EC06-278 Grazing Crop Residues With Beef Cattle

Richard J. Rasby
University of Nebraska-Lincoln, rrasby1@unl.edu

Galen E. Erickson
University of Nebraska - Lincoln, gerickson4@unl.edu

Terry J. Klopfenstein
University of Nebraska-Lincoln, tklopfenstein1@unl.edu

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Grazing Crop Residues With Beef Cattle

Richard J. Rasby — Extension Beef Specialist
Galen E. Erickson — Extension Beef Feedlot Nutrition Specialist
Terry J. Klopfenstein — Ruminant Nutrition Specialist
Casey Wilson — Graduate Student, Ruminant Nutrition
Don C. Adams — Beef Nutritionist
Roger A. Selley — Farm Management Specialist

The greatest cost to beef cow-calf and backgrounding operations is the feeding of stored feeds in winter months. To lower feed costs, many producers attempt to extend the grazing season by using crop residues. Nebraska has an abundance of crop residue available for late fall and winter grazing. Although corn crop residue grazing quite effectively reduces feed costs, some producers are concerned that it will have an adverse effect on subsequent crop yields. Another concern when grazing corn residue is the notion that genetic enhancements to corn may affect cattle performance. Residue grazing is an important management practice for many cattle operations, primarily as either a winter feed resource for maintaining the breeding herd or putting weight on cull cows. In addition, spring-born calves weaned in the fall also can be wintered on cornstalks if appropriate supplementation strategies are used.

Nutritional Content of Corn, Milo, and Soybean Residues

In vitro dry matter digestibility (IVDMD) and crude protein content of different residues are shown in *Table I*. IVDMD, an estimate of energy, is closely related to total digestible nutrients (TDN). The terms IVDMD and TDN will be used interchangeably in this publication.

The corn cob and stalk are lowest in protein, energy and palatability. The leaf and husk are intermediate in nutrient quality, but high in palatability. The grain is highest in nutrient quality (*Table I*). The nutrient quality of a cornstalk field can vary depending on whether or not the field was irrigated *(Table II)*. In dryland corn fields, the grain, husk and leaf, cob and stalk are generally equal to or greater in protein and energy content compared to residue components in irrigated corn fields. Although the proportions of husk and leaf and stalk differ between dryland and irrigated corn, the overall nutrient content per ton of dryland corn residue is expected to be slightly greater. More residue; however, is left in an irrigated corn field after harvest. Research indicates about two times more residue is left in an irrigated field (over 5,000 pounds per acre) compared to a dryland field (2,500 pounds per acre). The amount of residual grain left in the field varies depending on factors such as harvest date, lodging due to insects and disease and harvest efficiency. Low amounts of ear-drop in corn fields is more common today due to genetic advances that result in stronger stalks and the technical advances in combines that do a better job of harvesting corn.

Table I. Average percentage composition of harvested crop residues — dry matter basis.

	Percent dry matter	*Percent crude protein*		*Percent IVDMD*[a]	
		Range	*Average*	*Range*	*Average*
Corn					
Grain	73	9.5 - 11.2	10.2	88 - 95	90
Leaf	76	6.2 - 7.5	7.0	41 - 65	58
Husk	55	3.0 - 4.0	3.5	63 - 72	68
Cob	58	2.1- 3.8	2.8	59 - 65	60
Stalk	31	3.0- 5.1	3.7	45 - 60	51
Milo					
Grain	74	10.3 - 11.0	10.5	85 - 95	90
Leaf	66	6.0 - 13.0	10.0	40 - 65	56
Stalk	25	3.3 - 3.9	3.6	53 - 58	57
Soybean residue					
Leaf	87	11.0 - 13.1	12.0	36 - 40	38
Stem	88	3.6 - 4.5	4.0	33 - 36	35
Pod	88	4.5 - 9.0	6.1	34 - 51	41
Soybean	89	49 - 52.0	50.5	91 - 94	92

[a]IVDMD = *In vitro* dry matter digestibility. IVDMD is approximately equal to TDN (Total Digestible Nutrients).

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Table II. Proportions and quality of residue in irrigated and dryland field corn residue.

	Irrigated			Dryland		
Item	*Proportion, percent*	*CP[a], percent*	*IVDMD[b], percent*	*Proportion, percent*	*CP[a], percent*	*IVDMD[b], percent*
Grain	4.0	9.6	91.4	4.0	12.8	90.8
Leaf and husk	45.0	3.7	51.6	51.0	6.4	49.7
Stalk	40.0	3.0	42.6	33.0	5.9	47.8
Cob	11.0	2.6	33.6	12.0	4.6	36.2

[a]CP = Percent crude protein.
[b]IVDMD = *In vitro* dry matter digestibility.

