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Livestock Water Quality

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Water is an important, but often overlooked, nutrient. Livestock water requirements are affected by many factors, including size, productivity, diet and environmental conditions. Good water quality and cleanliness can increase water intake and improve livestock production.

Composition of Water

Water quality and quantity may affect feed consumption and animal health. Low-quality water normally will result in reduced water and feed consumption. Substances that may reduce palatability of water include various salts.

Salts may be toxic at high levels. Substances that are toxic without much effect on palatability include nitrates and fluorine, as well as salts of various heavy metals. Other materials that may affect palatability or toxicity include pathogenic microorganisms.

Water is an important nutrient for livestock. Water quality can affect livestock performance and health. (Photo by Gerald Stokka.)

Water quality can vary depending on the source. Groundwater tends to be of higher quality than surface water; however, some aquifers in North Dakota have naturally high levels of potentially toxic salts such as sulfate due to geology. **Figure 1 (Page 2)** shows the difference in the salts or total dissolved solids (TDS) between surface and ground water samples observed during the 2020 growing season in North Dakota.

Weather also can influence water quality. When runoff is low in the spring or during a drought, the salts in surface water become more concentrated as water levels decline and can reach levels that can be toxic.

pH

Water pH denotes alkalinity or acidity. High-saline water is not the same as alkaline water. A pH of 7 would be neutral; a number higher than 7 indicates alkalinity; below 7 designates acidity.

Most North Dakota waters are alkaline, with a pH value above 8. Acidic water (pH below 7) is not common in most of North Dakota; however, some reports indicate acidic water in the western part of the state in proximity to lignite coal veins.

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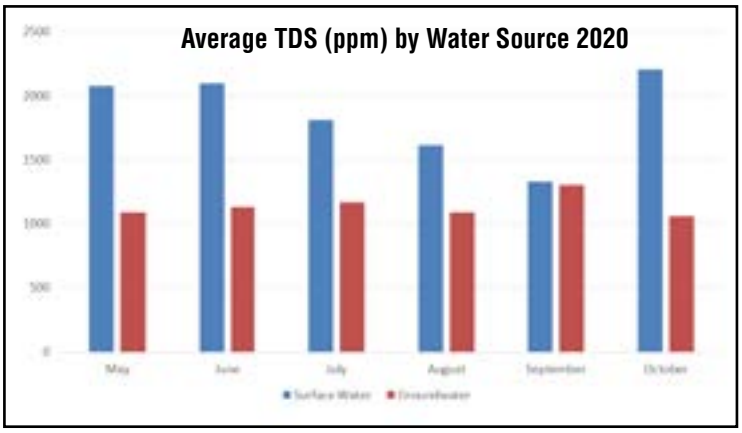

Figure 1.

Comparison of total dissolved solid levels between surface water and groundwater sources observed during the 2020 growing season.

(Source: NDSU Extension.)

When runoff is low in the spring or during a drought, the salts in surface water become more concentrated as water levels decline and can reach levels that can be toxic.

(Photo by Rachel Wald, McHenry County Agent.)

High alkalinity may cause digestive upsets, laxative action, poor feed conversion, and reduced water and/or feed intake.

Total Dissolved Solids and Salinity

Salinity refers to salt dissolved in water and is expressed as parts per million (ppm) or as milligrams per liter (mg/L). The term "total dissolved solids" (TDS) often is used to denote the level of water salinity.

TDS is a nonspecific indicator of water quality. TDS levels should not be used as the only measure of water quality.

Specific water components should be measured to determine suitability for specific applications. Salts commonly present include carbonate, bicarbonates, sulfates, nitrates, chlorides, phosphates and fluorides.

Highly mineralized waters (high solids) may not impact health parameters because cattle do seem to adapt. However, pipeline breaks and produced water or brine water spills are not uncommon in rural environments. These contaminants can include very high concentrations of salts, from several thousand to more than several hundred thousand ppm (milligrams/kilograms) of salt, especially sodium chloride.

Higher salt concentrations in water actually may increase water consumption; however, concentrations that lead to refusal to drink can lead to overconsumption when animals become too thirsty. Animals will have differing tolerance levels to salt content, depending on species, age, season of the year and physiological condition.

Generally, animals will tend to avoid high-saline water sources but will ingest poor water if it is the only water source available. Clinical signs of salt poisoning are weakness, dehydration, tremors, aimless wandering, ataxia, seizurelike activity, partial paralysis and death.

The prognosis is guarded in animals with clinical signs from salt toxicity. Cattle can die within 24 hours after the appearance of severe clinical signs.

Treatment options are focused on allowing limited access to good-quality water that can alleviate symptoms through time. Contact your local veterinarian for further advice.

When animals have clinical signs of exposure to high concentrations of salt, avoid giving the animals access to all the fresh water they will drink. Slowly return the animals to normal water hydration during a two- to three-day period.

For large animals, water intake should be limited to 0.5% of body weight at hourly intervals until hydration is normal.

Table 1 shows the health effects associated with the consumption of different levels of total dissolved solids.

Sulfates

High levels of sulfates can impact livestock health. Ruminants are especially susceptible. Sulfate recommendations are less than 500 ppm for calves and less than 1,000 ppm for adult cattle.

High levels of sulfate can reduce copper availability in the diet. If copper deficiency is suspected, water sources should be analyzed for sulfates.

Many feeds also contain sulfur, so the diet will influence the potential for sulfate toxicity. Table 2 shows the maximum sulfur and sulfate levels for different species of livestock in their diet and water, as influenced by diet.

