# CORN STALK RESIDUE GRAZING AND FEEDLOT WASTE MANAGEMENT

by

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DISSERTATION TITLE

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University of Nebraska GRADUATE COLLEGE

CORN STALK RESIDUE GRAZING AND FEEDLOT WASTE MANAGEMENT

Casey B. Wilson, Ph.D.

University of Nebraska, 2004

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A series of experiments were conducted to aid in the integration of crop and livestock systems. A study was initiated to evaluate the impact of spring corn residue grazing and tillage on subsequent crop yields in a corn-soybean rotation. Crop yields were evaluated for two different stocking rates. Normal stocking rates showed no detrimental impacts of grazing or tillage on subsequent crop yields. At higher stocking rates (2.5 times normal) grazing increased soybean yields. However, corn yields were depressed under no-tillage 2 years post grazing. The results from this study suggest that producers can maintain livestock on crop acres in the spring if soybeans are planted the subsequent growing season.

Another study evaluated transgenic (Corn Rootworm protected and Roundup Ready®) corn and non-transgenic corn for residue grazing. Growth performance of steers grazing corn residue from transgenic corn or their respective non-transgenic control was not different. This demonstrates that the feeding value of corn residue does not differ between transgenic corn hybrids and their parental controls

A trial was conducted to evaluate the effects of increasing levels of salt (NaCl) inclusion on animal performance and feed intake. Cattle were individually fed one of five treatments to include increasing levels of NaCl in the supplement from 0 to 0.5 % of diet DM. Overall, NaCl supplementation was not effective in increasing animal performance or feed intake. Results suggest that NaCl inclusion in diets is not necessary.

An experiment was conducted to evaluate pen cleaning frequency and the impact on nitrogen (N) volatilization during summer months and during composting of manure. Either monthly cleaning (MC) or cleaning pens at the end of the feeding period (EC) were evaluated. Within cleaning frequency, collected manure was composted with and without sawdust amendment. Monthly cleaning was more effective in recovering N in manure and reducing the overall loss from the pen surface than EC. Nitrogen recovery percentages were similar between pen cleaning treatments following composting and additional sawdust amendment was not beneficial.

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## Introduction

The research in this dissertation was conducted as part of the integrated farms project. The integrated farms project was designed to integrate crop and livestock production and better utilize the resources available to both systems and at the same time improve economic and environmental sustainability. The integrated farm project has provided the opportunity to evaluate the interactions and benefits of a number of different aspects of crop and livestock production aid in the implementation of a more systems based approach. The utilization of cattle feedlot manure resources is one example. Feedlot manure is composted and can be utilized as a fertilizer resource for crop production. Waste management and compost production are part of the integrated farm. Understanding the impacts of different waste management techniques on both feedlot operations and crop production are important to both entities. For example changing feedlot pen cleaning practices may reduce environmental losses of nitrogen from the feedlot and at the same time improve compost characteristics as a fertilizer source. Additionally, other nutrients fed in the feedlot may impact crop performance, for example sodium chloride. Sodium chloride feeding increases the Na content of manure and reduces water infiltration into the soil profile if manure with high Na contents are applied, consequently reducing crop yield. Understanding these manure and crop interactions are important parts of the integrated farm project.

Crop production and resource utilization are also important to the integrated farm. Using corn crop residues as feed resources is an important part of livestock production in the Midwest. Corn crop residue can be utilized as a low cost forage resource when other

grazing resources are not available. Evaluation of the impacts of residue grazing on crop yield during the winter and spring months is an important part of both systems. Additionally, the impact of genetically modified corn crop residue on cattle performance while utilizing residues is important to livestock production.

Integrating livestock and crop production systems into a more interdependent system allows for more viable and productive production from both systems. There are numerous benefits to crop and livestock production to utilize manure resources and crop residue for more productive purposes. The interdependence of both systems will make each production system more economically and environmentally viable over a longer period of time. The integration of crop and livestock systems is part of the integrated farms project more specific aspects of this research is discussed in this dissertation.

