INFO SHEET
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Water Quality in U.S. Feedlots

A plentiful and consistent supply of high quality water is essential for optimal production and health of feedlot cattle. Water of inadequate quality can result in decreased gains, poor feed conversion, and adverse affects on animal health. The greatest losses to producers are often through undetected production inefficiencies. Ultimately, water quality can have hidden but considerable influences on feedlot profitability.

Understanding of the importance of nitrate, nitrite, sulfate, and total dissolved solids as factors influencing water quality for feedlots has been increasing. Concentrations generally considered safe for consumption by cattle have been established (Table 1). However, these values may vary slightly depending on type and formulation of rations fed to cattle.

Table 1. Concentrations of nitrate, nitrite, sulfate, and total dissolved solids in water typically considered safe for livestock usage.*

Measurement	Concentration Considered Safe (mg/L**)
Nitrate	Less than 440
Nitrite	Less than 33
Sulfate	Less than 300
Total dissolved solids	Less than 3,000

* Sources, National Research Council, National Academy of Sciences, Washington, DC.

** mg/L is equivalent to parts per million (ppm).

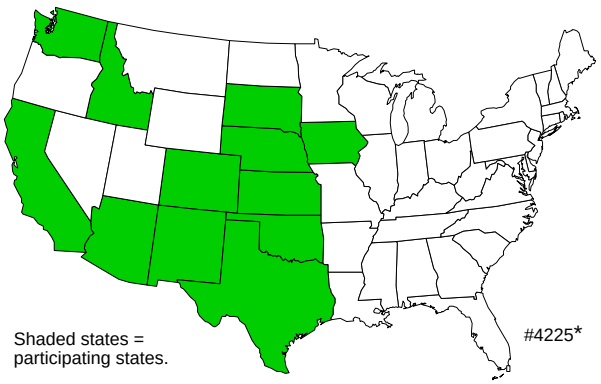
In the latter half of 1999, the USDA's National Animal Health Monitoring System (NAHMS) conducted the Feedlot '99 study on feedlots with 1,000 head or more capacity in the 12 leading cattle feeding states.[1] Eligible feedlots had 96.1 percent of U.S. feedlot inventory (January 1, 2000) and accounted for 84.9 percent of feedlots with 1,000 head or more capacity (1999).

Enumerators from the National Agricultural Statistics Service (NASS) administered an initial questionnaire and offered feedlots the opportunity to participate in a second phase of the study. Veterinary Medical Officers (VMO's) administered the second phase of the study which included the opportunity to have one representative water sample per feedlot analyzed for nitrate, nitrite, sulfate, and total dissolved solids. Additional information was collected regarding the percentage of cattle consuming the water, the water source (such as well or municipal source), and depth and age of wells.

A total of 263 feedlots from 10 states supplied a water sample for analysis. (No water samples were submitted from Arizona or Oklahoma.) The majority of samples (89.7 percent) were drawn from a well. Other sources included municipal/city (4.6 percent of samples), spring/river (2.3 percent), and pond/lake (2.3 percent). Eighty-one percent of the water samples were from a source that supplied all of the cattle (100 percent) on those feedlots.

Of the water samples that were from a well, 73.7 percent were from wells older than 10 years of age. Approximately one-third of the well samples were from wells older than 25 years. Only 1.7 percent of samples came from wells that were less than 30 feet deep. The largest percentage (45.3 percent) of samples were from wells that were 101 to 300 feet deep, whereas 22.5 percent were from wells deeper than 300 feet.

States Participating in the Feedlot '99 Study



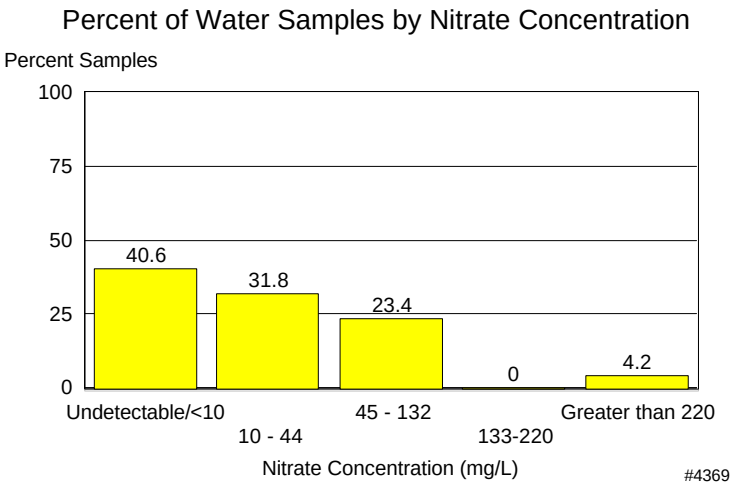
[1] Arizona, California, Colorado, Idaho, Iowa, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Washington.