Many of the nutrient quality aspects described for corn can also be applied to grain sorghum stubble; however, there are at least two differences *(Table I)*. The grain sorghum leaf is generally higher in protein than a corn leaf; however, sorghum grain is not used as well as corn grain. The sorghum berry's hard outer coat makes it more difficult for the animal to digest. Cattle can founder in grain sorghum fields with excessive amounts of grain left after harvest, indicating there is some use.

The TDN content of the soybean leaf, pod and stalk are low (35 percent to 41 percent; *Table I*). The low energy content for soybean stubble residue is due to the high lignin content, especially in the stalk. Lignin is the undigestible cell wall component of the plant.

Research has shown that, over time, the nutrient content of crop residue fields does decrease due to weathering. The greatest nutrient loss is energy content in the husk and leaves. Also, nutrient losses are greater in wet, humid conditions due to increased decomposition and weathering. Nutrient losses can result from trampling or cattle activity in wet, muddy conditions.

Grazing Characteristics of Crop Residues

When grazing residue, cattle will select and eat the grain first, followed by the husk and leaf and finally the cob and stalk. Because of this selection process, the cornstalk residue diet consumed could be very high in energy content (70 percent TDN) at first to very low (45 percent TDN) at the end of grazing. Also, as the stocking rate (number of cows per acre) increases, the nutrient content of the residue declines more rapidly as the grain and husk are being removed at a much faster rate.

Cows grazing cornstalks or grain sorghum stubble will consume 25-50 percent of the available residue in 30-100 days, depending on stocking density or stocking rate, leaving enough material to prevent soil erosion . In the Midwest, weather records indicate the range of continuous grazing days for crop residue is 65-111 days.

Weather can be the most important factor in successfully grazing crop residue. For example, snow cover can reduce or eliminate access; mud may make grazing difficult and may result in decreased animal performance and forage waste. During years of heavy snow accumulation, grain sorghum stubble provides better grazing than cornstalks. The grain sorghum head is cut off near the top of the plant leaving more standing forage in the form of leaves above the accumulated snow. However, delayed frost, unseasonably warm temperatures and moisture allow grain sorghum plants to remain green or develop new growth after grain harvest. *This new green growth, commonly referred to as "suckers," may be high in toxic prussic acid.* If "sucker" growth occurs, cattle should not graze the stubble until at least seven days following a hard freeze.

Determining Stocking Rate of Crop Residues

Stocking rate influences the amount of grain, husk, and leaf available per animal. The amount of grain and husk available affect diet quality because both are highly digestible. The rate of decline in digestibility is affected by stocking rate, trampling, residue components available, and environmental factors. Previous comparisons have shown that gains increase as stocking rate decreases. Stocking rate influences the quality of the diet consumed and, consequently, animal performance.

Residue (leaf and husk) yield is related to grain yield, but hybrids obviously vary in this relationship. With high producing corn (irrigated or with ample rainfall) there will be about 16 pounds dry leaf and husk per bushel corn yield. The specific relationship is: pound leaf and husk per acre on a dry matter basis = ([bu/acre corn yield x 38.2] + 429) x 0.39. Some residue disappears by trampling and other factors. We estimate 50 percent use of the leaf and husk. Therefore, 150 bushels corn produces 2,400 pounds leaf and husk per acre on a dry matter basis and 1,200 pounds (50 percent of the total 2,400 pounds) of husk and leaf on a dry matter basis available for the animal to consume. This is equivalent to about 1.76 AUM (Animal Unit Month) (1,200 pounds of husk and leaf per acre at 50 percent use/680 pounds of feed per AUM). One AUM is the amount of forage required to sustain a 1,000 pound cow or equivalent for one month, and it has been determined that a 1,000 pound cow will consume 680 pounds of dry matter monthly. A 1,200 pound cow is 1.2 AU and would consume 816 (680 pounds x 1.2AU) pounds of forage dry matter per month. If the corn yield was 150 bushels per acre and that yield produces 2,400 pounds of husk and leaf per acre on a dry matter basis and 50 percent of the husk and leaf are consumed, then this residue field would provide 1.5 AUM's (1,200 pounds of husk and leaf on a dry matter basis per acre/816 pounds of forage per month for a 1,200 pound cow = 1.47 AUM's) per acre for a 1,200 pound cow or 44 days of grazing (30 days per month x 1.5 AUM's = 44 days of grazing). If one acre would feed a 1,200 pound cow for 44 days then it would feed a 600 pound calf for 88 days. Higher grain yields provide more AUM and lower yields less. One acre of irrigated corn stalks or grain sorghum stubble will provide approximately 1.5 to 2 AUM of grazing. This number depends, though, on factors such as harvest conditions and subsequent weather conditions.

