# Mineral Content of Forages Grown on Poultry Litter-Amended Soils

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## Story in Brief

Four farms in northwest Arkansas and northeastern Oklahoma were used to monitor mineral concentrations in forages grown on poultry litter amended soils from April 2000 to March 2002. Mineral concentrations were compared to the requirements of beef cows in gestation and early lactation, and grass tetany ratios were calculated to determine the risk of grass tetany occurrence. For most of the grazing period, calcium, phosphorus (P), potassium (K), sulfur, and iron concentrations were adequate to meet the requirements of beef cows in gestation and early lactation. Forage magnesium (Mg) concentrations from all four farms were generally below the requirement for beef cows in early lactation during the winter months of 2001 and 2002. Forages from two farms surpassed the tetany ratio during the spring of 2000, indicating that grass tetany could be a potential problem in lactating cows during that period. In general, zinc concentrations were above requirements at three of the four farms, but barely met or were below beef cattle requirements during most of the fall and winter of 2000-2001 at Farm 1. With few exceptions, copper (Cu) concentrations at all farms were at or below cow requirements, indicating that Cu supplementation would be necessary throughout much of the year. Pastures fertilized with broiler litter may meet some but not all mineral requirements of beef cattle; therefore, supplementation with specific minerals, such as Mg and Cu, may be warranted.

## Introduction

Large amounts of broiler litter are produced each year in Arkansas and used to fertilize pastures and hay meadows. The use of broiler litter as fertilizer significantly reduces reliance on commercial fertilizers and reduces production costs. Broiler litter has an N : P : K ratio of 4 : 3.7 : 3, but forages generally need only a ratio of 4 : 1 : 3. Broiler litter also contains a myriad of other macro and trace elements that are potentially available for uptake by forages. However, concentrations of these minerals in the plant may vary with species, stage of maturity, season, soil mineral concentrations, and the amount and type of fertilizer nutrients applied. The objective of this study was to monitor the mineral content of forages grown on broiler-litter amended sites throughout the year and compare each mineral with its respective requirement for beef cows during gestation and early lactation.

## Experimental Procedures

Four farms in northwest Arkansas (Farms 1, 3) and northeast Oklahoma (Farms 2, 4) that have a history of utilization of broiler litter as a fertilizer source were sampled from April 2000 to March 2002. One pasture from each farm was chosen to monitor the addition and removal of nutrients. Soil samples were taken from each farm in February 2000 and March 2001 and analyzed for soil test phosphorus levels. Four cages were placed randomly throughout each experimental pasture to prevent removal of forage by grazing animals. On a monthly basis, cages were relocated within the pasture, available forage readings were measured from old and new cage sites as well as throughout the pasture, and representative forage samples were gathered; samples were not gathered if the producer was stockpiling forage for hay production. Each pasture and cage sample was analyzed for mineral concentrations.

Farm 1 was located in northeastern Oklahoma on a Nixa silt loam soil, with soil test phosphorus levels of 205 and 154 lb/acre in February 2000 and March 2001, respectively. The forage base consisted primarily of bermudagrass and crabgrass during the summer and fescue, orchardgrass, and winter annual weeds during the winter. The chosen pasture site was harvested for hay during the summer, then allowed to stockpile for grazing by cow-calf pairs during the winter. Broiler litter was applied (1.5 tons/acre) on May 6, 2000, May 5, 2001, and June 10, 2001. Farm 2 was located in northwest Arkansas on a Nixa silt loam soil. The forage base consisted of a mixture of fescue and bermudagrass. The site was grazed heavily, but intermittently during the spring, summer, and fall, and was used to house cows during the winter. Soil test phosphorus levels at this site were 568 lb/acre in February 2000 and 415 lb/acre in March 2001. No litter was applied in 2000, but it had been in previous years. Broiler litter (2.5 tons/acre) was applied on April 18, 2001 and 200 lb/acre of ammonium nitrate was applied in July 2001. Farm 3 was located in northeast Oklahoma on a Newtonia silt loam soil and had a forage base of bermudagrass, white clover, annual ryegrass, and winter annual weeds. The pasture was grazed intermittently except during April through October 2001, when forage was allowed to accumulate and subsequently harvested for hay. Soil test phosphorus levels were 253 and 226 lb/acre in February 2000 and March 2001, respectively. Broiler litter was applied (2.3 tons/acre) on June 5, 2001. Urea was also applied in June 2001 and September 2001 at rates of 250 and 150 lb/acre, respectively. Farm 4 was located in northwest Arkansas on a Nixa silt loam soil with soil test levels of 470 and 450 lb/acre in February 2000 and March 2001, respectively. The forage base consisted of bermudagrass and annual ryegrass and was grazed intermittently except for the period from June 2000 to August 2000 and April 2001 to October 2001 when forage was allowed to accumulate for hay production.