Nitrate and Nitrite

Nitrate is important in livestock health. Although nitrate is not a particularly potent toxin, it is readily reduced to highly toxic nitrite within the rumen. Nitrite is about 10 times more toxic than nitrate. Nitrite is absorbed where it interacts with red blood cells by inhibiting their ability to effectively transport oxygen.

Moderate nitrate intake may not cause any noticeable affect on animal health but may result in decreased animal gains and poorer feed conversion. Intake of large amounts of nitrate may result in death.

Figure 1



Nearly 41 percent of samples had a nitrate concentration that was undetectable or less than 10mg/L (Figure 1). Approximately one-quarter (23.4 percent) of the samples had 45 to 132 mg/L nitrate and 4.2 percent had greater than 220 mg/L nitrate. No water samples exceeded the recommended limit (440 mg/L, Table 1).

In general, nitrate concentration increased with well age and in shallow wells. Thus older, shallower wells typically had higher nitrate concentrations. The mean nitrate concentration in wells that were less than or equal to 100 feet deep and greater than 10 years old was 69.1 mg/L, whereas the nitrate concentration in wells that were 10 years old or less and more than 100 feet deep was 11.7 mg/L. This disparity was most likely due to damaged casings in old wells or because shallow wells are more readily contaminated by nitrogenous compounds than deep wells.

Although the recommended tolerable limit for water nitrate is less than 440 mg/L, this concentration may vary with the content of nitrate and non-protein nitrogen in the ration. Nitrate can accumulate in some forages used in feedlot rations, including forage sorghum, corn stalks, less commonly alfalfa, and other plants (such as weeds). Forage analysis is recommended whenever there is suspicion of excessive nitrate content.

Most likely, water nitrate concentrations approaching the recommended limit for cattle of 440 mg/L would not result in clinically apparent disease but may result in decreased animal performance. It would seem prudent to recommend an economically practical pursuit of lower water nitrate concentrations for optimal animal performance. There was a substantial degree of variation in water quality results between states (Table 2). Typically, feedlots in Colorado utilized water with higher nitrate concentrations (mean 42.89 mg/L), whereas California feedlots used water with the lowest concentrations (mean 2.0 mg/L).

Almost all samples (99.6 percent) had undetectable levels of nitrite, while those samples with detectable levels contained less than 30 mg/L.

Table 2. Water nitrate, sulfate, and total dissolved solids concentrations by state.*

State	Percent of Samples	Mean					
		Nitrate		Sulfate		Total Dissolved Solids	
		mg/L	Standard Error	mg/L	Standard Error	Percent	Standard Error
California	1.9	2.00	(2.00)	83.40	(48.29)	0.04	(0.01)
Colorado	14.6	42.89	(11.50)	279.61	(79.18)	0.08	(0.01)
Idaho	2.3	16.67	(16.67)	28.67	(28.67)	0.03	(0.01)
Iowa	8.8	24.78	(12.06)	167.83	(66.18)	0.07	(0.01)
Kansas	24.9	39.31	(6.09)	122.25	(33.19)	0.07	(0.01)
Nebraska	28.4	32.30	(5.80)	71.28	(17.12)	0.06	(0.01)
South Dakota	8.1	17.14	(12.58)	1007.10	(76.75)	0.20	(0.01)
Texas	8.4	35.23	(12.53)	167.82	(61.97)	0.12	(0.03)
Other	2.6	52.86	(35.57)	49.43	(49.43)	0.03	(0.01)
Total	100.0	33.56	(3.47)	204.91	(23.54)	0.08	(0.01)

* States with fewer than five water samples submitted are not included in the table. Nitrite concentrations are not reported because the majority (99.6 percent) of fee supplied water samples with undetectable concentrations.