Grazing Strategies

Do not force cattle to eat the cobs and stalks. Ordinarily, dry cows will maintain body weight and may gain .5-1 pound per head daily on corn and grain sorghum residue grazing programs, when grain, husks, and leaves are available. Both mature cows and first-calf heifers in late gestation grazing crop residues that contain no grain will need protein supplementation and, as grazing days increase, will also need energy supplementation. For calves grazing crop residues, energy and protein will need to be supplemented to achieve daily gains of more than 1 pound.

Producers who graze livestock on crop residue should have an emergency feed supply, such as hay or silage, for use during severe weather. Also, supplemental forage can extend the crop residue grazing period and enhance animal performance. Snow cover up to 5 inches will probably not reduce grazing. Do not be in a hurry to provide supplemental feed — cattle will become dependent on it and seem to have less interest to graze. The concern regarding weather is when freezing rain is followed by extended periods of cold temperatures that cause the residue to remain stuck to the ground, making it difficult for cattle to eat the residue.

Strip grazing (fencing off portions of a residue field) or moving cattle from field to field provides a more uniform nutrient intake. Daily gains of cattle are greater when fields are strip grazed versus whole-field grazing. However, if residue fields are strip grazed and there are extended periods of deep snow, some of the best feed may be ungrazed because of snow cover.

Whole-field grazing is the most common grazing strategy. Early whole-field grazing has the potential to allow cattle to consume the best feed (grain and husk) prior to snowfall or muddy conditions. Whole-field grazing should allow cows to put on weight during the early phase, with weight being maintained or lost after grain has been consumed. To keep cows gaining or maintaining weight using unsupplemented crop residue, move cows to a fresh field frequently (every 35 - 45 days).

Fall-calving cows may use crop residue for fall-winter grazing if fresh fields are made available at 3-5 week intervals. If the amount of ear drop is low, it may be advantageous to early wean fall calves at 90-120 days of age. Weaning calves would lower the nutrient needs of the cow, and grain or supplements that contain corn milling by-products and higher quality roughage can be fed directly to the calf and the cow could be maintained on crop residue. On the other hand, if the fall calving cow is pregnant with her next calf, it may not be necessary to wean. Cows grazing crop residues, not supplemented, and suckling a calf, will lose body condition; however, they will likely regain condition on summer pasture before fall calving. In this situation, pay close attention to first-calf-heifers.

Cows will graze soybean stubble if allowed access to both cornstalks and soybean stubble, consuming the pods or beans left on the ground. Again, because of the high lignin content of the soybean stem, there is little energy in this portion.

Estimating the Ear Drop

Estimating the amount of corn down in a field helps producers determine a grazing strategy. An 8-inch ear of corn contains about .50 pound of corn grain, therefore 112, 8-inch ears would equal 1 bushel (1 bushel = 56 pounds). By counting the number of ears, the amount of corn can be estimated. If corn is planted in 30-inch rows, count the number of ears in three different 100 foot furrow strips and divide by two to give an approximate number of bushels per acre. Small ears and broken ears should be counted as half ears, while very large ears could be counted as an ear and a half. Any amount beyond 8-10 bushels per acre will require a well-planned grazing strategy to ensure that too much grain is not consumed.

Estimating Milo Head Drop

Because of the hard outer coat, the grain in a milo stubble field is essentially unavailable to cattle, yet when there are large amounts of grain available, founder can occur. One milo head has about .12 pounds of grain, and about 400 milo heads would equal 1 bushel of milo (1 bushel = 56 pounds). As fields approach 10 bushels down in the field, producers need to implement well-planned grazing strategies to avoid founder.

Supplementation Strategies for Cattle Grazing Crop Residues

Nutrient (protein, energy, minerals, vitamins) requirements for beef females increase as their stage of production moves from mid-gestation to calving. Supplementing spring-calving cows on crop residue while they are lactating will require substantial amounts of energy and protein to meet their nutrient requirements. Because corn milling by-products are high in both protein and energy, they maybe feeds to consider if priced economically. Also, there is not a lot of protection in crop residue fields for the calves if there is a snowstorm.