**Corn Residue Grazing**

The highest cost to beef cow-calf and backgrounding operations is the feeding of stored feeds in winter months. The Midwest has an abundance of corn fields available for grazing. To lower feed costs, many producers attempt to extend the grazing season by using corn crop residues. Corn residue utilization is advantageous to beef production systems, since it provides low cost feed sources that generally is not utilized for other productive purposes (Guteirrez-Ornelas, 1991). Although corn crop residue grazing is quite effective in reducing feed costs, some producers are concerned that it will have an adverse effect on subsequent crop yields. Other concerns include the possibility that genetic enhancements to corn may affect cattle performance when residue is grazed.

Corn plants are mature when grain is harvested, and it is therefore assumed that the forage nutritive value is poor. This is true for all plant parts except for the husk, and the residual grain. The amount of residual grain can vary widely depending on a number of different factors. Factors such as date of harvest, level of insect or disease damage and combine adjustment can change harvest efficiency and increase ear loss. Increased harvest losses will impact the residual grain available during grazing (Bartle and Klopfenstein, 1988). Currently grain losses are reported at less than 1% of total grain yield (Folmer et al., 2001) showing improvements in harvest efficiency. Previously yield losses were reported at 4.2% of grain yield (Fernandez-Rizera and Klopfenstein, 1989a). The change in yield may be a result of both improved harvest efficiency and improved hybrid characteristics.

Stalk grazing is a unique situation. All of the feed is on the ground at the start of

grazing. Residual grain is the highest quality feed component remaining in a stalk field. Forage residue remaining consists of four distinct qualities and palatabilities. The husk is digestible and highly palatable. The leaf is palatable, but lower in digestibility compared to the husk. The stem and cob are lowest in both digestibility and palatability and are consumed only when the amount of remaining grain, leaf and husk is small (Klopfenstein et al., 1987; Bartle and Klopfenstein, 1988). The average energy content of a diet consumed by an animal grazing corn stalk residues is 54-55% digestibility (TDN) but this could vary from 50% to 60%.

Studies also indicate differences in forage quality components due to irrigation (Fernandez-Riveara and Klopfenstein, 1989a; Guiterrez-Ornelas and Klopfenstein, 1991), planting density (Graybill et al., 1991), and hybrid (Clanton, 1989). Dry land corn residues have a higher proportion of leaf and husk to stem, but generally the total amount of residue available is higher for irrigated fields. The leaf and husk are about 30 to 40% of the total corn residue remaining in an ungrazed corn stalk field (Guiterrez-Ornelas and Klopfenstein, 1991). Cows or calves will select the grain, followed by husks and then leaves (Fernandez-Rivera and Klopfenstein, 1989a). Stalks and cobs are generally not consumed. Intake is generally limited by the amount of residue (leaf and husk) available per animal which is a function of stocking rate and corn residue yield. Digestibility of forage components in the field declines daily because of consumption of more digestible parts, trampling, and environmental losses (Guiterrez-Ornelas and Klopfenstein, 1991). Greater stocking rates produce a faster decline in diet digestibility (Fernandez-Rivera and Klopfenstein, 1989b). Stocking rate (e.g. number of animal units and time) influences the

amount of grain, husk, and leaf available per animal. The amount of grain and husk available affect nutrient quality of the diet consumed because both are highly digested. When smaller quantities of these components are available at the initiation of grazing, more leaf is consumed, total intake declines, and the animal's performance eventually decreases (Fernandez-Rivera and Klopfenstein, 1989b). Stocking rate influences the quality of the diet consumed and, consequently, animal performance.

Animal performance grazing corn residue varies with residue quality and stalking rates. Fernandez-Rivera and Klopfenstein (1989b) found a range in steer performance ranging from 0.37 kg/d to 0.66 kg/d. Steer performance however was impacted by stalking rate. The lowest daily gain resulted from a stocking rate of 5.0 head/ha on irrigated corn residue. The highest gains were on dryland corn residues when stocking rate was 1.25 head/ha. The differences in gain are probably due to the differences in forage quality and availability with changes in stocking rates. Folmer et al. (2001) showed lower average daily gains than were previously demonstrated with 0.24 kg/d and 0.32 kg/d with Bt and non-Bt corn residue, respectively. The changes in ADG in these studies may be impacted by changes in forage quality, availability and supplementation programs.

Residue disappearance rates are generally lower during winter months, likely because many of the environmental losses have occurred prior to grazing. Weather conditions (moisture, temperature, wind) during and after harvest affect residue disappearance prior to grazing (Gutierrez-Ornelas and Klopfenstein, 1991). Mud during fall months can rapidly reduce forage availability. The effect of trampling during muddy

conditions can be minimized by strip grazing or shifting cattle to a grass sod or drylot during muddy conditions (Clark et al., 2003).

