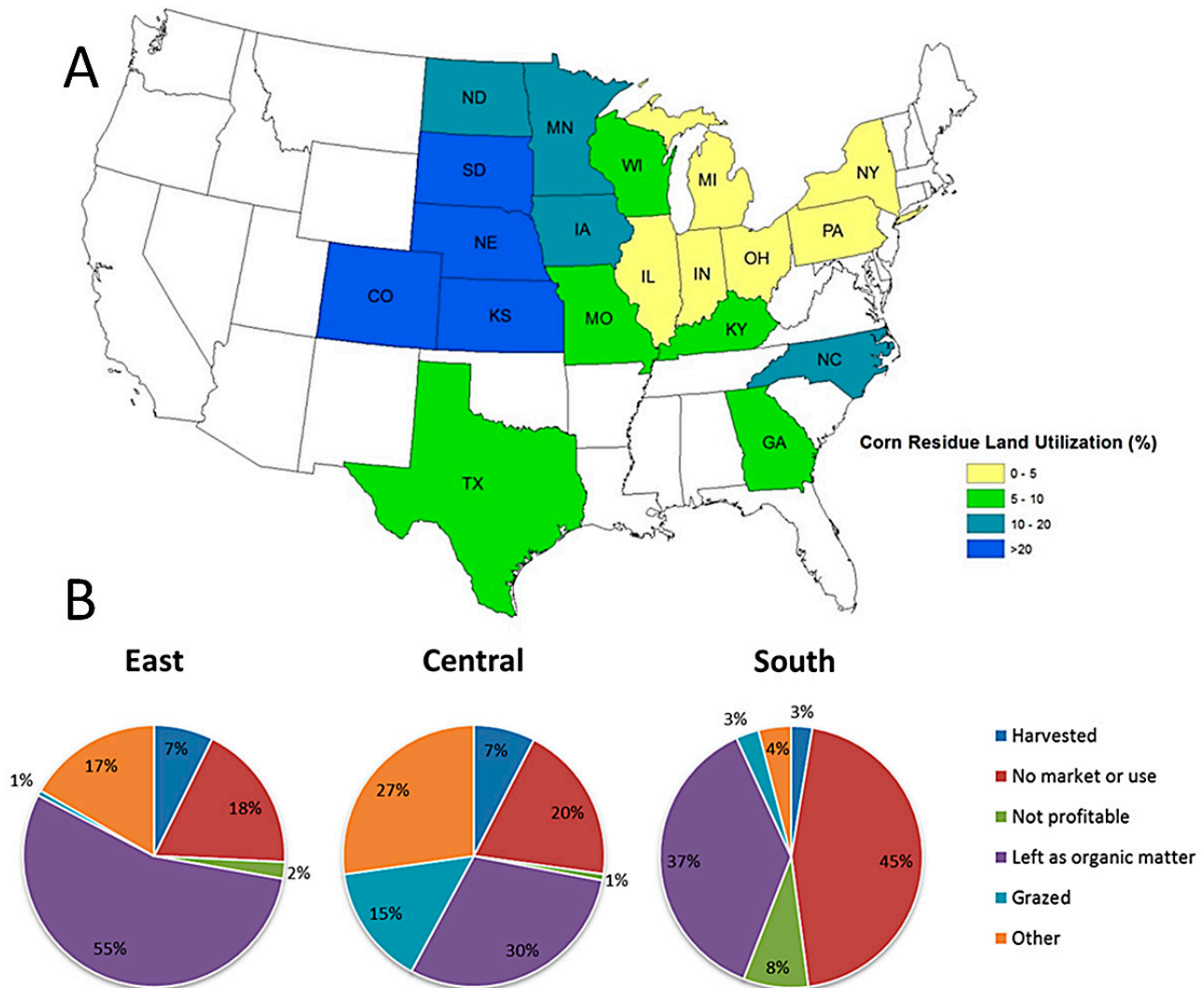


Fig. 1. (A) Corn residue land utilization as a percentage of total corn area by residue grazing or mechanical harvest in 2010 from 19 major corn producing states. (B) Corn producer survey responses by the east region (Illinois, Indiana, Michigan, New York, Pennsylvania, Wisconsin), central region (Colorado, Iowa, Kansas, Minnesota, Nebraska, South Dakota, North Dakota), and south region (Georgia, Kentucky, Missouri, North Carolina, Texas) regarding corn residue utilization.

For each question, multiple subquestions were asked to provide more detailed reasons for not harvesting corn residue, harvested residue amounts, number of livestock grazed, and so on. Summarized results are reported here, with a general discussion on current and future research needs.

Results

Eighty-three percent of corn residue utilization occurred by grazing (4.06 million ha), and 17% of corn residues was harvested and baled (0.81 million ha). Corn residue that was grazed after harvest represented 12% of the total corn acreage (33.07 million ha) across the 19 states but was largely skewed to the western Corn Belt Region. Four states (Colorado, Nebraska, Kansas, and South Dakota) had residue utilization rates >20%, while Iowa, Minnesota, North Dakota, and North Carolina had residue utilization rates of 10 to 20% of total corn acres (Fig. 1A). States in the Northeast and eastern Corn Belt had the lowest corn residue utilization rates surveyed (<5%) (Fig. 1A). Nebraska had the highest total of corn residue grazing at 1.91 million ha, followed by Iowa (385,000 ha), South Dakota (361,000 ha), and Kansas (344,000 ha) (Table 1). Both Nebraska and Colorado had significant corn residue utilization, with approximately 52 and 56% of their total corn acres being grazed (2.2 million ha) and, to a lesser extent, mechanically harvested (48,000 ha). Average grazing days from surveyed states ranged from 10 to 73 d (mean = 40 d). Total reported number of livestock grazing corn residues was 11.7 million, with 94% of the total comprising cattle.