Mineral concentrations of the forage samples gathered throughout the 2-yr period were compared with the NRC (1996) requirements for gestating and lactating cows.

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## Results and Discussion

Throughout most of the grazing season, concentrations of calcium (Ca), phosphorus (P), potassium (K), sulfur (S), and iron (Fe) in forages sampled on all farms exceeded the requirements of beef cattle. Forage Ca concentrations were adequate to meet the requirements for dry, pregnant cows on each sampling date at each farm (Figure 1). However, forage Ca concentrations on one sampling date at Farm 2 and on three dates at Farm 3 were not adequate to meet the requirements for a lactating cow. Forage P concentrations were below the requirements for a lactating cow in January and February 2001 for Farm 4 and in February 2001 for Farm 3 (Figure 2). Forage P concentrations were high during the spring of 2000 and 2001, ranging between 65 and 300% of the requirements for a lactating cow.

Forage K concentrations were excessive throughout much of the year at each farm (Figure 3). Concentrations of K were particularly high during the spring of 2000 and 2001 when they reached a maximum of nine times (Farm 4) the requirement for beef cows during gestation. Forage K concentrations were below requirements for beef cows in gestation and early lactation during January 2001 and February 2001 at Farm 4 and during February 2001 at Farm 3. Forage magnesium (Mg) concentrations at Farm 4 were below the requirements for beef cows in early lactation for the entire two-year period except for April and May of 2000 and April of 2001 (Figure 4). Concentrations of Mg at the other three farms were below requirements for beef cows in early lactation during the winter months of 2000-2001 and 2001-2002. Grass tetany, also called hypomagnesemia, is a disorder caused by a Mg deficiency, and is usually associated with grazing lush pastures during the spring. High levels of K may block Mg absorption by the animal and cause the onset of grass tetany. Physical symptoms range from reduced appetite, dull appearance, and staggering gait to signs of increased nervousness, frequent urination and defecation, muscular tremors, and excitability followed by collapse, paddling of feet, coma, and death (Mayland and Cheeke, 1995). The probability of grass tetany increases when the equivalent ratio of reaches 2.2 or greater. Concentrations of forage minerals at Farms 2 and 4 resulted in tetany ratios that surpassed this tetany threshold during the spring of 2000, and again during April 2001 for Farm 4, thereby increasing the chance for animals to contract grass tetany (Figure 5).

Concentrations of sulfur (S) at the four farms were adequate to meet cow requirements during every month except February 2002 at Farm 1 (Figure 6). Forage Fe concentrations were adequate to meet the Fe requirements of beef cattle for the entire two-year grazing period, except for September 2000 on Farm 4 when the forage concentration was 3 ppm below the 50 ppm requirement (Figure 7). Concentrations of zinc (Zn) in forages sampled during the winter months of 2000-2001 and January 2002 at Farm 1 were generally below requirements for beef cows. Zinc concentrations were below cow requirements on two isolated dates at Farms 2 and 3. Generally, concentrations of Zn in forages at Farms 2, 3, and 4 were well above cow requirements. With few exceptions, forage copper (Cu) concentrations tended to remain at or below the requirements for beef cows at all farms during the period of May 2000 to March 2001. Concentrations of forage Cu at Farm 1 exceeded beef cow requirements in April 2001 and March 2002 only, but remained well below requirements for the majority of the two-year period. Forage Cu concentrations at Farm 2 were at or below cow Cu requirements for much of the first year, but were generally above cow requirements for the remainder of the trial. Concentrations of Cu in forage at Farms 3 and 4 were generally close to cow requirements of 10 ppm but exhibited occasional spikes in concentration.

