

Nutrient Retention Performance of a Crushed Limestone Floor Surface in a Bedded Hoop Barn with Confined Beef Cattle

A.S. Leaflet R2434

Shawn Shouse, extension field specialist – ag engineering;
Mark Honeyman, professor of animal science;
Dallas Maxwell, ag specialist, Armstrong Research Farm;
Darrell Busby, extension field specialist – livestock

Summary and Implications

Bedded confinement systems with partial concrete floors are increasingly being adopted by beef cattle feeders. The objective of this study was to determine the extent that manure nutrients moved into the soil below the geotextile fabric and packed limestone screenings floor of a bedded hoop barn used for beef cattle feeding at the ISU Armstrong Research and Demonstration Farm. Soil samples were taken (shallow and deep) before construction in 2004 and in 2008 after 7 groups of cattle were fed. Although single samples before and after animal feeding cannot provide conclusive evidence of moisture or nutrient migration, comparison of the sample results confirm a trend consistent with slow migration of manure nutrients into the soil profile. Phosphorus, calcium and magnesium did not show consistent or major trends with time. Organic matter showed a consistent increasing trend in both shallow and deep samples. Shallow sampling showed a marked increase only in nitrate-nitrogen, from 1.51 ppm to 11.47 ppm. These results are consistent with measurable, but very slow migration of moisture and nutrients into the soil profile. Additional soil tests over time and performance of an infiltration ring study may give more conclusive answers in the future.

Introduction

Bedded confinement systems are increasingly being adopted by beef cattle feeders as a tool to increase environmental stewardship and capture increased manure nutrient value. Controlling construction costs is critical to making these systems cost-effective. As an alternative to poured concrete flooring, many producers are experimenting with partial earthen floors or combinations of geotextile fabric and granular materials as flooring. The beef cattle confinement building at the ISU Armstrong Research and Demonstration Farm was equipped with a combination flooring system in order to evaluate the durability (ability to withstand cattle foot traffic and loader equipment traffic) and containment performance (ability to maintain manure nutrients) of such a floor. The objective of this study was to determine the extent that manure nutrients moved into the

soil below the geotextile fabric/packed limestone screenings floor of a bedded hoop barn used for beef cattle feeding.

Materials and Methods

A 50 × 120 foot hoop barn was constructed at the ISU Armstrong Research Farm in the late fall of 2004. The building houses 120 head in three pens. A description of the building is reported in Animal Industry Report (ASL-2000) and Hoop Barns for Beef Cattle (MidWest Plan Service AED-50).

A poured concrete apron covers the floor of the barn in a strip (20 feet wide by 120 feet long) adjacent to the feed bunk. The remaining floor area (30 feet wide by 120 feet long) is comprised of a layer of non-woven geotextile fabric covered by 5 inches of crushed limestone (limestone screenings). The limestone screenings is a by-product of a local limestone quarry which is too coarse to be marketed as ag lime and too fine to be marketed as road rock. Particle size is smaller than 0.375 inches.

The geotextile fabric was spread over the graded soil surface with approximately two feet of overlap at the seams. The crushed limestone was spread over the fabric with a truck-mounted fan spreader (ag lime spreader). The crushed limestone was leveled to a thickness of approximately 5 inches and packed in place with farm tractor wheel traffic. The limestone floor area was bedded with dry corn stalks (stover) prior to stocking with beef cattle. Bedding and manure pack was allowed to accumulate on the crushed limestone portion of the barn floor during each of seven cattle feeding periods (110 to 140 days) and removed from the building at the end of each feeding period. Manure was removed from the concrete feeding apron weekly. Total accumulated cattle housing time was approximately 27 months.

On December 8, 2004, prior to installation of the fabric and crushed rock, and prior to confinement animal stocking, the soil inside the confinement building was sampled for nutrient concentration. Ten cores were taken along a diagonal line across the center pen of the building. A composite sample was made from the ten cores and a representative sample taken for analysis. One sample (shallow) was created from the portion of the cores between 1 and 2 feet deep. A second sample (deep) was created from the portion of the cores between 4 and 5 feet deep. Samples were analyzed for pH, phosphorus, potassium, calcium, magnesium, soluble salts, organic matter and nitrate-nitrogen.

Iowa State University Animal Industry Report 2009

On April 18, 2008, following production of 7 groups of cattle through the building, soil beneath the crushed limestone portion of the center pen was again sampled. Six cores were taken in a grid pattern approximately 3 feet apart near the center of the pen. The soil condition was much drier than the original samples, and soil probe resistance was much greater. Three feet was the maximum attainable core depth attainable with the sampling probe. A composite sample was made from the six cores and a representative sample taken for analysis. One sample (shallow) was created from the portion of the cores at 1 foot deep. A second sample (deep) was created from the portion of the cores at 3 feet deep. Samples were analyzed for pH, phosphorus, potassium, calcium, magnesium, organic matter and nitrate-nitrogen.

Results and Discussion

Results of the soil testing are shown in Table 1. Although single samples before and after animal feeding cannot provide conclusive evidence of moisture or nutrient migration, comparison of the sample results confirm a trend consistent with slow migration of manure nutrients into the soil profile.

As expected with less mobile nutrients, phosphorus, calcium and magnesium did not show consistent or major trends with time. Organic matter showed a consistent increasing trend in both shallow and deep samples.

Nitrate-nitrogen, highly mobile with water, may be expected to show the most reliable indication of manure nutrient migration. The shallow sampling showed a marked increase in nitrate-nitrogen, from 1.51 ppm to 11.47 ppm. However, the deep sampling showed a slight decrease from 2.26 ppm to 1.70 ppm. These results are consistent with measurable, but very slow migration of moisture and nutrients into the soil profile. Very slow movement would be consistent with the observed condition of very low soil moisture beneath the crushed limestone floor.

Additional soil tests over time and performance of an infiltration ring study may give more conclusive answers in the future.

Acknowledgements

The project is supported by a USDA Special Grant, the Iowa Cattlemen's Foundation, the Iowa Beef Center, the Leopold Center for Sustainable Agriculture, the Wallace Foundation for Rural Research and Development, and personal donations of many western Iowa cattle feeders.

Table 1. Soil samples beneath crushed limestone flooring before and after 27 months of bedded confinement cattle feeding.

Parameter	Units	December 2005		April 2008	
		Shallow ¹	Deep ²	Shallow ¹	Deep ³
pH		6.3	6.5	6.0	6.4
Phosphorus (P)	ppm	4	10	11	6
Potassium (K)	ppm	143	114	267	147
Calcium (Ca)	ppm	2127	1951	2252	2164
Magnesium (Mg)	ppm	507	648	437	658
Soluble Salts	mmho/cm	0.232	0.192		
Organic Matter	percent	2.5	1.4	3.6	2.8
Nitrate Nitrogen	ppm	1.51	2.26	11.47	1.70

¹ Samples from 1 foot depth

² Samples from 4 to 5 foot depth

³ Samples from 3 foot depth