For a 1,200 pound mature cow producing 18 pounds of milk, and consuming about 25.1 pounds of intake on a dry matter basis, the percentage of protein in the diet should be 6.0 to 6.5 percent in mid-gestation and 7.0 to 7.5 percent for cows in late-gestation. Restated in pounds, cows described above need 1.6 pounds of crude protein daily in mid-gestation and 1.9 pounds of crude protein in late-gestation. Likewise, energy (TDN) needs increase from mid-gestation to late-gestation. Percent TDN needed in the ration daily is about 50 percent (12.6 pounds TDN) and about 56 percent (14.1 pounds TDN) for cows in mid-gestation and late-gestation, respectively. For the first-calf heifer, the pounds of crude protein and TDN needed on a daily basis follow the same pattern as they move from mid-gestation to late-gestation. If she weighs about 1,020 pounds at her first calving, she will eat about 22 pounds of feed daily on a dry matter basis. Percent of the ration needing to be crude protein is 8.1 percent (1.78 pounds daily) and 8.6 percent (1.89 pounds daily) for first-calf-heifers in mid- and late-gestation. Likewise, the percent of the ration that needs to be TDN is 57 percent (12.5 pounds daily) and 59 percent (13.0 pounds daily) in mid- and late-gestation. The reason for the higher percentage of nutrients required by heifers compared to cows is that first-calf heifers have less rumen capacity and their rations must be more nutrient dense because they can't eat as much as mature cow. In addition, heifers still have a nutrient requirement for growth. Diet quality is important because research data indicate that feed intake decreases by 17 percent in heifers as they approach their first calving. Rumen capacity is likely reduced because of the growing fetus.

Periodically, producers should check what nutrients are available in the residue field. If corn is visible in the manure of gestating cows grazing corn residue, supplementation other than vitamins and minerals is probably not necessary. However, after most of the grain has been consumed, protein supplementation is needed. *Cows in mid- to late-gestation forced to eat the cob and stalk will lose weight and body condition.* It is essential to monitor the body condition of cows and manage them to achieve moderate body condition before calving (moderate condition score 5 for mature cows and condition score 6 for first-calf heifers using the scale 1 = very thin to 9 = obese).

After approximately 40 days of cows grazing a corn field that has less than 1 bushel of ear-drop per acre, protein supplementation is likely. The supplement will need to contain degraded intake protein (DIP). This protein supplement could contain some nonprotein nitrogen (NPN), but it is recommended that 10 percent or less of the protein in the supplement coming from a NPN source. When supplementing cattle, it is essential all animals get their share. Feeding the protein source every other day or every third day means larger quantities are fed and timid and young cows are more likely to get their share compared to daily feedings.

Cows and First-Calf-Heifers

As long as cows have grain to select in a cornstalk field, the diet is probably above 8 to 9.5 percent crude protein and as high as 70 percent TDN (*Figure 1*). This will exceed the protein and energy needs of a 1,200 pound cow in mid-gestation. Based on *Figure 1*, average TDN content of a cornstalk field that has approximately one bushel of ear-drop per acre the diet is about 66 percent TDN and the protein content is likely between 7 percent and 8 percent the first 25 days that the residue is grazed. As days of crop residue grazing increase, energy content decrease (*Figure 1*). Between days 25 and 45 for cows grazing cornstalk residue, TDN content of the diet will average 54 percent and crude protein during this period will be about 5.0 percent. For the 1,200 pound cow in mid-gestation and average body condition, energy is adequate but the diet is deficient in protein. These cows are approximately 0.38 pounds deficient in

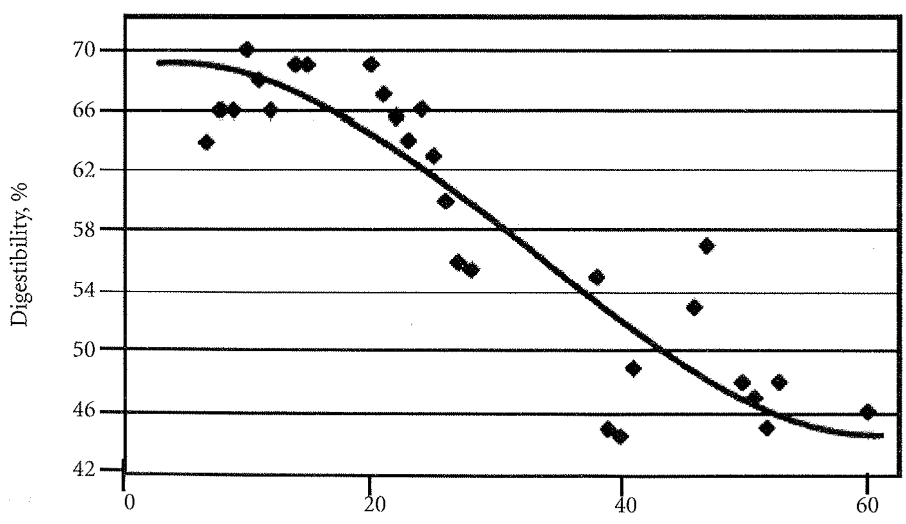

Figure 1. In vitro dry matter disappearance of the roughage fraction of diets selected by esophageally fistulated calves grazing cornstalks.