## Implications

Long-term applications of broiler litter to pasture may lead to accumulation of high levels of calcium, phosphorus, potassium, sulfur, and iron in the forage, but other minerals such as copper may be marginal to deficient. This may reduce supplemental mineral needs, but forage analyses should be used to ensure mineral concentrations are adequate to meet livestock requirements.

## Literature Cited


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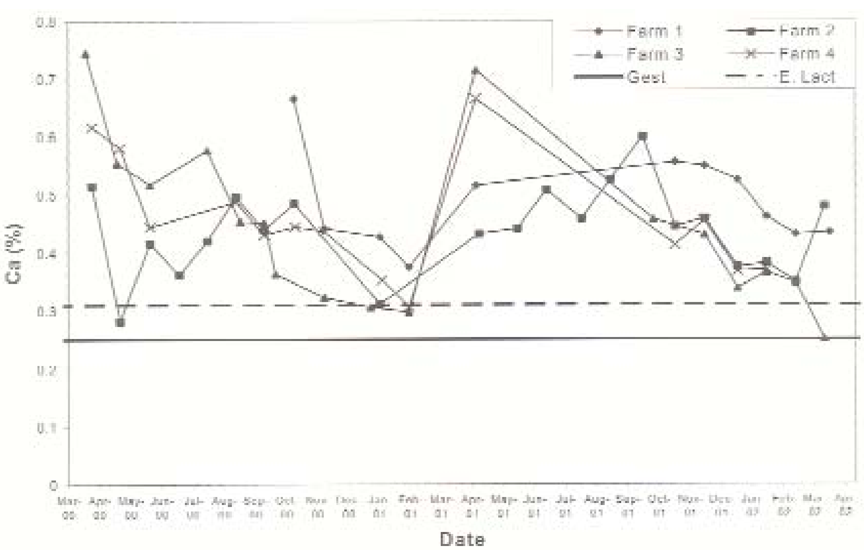