Genetically Modified Corn Residue

Genetic engineering or the ability to introduce DNA directly into crop plants enables a selective plant improvement process that simplifies management using more sustainable and environmentally sound approaches. Numerous traits are being evaluated for their potential to provide selectivity to more desirable herbicides for improved weed control or insect resistance to reduce input use. With genetic modification in plants there are concerns that crop residue characteristics will be altered and animal performance will be reduced.

Research with corn residue grazing demonstrated no difference in steer performance due to the incorporation of the Bt (*Bacillus thuringiensis*) trait for corn borer protection (Folmer et al., 2002). Average daily gain of steers grazing corn residue was similar (.11 and .15 kg/d, Bt and non-Bt respectively). Additionally there was also no apparent difference in animal selectivity between Bt and non-Bt hybrids. During the grazing period, 47.5% of the steers were observed grazing Bt residue, and 52.5% of the steers were observed grazing non-Bt residue. All grazing preference measurements were made between 0600 and 1000 daily. There were a total of 50 observations made during a 70 d grazing trial.

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 (Russell, 2001). The concentration of digestible organic matter of forages

selected by animals grazing crop residues from Bt-corn hybrids were equal to those grazing the non Bt-corn hybrid. Rates of change in the concentrations of digestible dry matter and CP over winter were not affected by corn hybrid. Overall, Bt corn hybrids did not affect the corn crop residue or animal performance.

In summary, the literature suggests that there is little impact of genetic modification on cattle performance during corn residue grazing. However, because different genetic modification to the corn plant may have varying impacts on corn residue quality and potentially cattle performance, further investigation is merited.

Effect of Grazing and Subsequent Grain Yield

Experiments were conducted during the fall and winter to evaluate performance of calves grazing cornstalks and subsequent grain yield of conventional and ridge-till fields (Lesoing et al., 1996). In these experiments, calf stocking rate was 3 hd/ha for a 60 d grazing period from December to February. To determine impact of grazing on grain yield, yields were measured by machine harvest the following fall from grazed and ungrazed areas of each tillage method. The three-year yield for ridge-till and conventional systems were not different and corn yields averaged 6026.5, 6340.4, 6026.5 and 6152 kg/ha for grazed ridge-till, ungrazed ridge-till, grazed conventional, and ungrazed conventional, respectively.

In another study 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 (Lesoing et al., 1996). For the three years of the experiment, soybean yields were similar for grazed and ungrazed fields.

A three year study was conducted to evaluate the impact of grazing on soil density (Clark et al., 2003). 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 0.27 ha/cow/28 d in each year. Soil samples were collected to determine differences in soil bulk density present before and after grazing. Soil bulk density ratios pre or post grazing of areas grazed in any month were not different from ungrazed areas in this 3 yr study. Post-grazing soil moisture contents did not differ between grazed and ungrazed fields. This would suggest cattle grazing corn stalk residues have limited impact on soil parameters.

Soybean yields were not different between ungrazed and grazed areas in fields planted by disking or no tillage in the first 2 yr (Clark et al., 2003). However, soybean yields in the areas grazed the second month were 8% lower than ungrazed areas in fields planted with no tillage in yr 3. The decrease in yield with no tillage in yr 3 seemed to be an effect of the ground being thawed during this time period. Therefore, the effect of grazing corn crop residue has limited impact on soil physical properties and subsequent soybean yields as long as grazing is restricted to periods of below freezing temperatures.

In summary, the literature suggests that corn residue grazing has limited impact on subsequent crop performance when grazing is conducted during the winter. However there is little information on the impact of spring grazing corn stalk residues and subsequent yields. Additionally the impact of stocking density and subsequent crop

performance has not been conducted during this time period. Understanding the impacts of spring grazing may allow for extended grazing seasons and improved profitability for livestock producers as well as allow crop producers additional income from corn residue grazing.

## Sodium

Requirements

Cattle evolved without abundant dietary sodium to meet nutritional needs. Therefore, the body developed the ability to conserve sodium and efficiently absorb Na from the lower small and large intestine (NRC, 2001). Feeding sodium in excess of needs directly results in increased excretion which may contribute to increased salinity of water and soil and potentially toxicity to plants.