crude protein. This protein deficiency could be made up by feeding 2.5 pounds of alfalfa (18.0 percent CP, 58 percent TDN, 88 percent dry matter) per head per day or 1.5 pounds of a 32 percent range cube (90 percent dry matter) per head per day. As grazing days on the same residue field increase, nutrient quality decreases at the same time spring-calving cows move closer to calving and nutrient needs increase. At recommended stocking rates, after about 50 days of grazing in the same cornstalk field, to avoid a lot of supplementation, it would be best to move to a fresh field. Nutrient quality of a stalk field between 50 and 60 days of continuous grazing will average about 48 percent TDN and about 4.9 percent crude protein and cows in late gestation will be deficient in protein and energy. These cows are about 0.67 pounds deficient of protein and 1.9 pounds deficient in energy daily. All calculations are based on a stalking rate determined using grain yield and that 50 percent of the remaining residue is used (guidelines for determining stocking rate provided in an earlier section) provided.

Spring-calving heifers in mid-gestation grazing residue fields the first 25 days will likely meet both their protein and energy needs and should gain weight and body condition. After the grain has been consumed, protein and energy supplementation will be needed. Between days 25 and 45 for cows grazing cornstalk residue, TDN content averages 54 percent (*Figure 1*) and crude protein during this time period will be about 5.0 percent. For the 1,020 pound heifer in mid-gestation and average body condition, energy and protein in the diet are deficient. These heifers are approximately 0.68 pounds deficient in crude protein and 0.7 pounds deficient in energy. These deficiencies could be made up by feeding 4.0 to 5.0 pounds of alfalfa (18.0 percent CP, 58 percent TDN, 88 percent dry matter) per head per day or 2.4 pounds of a 32 percent range cube (90 percent dry matter) per head per day. Corn milling by-products like distillers grains and corn gluten feed would be good choices as a supplement in this situation because they are excellent protein and energy sources and compliment forage diets that are deficient in these nutrients. Heifers in late gestation grazing the same stalk field for 60 days will need supplementation of both energy (2.4 pounds per day deficient of TDN) and protein (0.8 pounds per day deficient in crude protein). It would be recommended to move first-calf heifers to a fresh stalk field after 50 to 60 days of grazing or start feeding them harvested feeds.

Lactating cows, such as fall-calving cows, grazing crop residue also must be managed carefully. As long as lactating cows have grain to select in the field, their energy needs should be met but protein will need to be supplemented. So the first 25 to 30 days on a fresh stalk field, a 1,200 pound cow producing 18 to 20 pounds of milk daily would eat about 27 pounds of dry matter and need a diet that is about 10 percent protein (2.7 pounds) and 64 percent TDN (17.3). If the crop residue the first 30 days consumed during this period is 66 percent TDN and 9 percent crude protein, then the lactating cow is 0.3 pounds deficient in protein. After 25 to 30 days of grazing the same stalk field, substantial supplementation of protein and energy will be needed. Again, this may be a situation where corn milling by-products will work. It may be as beneficial to move the lactating cows to a fresh field every 30 days. This may also be a scenario where early weaning the calves and managing a dry cow on stalks with no supplementation may be the most cost effective.

Salt and mineral and vitamin A supplements are recommended for all cattle grazing crop residues during the time that cows are not being fed a protein or energy supplement. The supplemental mineral profile will change depending on the type of supplement fed. If corn milling by-products are used as the source of supplement, then phosphorus in the mineral supplement can be eliminated. These supplements can be supplied free-choice.

Calves

Forage bulk of crop residues will cause lower performance for young cattle, as their rumen capacity per unit of body weight is less than that of mature cows. Protein supplementation is necessary for calves grazing cornstalks which should result in gains of 0.05 to 1.0 pounds per day. This may be adequate if a producer is wintering calves for low rates of gain and plans to summer them on grass. Previous research indicates that faster rates of gain (1.5 pounds per day or greater) are more economical. Supplementing the calf with energy and protein will support higher gains. Data indicate that the protein supplement should have at least 0.36 pound of escape protein (undegraded intake protein, UIP, or by-pass protein) per head per day is appropriate to get the best weight gains with calves. Total protein supplementation may need to be as high as 0.9 pound per day. Calves will need more supplemental protein early in the grazing period than later because of their need to use the higher energy content of the diet early in the crop residue grazing period.