**Figure 1. Concentrations of calcium in forage harvested at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

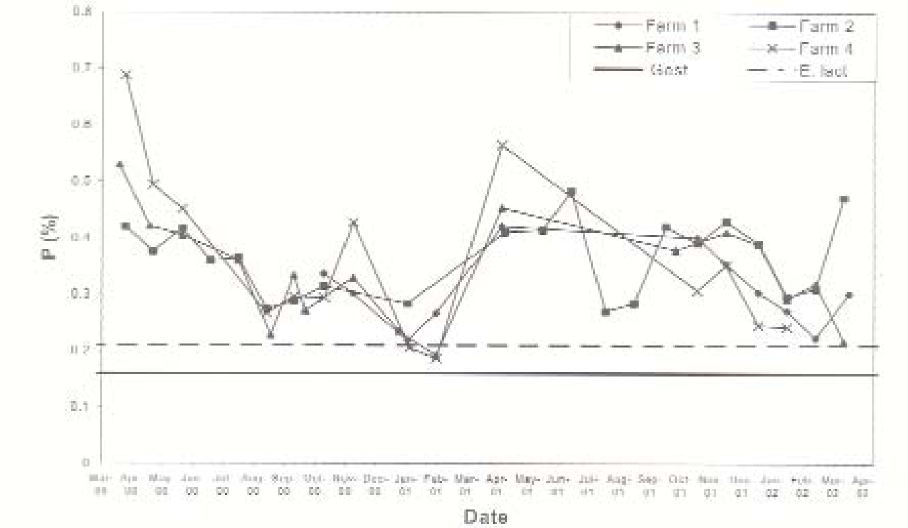


**Figure 2. Concentrations of phosphorus at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

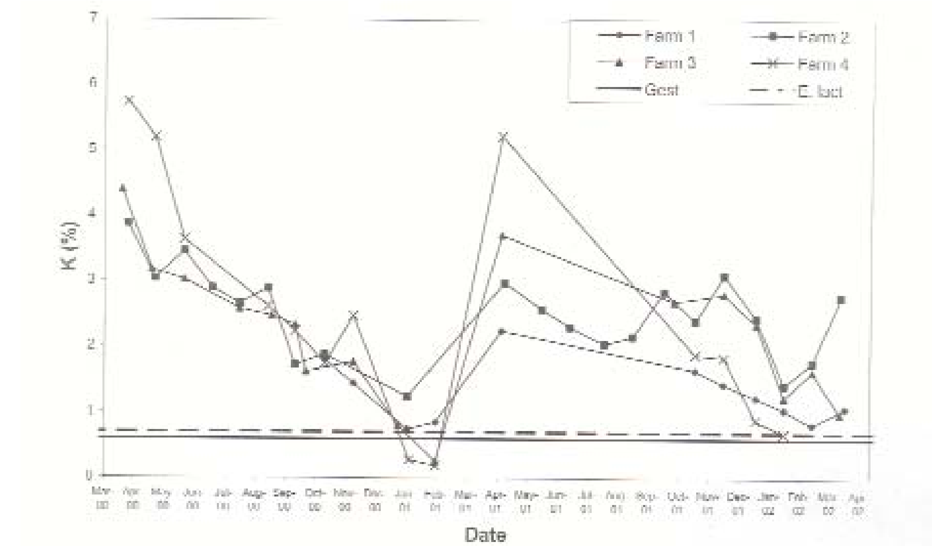


**Figure 3. Concentrations of potassium at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

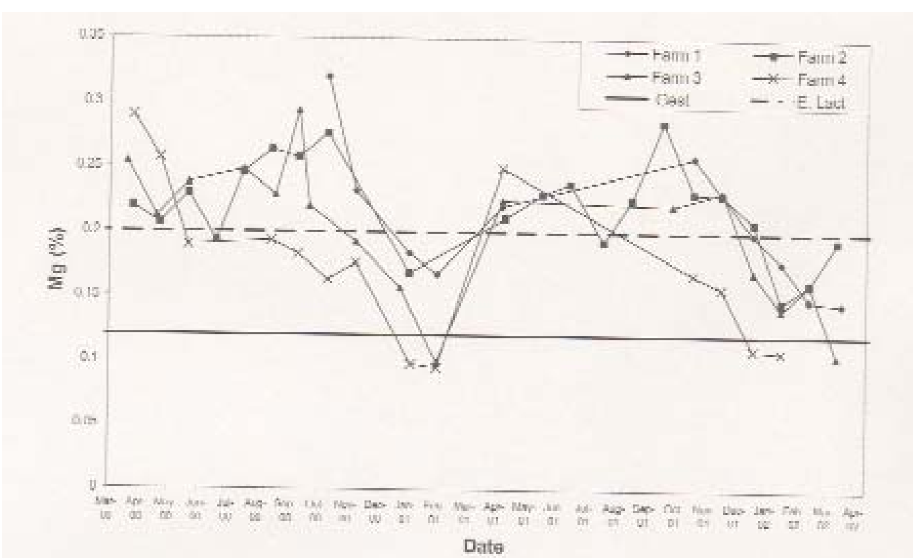