Sodium is the primary extracellular cation. Sodium along with chlorine and potassium in proper concentrations and balance are indispensable for a number of important physiological functions. These functions include the regulation of extracellular fluid volume and acid-base equilibrium (McKeown, 1986), creating electric gradients for nutrient transport (Guyton and Hall, 2000) and a major contribution to salts in saliva for rumen buffering (Blair-West et al., 1970).

Absorption occurs throughout the digestive tract and dietary sodium generally is assumed to be almost completely available. Absorption occurs by active transport in the reticulorumen, omasum, abomasum and duodenum. Active absorption also occurs in the lower small intestine and large intestine (Renkema et al., 1962). With the transport mechanisms available, very little sodium is excreted in the feces. With the active

transport mechanisms in place the ruminant is able to survive for long time periods on feeds that are relatively low in Na (NRC, 2001).

Sodium concentrations in blood and tissues are maintained principally by reabsorption and excretion by the kidneys. When sodium intake is low, the body conserves sodium by increasing reabsorption of sodium from the kidney (McDowell, 1992). Additionally, when cattle are depleted of sodium, salivary glands decrease secretion of sodium in saliva to maintain other essential functions.

Requirements for sodium in nonlactating beef cattle do not exceed 0.06 to 0.08% of diet DM, while lactating beef cows require approximately 0.10% sodium (NRC, 1996). Ruminants have an appetite for salt, and if it is provided ad libitum, they will consume more sodium than they actually require (NRC, 2001).

Signs of deficiency of sodium are rather nonspecific and include pica and reduced feed intake, growth, and milk production (Ensminger, 1990). More extreme signs of deficiency include incoordination, shivering, weakness, dehydration, and eventually death (NRC, 2001).

High concentrations of salt have been used to regulate feed intake and cattle can tolerate high dietary concentrations provided an adequate supply of water is available (NRC, 1996). The maximum dietary salt concentration has been reported at 9% (NRC, 1980). However the toxicity level changes when Na is present in drinking water. Consumption of water with elevated Na concentrations ( > 7,000 mg Na/kg) has resulted in reduced feed and water intake as well as decreased growth and digestive upset (NRC, 2001).

Cattle Performance

In a 2 yr study with beef cows grazing forage containing from 0.012 and 0.055 % sodium or grazing the same forage, providing salt ad libitum did not affect calf weaning weights or cow body weights (Morris et al.,1980).

Two hundred ninety-six crossbred beef steers were fed for 163 d in a randomized block design to evaluate effects of four dietary levels of NaCl on growth performance, cost of gain, carcass characteristics and manure nutrient content (Flatt et al., 2003). Four supplemental NaCl treatments (6 pens per treatment; containing 11 to 13 hd/pen) of 0.0, 0.125, 0.25% or block salt. Concentrations of sodium in the total diet were 0.05, 0.10, 0.15 and 0.14% for treatments one through four, respectively. Estimated water consumption added 0.03 to 0.04% sodium to all treatments. Average daily feed intake, ADG and feed efficiency were not affected ($P>0.05$) by dietary NaCl level. Dressing percentage and hot carcass weight tended to decrease ($P=0.08$) linearly as salt supplementation increased. As dietary NaCl increased, concentrations of Na increased linearly ($P>0.05$) in core manure samples taken in pens behind the feedbunk apron.

Environmental Problems

Accumulation of Na in the soil can lead to decreased yields and crop failure (Lamond and Whitney, 1992; Ginting et al., 2004). Significant reductions in crop yield have been noted with increased levels of salt in the soil profile.

Salt-affected soils can be classified into three categories: saline, sodic, and saline-sodic soils. Saline soils have high levels of soluble salts, sodic soils have high levels of exchangeable sodium, and saline-sodic soils have both high contents of soluble salts and

exchangeable sodium (Sparks, 1995).

Considering the negative impact of elevated Na levels and other salts on soil and potentially crop production careful evaluation of nutrient concentrations in livestock feeds needs to occur. Salt-affected soils are most often found in arid and semiarid climates (Tanji, 1990), areas that are often associated with large cattle feeding facilities. The problem in arid and semiarid climates is that there is not enough water to leach salt from the soil. Consequently, the soluble salts accumulate, resulting in salt-affected soils. Sodium often becomes the dominant ion associated with salt-affected soils.