Corn milling by-products (i.e., corn gluten feed and distillers grains) are excellent supplements for calves or cows grazing stalk fields. They are excellent sources of protein (16 to 30 percent), phosphorus (0.8 to 1.0 percent), and energy (100 to 125 percent energy value of corn grain). Corn milling by-products could be used as a protein and/or energy supplement for calves grazing crop residues. Distillers grain is a good source of by-pass protein (65 percent by-pass or undegraded intake protein, UIP). If corn milling by-products are used as a supplement, then phosphorus supplementation is not necessary. Steers calves weaned in the fall supplemented with 5.0 - 6.0 pounds per head per day of corn gluten feed while grazing cornstalks will gain between 1.5 to 1.9 pound per head per day. Minerals and vitamins can be offered "free choice." If distillers grain or corn gluten feed are fed, adequate calcium (i.e., limestone) in the diet should be provided because of the high phosphorus content of these feeds.

Milo Stubble Supplementation

On average, the energy and protein in the leaves of milo stubble appear adequate for cows in mid- to late gestation, but not for heifers in late gestation *(Table I)*. Monitor body condition of mature cows grazing milo stubble. If they appear to be losing condition, supplement protein. If the nutrient quality is low, cows are about 0.45 pounds deficient in protein and need to be supplemented similar to that described above. Remember, because of the milo's hard outer coat, it is not used as well as corn grain is by the cow.

Grazing Strategies for Cornstalk Fields with Excess Grain

Excess grain (more than 8-12 bushels per acre) left in the field can cause both acidosis and founder in cattle. Founder, a severe foot or hoof condition, results from excessive grain intake, which causes an increase in rumen acid production. In severe cases of acidosis, the result is long toe or hoof growth and severe lameness. While hand picking corn would be the most effective solution, it may not be realistic for producers.

Strategies for using high-grain cornstalk fields include: graze yearling cattle or calves first, then follow with cows; graze cull cows destined for slaughter first, then follow with the main herd; short-term graze (only a few hours per day); increase the stocking rate to reduce grain intake per animal; divide the field into strips with power fence using polywire and fiberglass posts, forcing cows to consume some husks and leaves along with the ears of corn, thus reducing the potential of founder.

The experience level of the cattle grazing a cornstalk field determines how efficiently they will glean a field for grain. Old cows with previous experience in cornstalk fields can pick up amazingly high amounts of corn, as can experienced yearling cattle, so inexperienced calves may have the least risk of founder or acidosis in high-grain cornstalk fields because they must first learn how to find corn so their grain intake increases gradually. Another technique to reduce risk of acidosis or founder might be to feed some ear-corn 7-10 days before cattle are turned out to help them adapt to a high-grain field.

Grazing Crop Residue and Effect on Subsequent Grain Yield

Few experiments have evaluated the effect of winter grazing of crop residues on subsequent grain production. Three years of data from experiments conducted in Nebraska indicate that fall and winter grazing has no significant effect on crop yields compared to ungrazed areas. Neither corn, soybean nor grain sorghum yields were adversely affected following grazing. However, residue cover was significantly reduced from grazing compared to ungrazed plots. In no-till cropping systems, additional tillage was not required following fall and winter grazing. In a ridge-till system, grazing of cornstalks did not adversely affect the integrity of the ridges, but soil bulk density in the top (0-3 inches) depth was increased in the interrow following grazing under muddy conditions. Other measurements showed soil bulk density may increase in tracked areas following grazing. Spring grazing indicated a significant decrease in water infiltration rate compared to ungrazed areas. Spring grazing of stalks also showed a decrease in residue cover and increase in bulk density. Using 15 years of data, there was no negative effect on corn yields in grazed compared to ungrazed fields.

Time of Grazing and Crop Yield

Experiments were conducted during the fall and winter to evaluate performance of calves grazing cornstalks on conventional and ridge-till fields. In these crop residue grazing experiments, calf stocking rate was 1.2 head/acre for a 60 day grazing period from December to February. To determine impact of grazing, yields were measured by machine harvest the following fall from grazed and ungrazed areas of each tillage method. The three-year yield averages for ridge-till and conventional systems show little difference between treatments. Corn yields averaged 96, 101, 96 and 98 bushel/acre for grazed ridge-till, ungrazed ridge-till, grazed conventional, and ungrazed conventional, respectively.

Cows grazed corn residue under 1/4 of a center pivot irrigation system in December and January. This was compared to 1/4 of the center pivot that was ungrazed. Irrigated soybeans were planted in the spring of each year and yields measured on the grazed and ungrazed fields in the fall. Results indicate no effect on soybean yields from grazing corn stalks during the fall and winter. For the three years of the experiment, soybean yields were similar for grazed and ungrazed fields.