Corn residue harvests primarily occurred in the central and northern Corn Belt (Table 1). Iowa was first in mechanically harvested residue at approximately 224,000 ha, followed by Minnesota (108,000 ha) and Wisconsin (94,000 ha). These three states represented 52% of the total corn residue area that was harvested in 2010. An estimated 2.9 Tg of corn residue was harvested across the surveyed states, with a weighted harvest average of 3.6 Mg ha⁻¹. Producers' responses indicated that partially harvesting sections of a field is a common practice; with 1.6 million ha of corn fields designated for corn residue harvest, approximately 0.8 million ha was harvested.

Table 1. Primary corn residue grazing and residue harvesting states in 2010. Data derived from the USDA Agricultural Resource Management Survey (Corn production practices and costs reports for 2010, Phase II) USDA, 2010.

Rank	State	Residue grazing	
		ha	Livestock no.
1	Nebraska	1,917,000	4,042,000
2	Iowa	385,000	1,440,000
3	South Dakota	361,000	1,575,000
4	Kansas	344,000	593,000
5	Colorado	272,000	745,000
Rank	State	Mechanical harvest	
		ha	Mg
1	Iowa	224,000	884,000
2	Minnesota	108,000	334,000
3	Wisconsin	94,000	451,000
4	Kansas	74,000	204,000
5	Illinois	70,000	307,000

Corn residue harvest occurred on approximately 2% of the total corn acreage across the 19 states.

The majority of producers indicated the reasons not to graze or harvest corn residue as primarily a lack of market or leaving on the field to supply organic matter to soils. Survey results also indicated regional differences in overall reasons to utilize corn residue or not (Fig. 1B). Producers in the South answered a lack of market or use (45%) for corn residue. Producers in the East answered leaving the corn residue for organic matter (55%). Responses from producers in the central United States were more evenly distributed, but the majority answered leaving on field as organic matter (30%) as the primary use of corn residue.

Discussion

The USDA Economic Research Service survey responses to corn residue utilization show similar results to other regional and state-level surveys (Mueller et al., 2012; Ulmer et al., 2016). In a separate 2010 survey, 58% of corn producers ($n = 116$) in the western Corn Belt (western two-thirds of Nebraska and Kansas) reported using corn residue either through grazing or mechanical harvests, and an estimated 1.4 million ha of corn residue was grazed in the western two-thirds of Nebraska (Mueller et al., 2012). A 2015 University of Nebraska survey indicated that 52% of Nebraska corn producers ($n = 130$) allowed corn residue grazing on their fields, while 37% of respondents primarily cited soil compaction, inconvenience, or a lack of demand as reasons for not allowing corn residue grazing (Ulmer et al., 2016). Existing research on soil compaction has generally shown minimal effects by livestock grazing corn residue when following recommended management practices (Clark et al., 2004; Maughan et al., 2009; Shaver et al., 2014). Impacts on grain yield were not considered to be a major factor by Nebraska corn producers (Ulmer et al., 2016), which is in agreement with field research that soybean and corn yields following cattle grazing corn residues are similar to nongrazed treatments (Clark et al., 2004; Drewnoski et al., 2016; Stalker et al., 2015; Wilson et al., 2004).

A major research gap in integrated crop–livestock research was the extent to which corn residues were used by livestock in the United States. Survey results highlight the importance of corn residue and relative integration with the US cattle industry. Unfortunately, we cannot distinguish between beef cattle and dairy cattle from the survey, but grazing by beef cattle was likely predominant in the western Corn Belt, and residue harvesting was likely predominant for dairy cattle as bedding in the north-central Corn Belt region (e.g., Iowa, Minnesota, and Wisconsin). We speculate that corn residue grazing is relatively stable particularly in the western Corn Belt, but it is unclear if corn residue harvest has increased in the past decade. The level of residue harvest variability over time is also unclear. We further assume that corn residue harvests in 2010 were not used as a bioenergy feedstock because no commercial-scale cellulosic bioenergy facilities were operational at that time. As a result, corn residue utilization by livestock should be considered when determining corn residue availability for bioenergy (Langholtz et al.,

2016). In addition, within the *2016 Billion Ton Report*, 50% of corn residue feedstocks are estimated to be operationally available in the near-term and increase to 90% of available residue yield by 2040 (Langholtz et al., 2016). The USDA Economic Research Service survey results suggest that producer willingness to utilize corn residues is currently below these estimates.

Considerable research has been conducted on corn residue harvest effects related to soil quality, soil fertility, grain yield, and greenhouse gas emissions over the past decade (Karlen and Johnson, 2014; Mitchell et al., 2016). Research on corn residue grazing, however, is limited even though significantly more corn residue acres are grazed by livestock than harvested and baled. Further research is needed on (i) how corn residues can be profitably incorporated into regional integrated crop–livestock systems, (ii) the long-term effects of corn residue grazing on soil property changes and crop yields, and (iii) understanding the socioeconomic factors affecting corn producers' willingness or reluctance to utilize corn residues.

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