Salt-affected soils are often associated with soil structural problems. Soil structure or the arrangement of soil particles directly affects the ability of water to penetrate soil. If a soil has high quantities of Na, soil permeability is decreased due to alterations of soil structure (Shainberg, 1990). The most common soil structure change is the swelling of clay particles. Swelling causes soil pores to shrink and consequently reduces the rate at which water can infiltrate the soil (McNeal and Coleman, 1966). The effect of Na can change with differences in clay mineralogy, the type of ions absorbed and the electrolyte concentration in soil solution (Goldberg and Glaubig, 1987). Elevated Na levels can be toxic to plants and soil sodicity can create mineral nutrition problems such as $Ca^{2+}$ deficiencies (Sparks, 1995).

Characterization of salt-affected soils depends primarily on the concentrations of salts in the soil solution and the amount of exchangeable $Na^+$ in the soil. Additionally soluble salt can be increased with irrigation and drainage waters, addition of inorganic and organic fertilizers and sludges and sewage effluents (Sparks, 1995). Cattle manure

(feces and urine) may contain high levels of soluble salt, specifically Na. With elevated salt levels in manure and effluent, applications can result in soil salt levels which are detrimental to crop growth.

In summary, the literature suggests feeding Na over NRC (1996) requirements is not necessary. Feeding Na at higher levels would potentially increase the risk to the environment with manure and runoff applications. Furthermore waste application to crop land may eventually reduce crop yields. Increasing our understanding of Na requirements, the route of excretion and environmental losses in cattle would prove beneficial to both crop and livestock production.

## Nitrogen

### Environmental concerns and manure utilization

Industrialized livestock and grain production has provided the world with highly efficient food and fiber production, but at the same time has required increased chemical and energy inputs, reduced soil nutrients and organic matter, and increased the potential for surface and groundwater contamination (NRC, 1993). Agriculture in the Midwest is recognized for efficient large scale operations. Approximately two-thirds of the beef cattle feeding in the United States occurs in Nebraska, Texas, Kansas, Iowa and Colorado. It is estimated that 80% of fed cattle are produced in feedlots of over 1,000 head, with 50% being produced in lots with more than 16,000 head capacity (Eghball and Power, 1994). Large capacity feedlots are faced with increased pollution potential with concentrated animal production. The manure from large scale operations is often managed as a waste product when it has potential as a nutrient resource (NRC, 1993).

A lack of on-farm manure resources and declines in soil quality leaves grain production faced with shortages of nutrients and organic matter. This increases the reliance on the addition of commercial fertilizer to maintain soil quality and maximize yield (DeLuca and DeLuca, 1997). The increased dependence on external fertilizer sources with grain production and the nutrient excesses associated with livestock production allow for mutually beneficial relationships. This relationship has the ability to provide crop production with vital nutrients and feedlot operations with an outlet to properly utilize manure.

Manure from feedlot operations has the potential to supply all essential nutrients and restore depleted OM (Eghball and Power, 1999). However, manure produced by beef cattle can potentially be a source of pollution for water, air, and land, because of the potential for excess nitrates, salts, pathogens, odors and possibly weed seed (Eghball and Power, 1994).

Beef cattle feedlot manure is different from other livestock manure, as it is left on the feedlot surface for up to 1 year before it is collected. By the time manure is collected from cattle feedlots about 50% of the excreted N is lost, primarily by $NH_3$ volatilization (Gilbertson et al., 1971). Following $NH_3$ volatilization the remaining N is more stable and not subject to as high a loss.

Nitrogen losses can be highly variable with time of year. Adams et al. (2004) determined that approximately twice as much N can be volatilized from the pen surface during the summer months compared to the winter/spring months. This indicates that volatilization is enhanced by warm conditions. Other research indicated that 60 to 70%

of excreted N is lost during the summer months and 40% lost during the winter/spring (Erickson and Klopfenstein, 2001a).

In addition to the losses associated with manure accumulation on the pen floor 50% of the remaining N may be lost in hauling, spreading, and incorporating manure into the soil (Eghball and Power, 1994). Considering these losses to the environment, finding ways to conserve nutrients with improved manure management is important.