Because no differences were observed due to winter grazing, spring grazing was evaluated to determine the impact of compaction on subsequent crop yield. When grazing caused surface compaction, we hypothesized that tillage would offset the compaction and maintain yield. Crop production was based on an annual corn-soybean rotation with one-half of the field planted to each crop. Tillage treatments included ridge-tilling during the summer, no-tillage, fall tillage with a chisel followed by conventional tillage (disk) in the spring, or spring conventional tillage alone. All tillage treatments were conducted during the corn rotation with no tillage following the soybean crop. This grazing trial was conducted with a calf stocking rate of 0.8 acres per calf for 60 days. The stocking rate was based on average stocking rates to optimize animal performance. Soybean yields showed no difference between grazed and ungrazed treatments. Spring and fall tillage treatments had no effect on soybean yield when compared to the no-till treatments. Corn yields two years post grazing showed no significant differences due to grazing or tillage treatments. In another grazing trial with stocking rate was increased 2.5 times to

0.32 acres per calf for 60 days. Overall grazing improved soybean yields over ungrazed treatments and included significant improvement in yield in no-till grazed over no-till ungrazed treatments. Spring and fall tillage had no effect on soybean yield when compared to no-till treatments. There was a trend for grazing to reduce corn yields the second year after grazing when compared to the ungrazed treatments. The no-tillage grazed treatment showed a significant depression in yield compared to no-tillage ungrazed treatment. The ridge-till grazed treatment showed no difference when compared to ridge-till ungrazed treatment. This suggests that grazing of ridge-till stalks in the spring is not detrimental to corn yield.

Grazing Impacts on Soil Density

Studies have been conducted to evaluate the impact of grazing on soil density. After corn grain harvest, fields were divided to determine the effects of cornstalk grazing on the yields of soybeans planted with no tillage or tillage once with a disk the year following grazing. Stocking rate was 0.67 acres/cow/28 days in each year. Soil samples were collected to determine any differences in soil bulk density present before and after grazing. Neither the initial soil bulk measurements nor the post-grazing soil bulk density ratios of areas grazed in any month have differed from the ungrazed areas in the three-year study. Post-grazing soil moisture contents did not differ between grazed and ungrazed paddocks in all three years.

Soybean yields did not differ between ungrazed and grazed areas in fields planted by disking or no tillage. However, soybean yields in the areas grazed in the second period were 8 percent lower than ungrazed areas in fields planted with no tillage in year three. The decrease in yield with the no tillage system in year three seemed to be an effect of the ground not being frozen during this time period. Therefore, the effects of grazing crop residues by beef cattle on soil physical properties and potential yields interact with whether the ground is frozen.

Careful strategies should be considered when grazing crop residues in March, due to the high possibility of mud. In our research, we have observed no negative impacts when grazing cattle on crop residues in "normal" spring conditions.

Grazing Genetically Modified Corn

Recent concerns with changes in animal performance due to genetically modified corn residues also has been evaluated. Steer calves grazing four different fields of corn residue (Bt corn root worm protected, nonBt, RR and nonRR) stocked at equal stocking density (1.06 acre/steer/60 days) were used to evaluate genetic enhancement on animal performance. Steer performance was not different between Bt corn root worm protected or RR hybrids and their parental controls following the 60 day grazing period. The animal performance demonstrates feeding value of corn residue does not differ between genetically enhanced corn hybrids and their nongenetically enhanced parent hybrid. Similar research at the University of Nebraska also showed no difference in steer performance due to the incorporation of the *Bt* trait for corn borer protection. There also was no preference between *Bt* and non*Bt* hybrids. During the grazing period, 47.5 percent of the steers were observed grazing Bt residue, and 52.5 percent of the steers were observed grazing nonBt residue.

To determine the effects of grazing crop residues for *Bt*-corn hybrids on performance of pregnant beef cows, one non-*Bt*-corn hybrid and three *Bt*-corn hybrids were compared. Rates of change in the concentrations of digestible dry matter and CP over winter were not significantly affected by corn hybrid. Mean amounts of hay required to maintain body condition score of cows maintained in a drylot were greater than cows grazing crop residues (3,199 vs 825 pounds/DM/cow) but did not differ between corn hybrids.

The data from these experiments suggest genetic enhancement has no effect on corn residue use by grazing beef cattle. Producers can take advantage of increased yields and reduced herbicide/pesticide use with *Bt* corn root worm protected or RR hybrids without adverse effects on corn residue grazing performance.

What Are Crop Residues Worth?