Sulfate

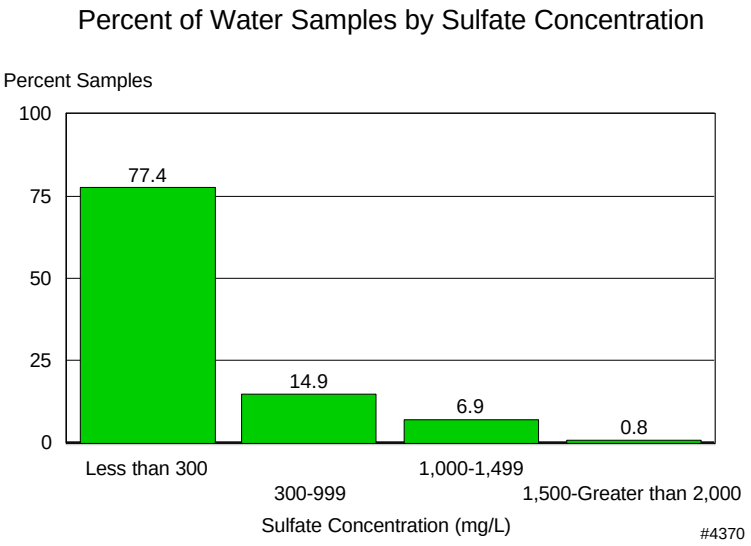
Sulfur is an element that is required by all animals. The recommended sulfur intake for beef cattle is 0.15 percent of the ration and the maximum tolerable limit is 0.4 percent of the ration on a dry matter basis. Water can contribute significant quantities of sulfur, as sulfate, towards total sulfur consumption. Sulfur constitutes one-third of the molecular weight of sulfate. So if an animal consumes 30 grams of sulfate by drinking water, it effectively consumes 10 grams of sulfur. Sulfur and sulfate are relatively non-toxic in these forms. But, like nitrate, sulfate/sulfur is readily reduced in the rumen to highly toxic products. These potent toxins are collectively known as sulfides and include hydrogen sulfide (known for its rotten egg smell). Concentrations of water sulfate that result in excessive total sulfur consumption can result in decreased water consumption, feed intake, and average daily gains and have adverse effects on feed conversion.

In addition to adverse effects on performance, elevated rumen sulfide concentrations secondary to excessive sulfur consumption are associated with a neurological disease of cattle, polioencephalomalacia (PEM). Occurrences of sulfur-associated PEM may serve as a marker for substantial hidden losses in production efficiency.

Approximately three-quarters (77.4 percent) of the samples had water sulfate concentrations considered safe (less than 300 mg/L, Figure 2). Almost 8 percent of samples had a water sulfate concentration of 1,000 mg/L or greater. The mean sulfate concentration in South Dakota feedlots was in excess of 1,000 mg/L (Table 2).

Effects of elevated water sulfate are greatest during the warmest months of the year when water consumption is increased. However, problems associated with excessive sulfur consumption can be seen year-round when the sulfur content of the ration is also elevated. It is possible to reduce adverse effects by making adjustments to the ration, such as decreasing the sulfur content during summer months if water sulfate concentrations are high. Adjustment may be necessary at other times to assure sulfur consumption remains at safe levels.

Figure 2



Total Dissolved Solids

Total dissolved solids is a measure of the total amount of dissolved material in the water, such as magnesium, calcium and sulfate. One component of total dissolved solids, calcium carbonate, is important in determining water hardness. Total dissolved solids in water in excess of 3,000 mg/L, or 0.3 percent, may result in diarrhea and water refusal in cattle. Almost all (97.7 percent) of Feedlot '99 water samples contained total dissolved solids of less than 3,000 mg/L.

Water quality is an important factor influencing animal performance on feedlots. Since concentrations of nitrate, nitrite, sulfate and total dissolved solids can fluctuate throughout the year, routine water analysis is warranted. It is also recommended that feedlots have their ration routinely tested as well. Where cases of clinical disease, such as PEM, occur as a result of poor water quality, there is likely an underlying and substantial loss in production efficiency.

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