Over 90% of the agricultural ammonia emissions are estimated to originate from manures produced by livestock (Sommer and Hutchings, 1995). Ammonia volatilization is high in livestock systems because livestock excrete excess dietary N in urine as urea (Tamminga, 1996). Following excretion urea is rapidly hydrolyzed to $NH_4$ (ammonium) and $CO_2$. This hydrolysis is promoted by the urease enzyme present on the feedlot pen floor. Ammonium is not volatile but it is readily converted to the volatile form of N (ammonia, $NH_3$). The conversion of $NH_4$ to $NH_3$ is dependent on a number of different factors including urease activity, pH, temperature and air speed (Schulte, 1997).

Methods to reduce nitrogen losses

Numerous strategies have been researched in order to reduce volatile $NH_3$ emissions and conserve N in manure. The most common of these methods is altering the C:N ratio of manure. There are two methods that can be utilized to increase the C:N ratio of manure and reduce N losses. One method is the direct addition of carbon to manure and the second is indirect addition by dietary manipulation (increased OM excretion). The C:N ratio in feedlot manure range from 10:1 to 12:1 (Eghball and Zhang, 1998), however, for optimal N utilization by bacteria a C:N ratio of 24:1 is necessary

(Brady and Weil, 1996).

Direct amendments of straw and sawdust have been utilized in several different experiments. Bussink and Oenema (1998) found conflicting results when straw addition was utilized to reduce $NH_3$ in collected manure. Differences in results could be dependent upon storage conditions (anaerobic vs aerobic), amount of straw added, and the C:N ratio of manure before and after amendment.

Lory et al. (2002) evaluated sawdust addition to open feedlot pens on N losses during the summer months. Sawdust was applied two times per week at a rate to provide a 2:1 ratio of sawdust to fecal dry matter. Adding sawdust at this rate increased manure N by 78% and reduced N loss by 21% as compared to no sawdust application. Adams et al. (2004) evaluated sawdust applications to pen surface during both summer and winter months. Adding sawdust during the winter months reduced N losses by 46%, whereas adding sawdust during the summer months had no effect on N losses.

The reviewed research suggests that altering the C:N ratio with direct amendment provides variable results. Considering the additional management and costs associated with adding material to the feedlot pen floor other methods may prove more effective in reducing N losses.

Dietary manipulation has been utilized to alter the C:N ratio of manure on N losses from open feedlot pens. Erickson and Klopfenstein (2001b) evaluated feeding corn bran at levels of 0, 15 and 30% of diet DM to determine if an increase in OM excretion would decrease N losses from open feedlots. During trials conducted during the winter/spring period, OM in manure was increased 51 and 105% for cattle fed 15 and

30% bran, respectively, compared to those fed no bran. Manure N recovered in pens was 67 and 98% greater with cattle fed 15 and 30% corn bran. Nitrogen losses were reduced linearly by 14.5 and 20.7% for the 15 and 30% bran diets compared to those fed no bran. However, in a summer trial, OM in manure only increased 15 and 25% for 15 and 30% bran diets, respectively, and did not influence manure N or N losses. The C:N ratio was increased with corn bran feeding in the summer, however, it was not sufficient enough to reduce N volatilization losses. These data would suggest that increasing the C:N ratio using corn bran in the diet has variable impacts depending on the time of year.

Adams et al. (2004) evaluated direct addition of OM to the pen surface versus indirect addition by dietary manipulation. Summer and winter treatments included a diet containing 0% corn bran and a diet designed to decrease digestibility and increase OM excretion (30% bran). A management treatment was also utilized where cattle were fed 0% corn bran and weekly applications of sawdust were added to the pen surface at a rate calculated to match OM excretion by the 30% bran diet. During the winter trial, adding OM to the pen surface either by direct (sawdust) or indirect (feeding corn bran) addition increased the amount of N in manure and reduced N losses from the pen surface. There were 20 and 23% reduction in N loss for 30% corn bran fed cattle and pens in which sawdust was applied, respectively, compared to the 0% corn bran diet. During the summer trial, losses of N were not different. This suggests that exposure to drying and elevated temperatures impacted N loss regardless of OM concentration.

Farran et al. (2004) conducted a finishing trial to evaluate the effect of dietary manipulation and management on N losses from open feedlots during winter/spring. A 2