**Figure 4. Concentrations of magnesium at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

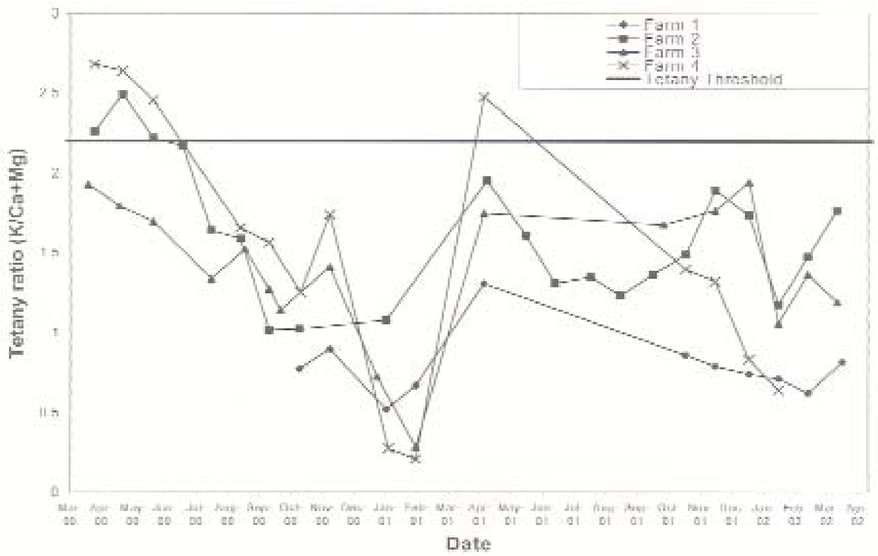


**Figure 5. Grass tetany ratio at four farms compared with the tetany threshold.**

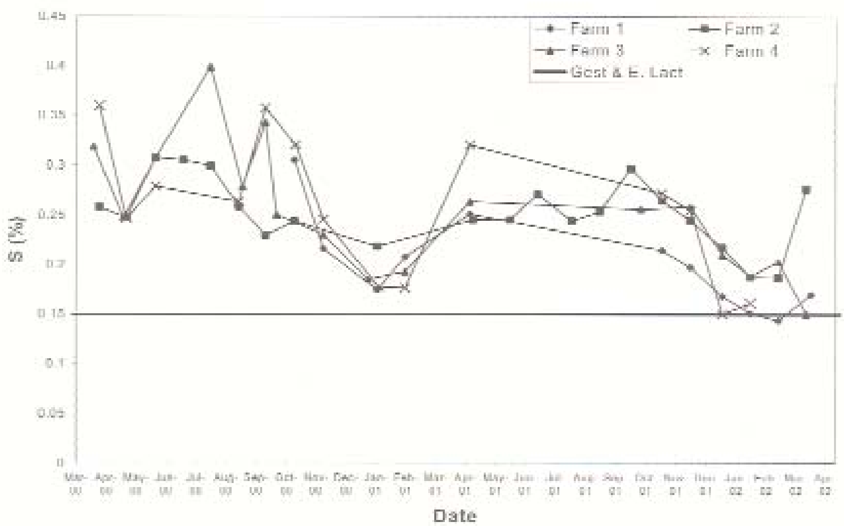


**Figure 6. Concentrations of sulfur at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

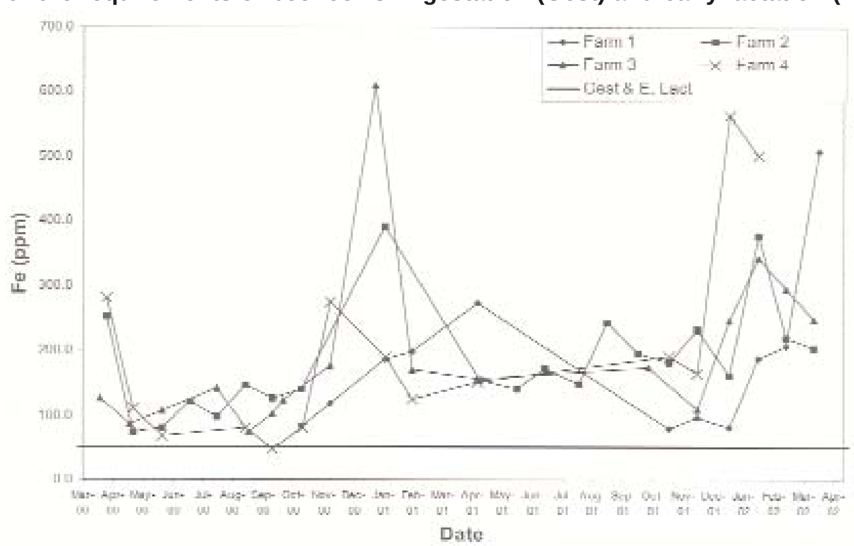