There are several ways to assign a value to crop residue. The owner of the corn field can consider what is being sacrificed—the nutrients and organic matter removed from the field, the cost of waiting to begin post-harvest field operations and scattering weed seeds. On the other hand, pasturing corn stalks can reduce volunteer corn problems next year and eliminate the need to shred stalks and some nutrients are returned to the soil in the manure. The user of the cornstalk field may have feed savings and additional weight gains from using the field, but may incur additional costs in moving the livestock and providing water and fencing.

Several of the advantages and disadvantages of pasturing crop residue are difficult to value, including the cost of delaying field operations, the loss from removing nutrients and organic matter, and the benefit from reducing volunteer corn and getting cattle out of a confined lot.

The feed value of crop residue can be estimated based on daily consumption and price of feed saved, which is usually the largest benefit of using crop residue. Corn and grain sorghum residue are comparable in nutritional value to good quality grass hay (8 percent protein and 52-58 percent TDN). Additional savings may be realized in reduced wear-and-tear of drylot facilities, reduced equipment operating costs, and labor reduction for feeding and manure removal. These savings may be more than offset by the additional costs of supplying water and fencing, moving cattle and inspecting the grazing cattle.

Table III. Example budget estimating the value of grazing crop residue

	60 Cows Grazing 160 Acres of Crop Residue for 120 Days	
Net benefit to livestock enterprise		
Feed savings[1]	60 head @ $.65 per day for 80 days	$ 3,120.
Drylot savings[2]		837
Value of additional weight gain (loss)[3]		0
Less crop residue grazing costs[4]		- 2,343
	Net livestock benefit	$1,614.
	per acre = $1,614 - 160 acres =	$ 10.09
	per head day = $1,614 - (60 head x 120 days)=	$ .224
Net benefit to crop enterprise		
Saving shredding stalks 160 acres @ $2.50/acre[5]		$ 400.
Manure credit less nutrient and organic matter consumed[6]		0
	Net crop benefit	$ 400.
	Per acre	$ 2.50

[1]Example feed savings based on 80 days at 26 pounds grass hay per head per day at $50 per ton. May need to be adjusted for supplemental feed needed while grazing crop residue.

[2]Electricity cost for pumping 25 gallons water per head per day at 5¢ per 1,000 gallons. Depreciation and interest for water tank and tank heater of $32 per annum. Fuel cost for tank heater based on 1 gallon per day for 60 days. Lot cleaning and repairs of $100 per year. Labor for feeding and oversight of 1 hour per day.

[3]Add value of any additional weight gain expected from crop residue grazing (or subtract loss in value). Example assumed to be zero.

[4]Moving cattle 5 miles at 30 cents per mile equipment charge plus 12 hours labor. Water costs as described above plus hauling 1 mile at 25 cents per mile equipment charge and 2 hours of labor per day. A total of $154 per year for depreciation and interest on fencing materials, battery charge and labor for installation and tear down. Additional oversight costs of 10 pickup miles per day at 25 cents per mile, plus 30 minutes labor time per day.

[5]Fuel, repairs and labor cost.

[6]The manure produced may contain more nutrients than the stalks removed, but nitrogen losses are possible, making it difficult to estimate a net manure credit.

An example for estimating crop residue value is presented in *Table III.* The budget assumes 1 AUM per acre actual grazing (60 head at one animal unit per head for 80 days for a total of 4,800 animal days or 160 AUM's). The example considers an additional 40 days on a 160-acre crop residue pasture but with snow cover requiring supplemental feed. For illustration, additional weight gain is assumed to be zero. Manure credit is also ignored, as little detailed information is available on the net gain or loss in converting crop residue to manure. The primary savings in manure may likely be the reduced cost in removing and spreading the manure from the drylot facilities.

The value of the crop residue can be estimated on an acre or head-per-day basis. Due to weather variability, the rental value of crop residue grazing on a per acre basis is uncertain. Renting crop residue on a per day basis can reduce renter's uncertainty, if the rental period can be adjusted with weather conditions. Livestock producers grazing their own crop residue would realize the benefit from both sides as estimated in *Table III.* Livestock producers renting crop residue could consider the net cost of their next best alternative (for example, supplementation on dormant pasture or feeding in drylot) as the maximum rental value of the crop residue. Landlords could consider any livestock costs covered by the landlord, minus the net benefit to the crop enterprise, as the minimum rental value of the crop residue. Both the maximum rental value the cattle could realize ($10.09, *Table III*) and the minimum rental value the crop must cover ($2.50, *Table III*) should be adjusted based on factors discussed earlier. The remaining range in rental values provides a basis for negotiating a rental rate.