**Figure 7. Concentrations of iron at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

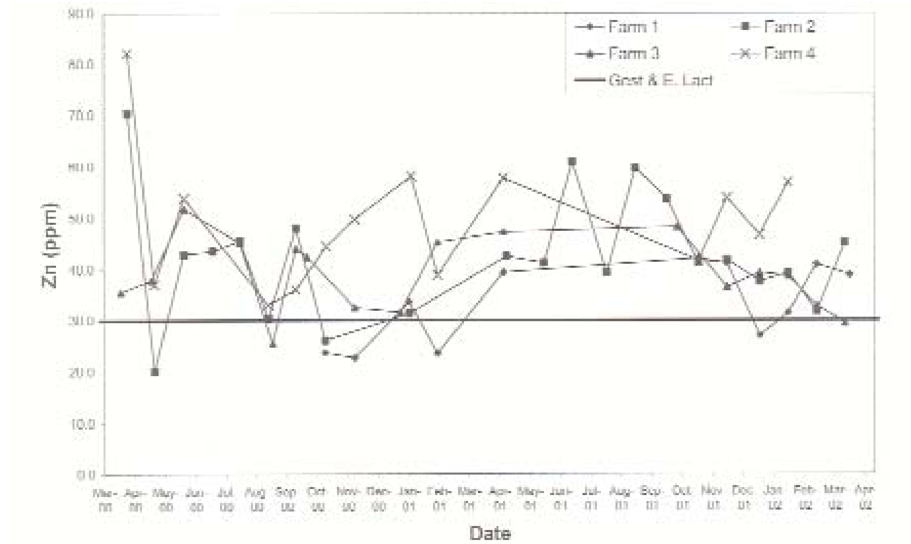


**Figure 8. Concentrations of zinc at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**

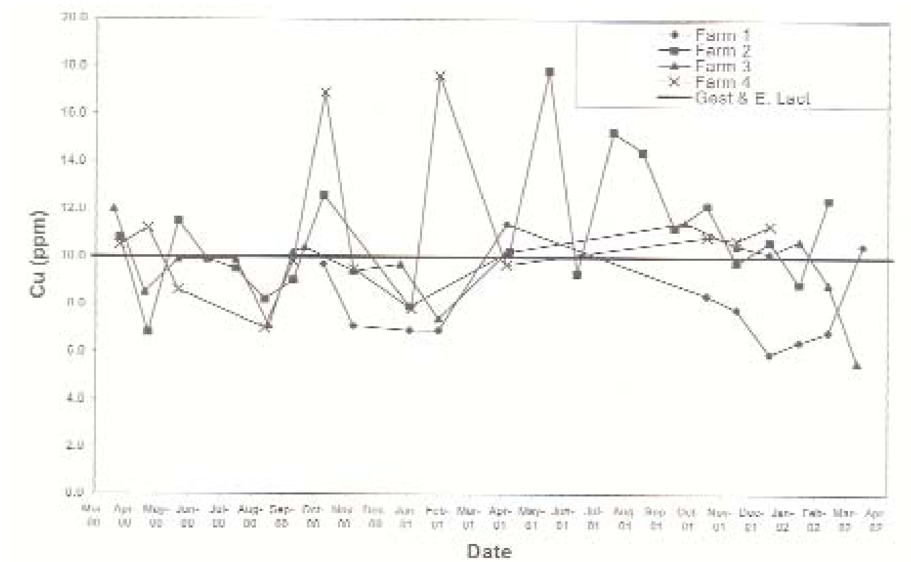


**Figure 9. Concentrations of copper at four farms compared with the requirements of beef cows in gestation (Gest) and early lactation (E. Lact).**