Use caution in evaluating sulfate levels in water because of interactions with copper and molybdenum. Elevated levels of sulfates may cause loose stool, whereas very high levels of sulfate can induce central nervous system (CNS) symptoms. High levels of sulfates also may contribute to an increased incidence of polioencephalomalacia (PEM), a brain disorder found in cattle.

Other Minerals

Water hardness is caused by calcium and magnesium. Softening the water through an exchange of calcium and magnesium with sodium may cause problems if the water already is high in salinity.

When a significant amount of calcium is in water, it should be considered as a part of total mineral intake. However, many mineral salts are relatively insoluble and pass through the body without being absorbed. Even in hard water, the amount of mineral ingested from the water is not likely to be substantial.

Table 1. Recommendations for livestock water used based on total dissolved solids (TDS).

TDS (ppm or mg/L)	Effects of Livestock
< 3,000	Usually satisfactory for most livestock
3,000 – 5,000	May not cause adverse effects for adult livestock. Growing/young livestock could be affected by loose stool or poor feed conversion. Levels near 5,000 ppm are unacceptable for poultry.
5,000 – 7,000	Should not be consumed by pregnant or lactating females. Usually a laxative and may result in reduced water intake
7,000 – 10,000	Do not use for swine. Do not use for pregnant or lactating ruminants or horses.
> 10,000	May cause brain damage or death

Table 2. Maximum sulfur and sulfate levels for livestock

Livestock Type	Diet	Sulfur in Diet	Sulfate in water ppm or mg/L
Cattle and sheep	> 85% concentrate, < 15% forage	0.3%	< 600
Cattle and other ruminants	> 40% forage	0.5%	< 2,500
Swine		0.4%	< 3,000
Chicks		~ 0.4%	< 1,000

Nitrates

Water may be a source of toxic levels of nitrate for livestock. Water may become contaminated by fertilizer, animal wastes or decaying organic matter. Shallow wells with poor casings are susceptible to contamination.

Marginally toxic levels of nitrate in water and feed together may cause nitrate toxicity in animals. Remember to consider both sources of nitrate. For more information regarding nitrates and nitrate poisoning, refer to NDSU Extension publication “Nitrate Poisoning of Livestock” (V839 Revised).

Microbiological Contaminants

Cyanobacteria

Algae that builds up in large livestock tanks or ponds may be due to a specific species known as cyanobacteria (sometimes called blue-green algae). It responds to sunlight and appears in stagnant water during hot, dry weather.

Signs of cyanobacteria toxicity in livestock are diarrhea, lack of coordination, labored breathing and death. For additional information on blue-green algae poisoning, refer to NDSU Extension publication V1136, “Cyanobacteria (Blue-Green Algae) Poisoning.”

Other Microbiological Properties

Many water sources contain microorganisms. Most microorganisms are quite harmless, but some do cause animal health problems.

Coliform counts below 50 per milliliter of water are safe for all cattle. Other possible contaminants include bacteria, parasites and viruses that will not be reflected in the coliform count.

Microorganisms can enter a well that has improper surface protection. A well is situated improperly if it receives drainage from livestock pens or a manure storage structure. Cracked well casings also may allow bacteria to enter the water supply.

Contamination also may occur from a heavy spring rainfall. In addition, protect the surface of wells from contamination by rodents.

Chemical Contaminants

Many chemicals, some of which could be detrimental to livestock production, may be found in water. Safe levels of herbicides and pesticides in water for animals have not been determined. Fish are more sensitive to pesticides than other livestock.

Herbicides and pesticides can enter a ground water or surface water supply from runoff, drift and accidental spills. Provide adequate drainage around the water supply. Wells should be on elevated ground to prevent surface runoff into the well.

Industrial Products

Livestock often coexist in the same environment with industrial development. Livestock producers need to be aware of sources of industrial contaminants, particularly petroleum related, that can be released into the environment, especially water sources.

Animals can be exposed to fresh and weathered crude oils, refined hydrocarbons (for example, gasoline, diesel fuel and other petroleum-based products), concentrated and diluted hydraulic fracturing ingredients, glycols (for example, ethylene and diethylene glycols), methanol, produced water (brine or formation water) and oil field wastes.

The sources of these exposures may occur from pipeline spills, broken equipment and offsite leaching, inadequate or broken fences and accidents. Livestock, particularly cattle, are curious and often will explore novel sites and ingest contaminated water, soil and forages. Cattle actually will seek out lead-containing batteries and ingest petroleum hydrocarbons, and lick at greases and salty-tasting contaminants.

Acute and chronic clinical signs occur in livestock following significant petroleum ingestion. Signs may include diarrhea or constipation, bloat, poor rumen motility, nervous system signs (tremors and seizures or incoordination and depression), and poor appetite with chronic wasting and marked weight loss. Respiratory signs, including rapid, shallow breathing, coughing and pneumonia, often occur.

Following ingestion of moderate to large amounts of hydrocarbons, animals may vomit and aspirate contents into lungs a nd subsequently develop aspiration pneumonia. Reproductive effects have been reported with petroleum hydrocarbon toxicity, including abortions, dystocia, poor mothering and abnormal development.

In addition to reproductive and production losses, death can occur days after petroleum hydrocarbon exposures. Immune suppression and secondary infections also are associated with livestock losses due to petroleum hydrocarbon toxicosis.

If exposure to industrial contamination is suspected, immediately remove livestock from the contaminated area to stop further exposure. Provide the animals with uncontaminated fresh water and adequate feedstuffs. Contact a veterinarian. The local veterinarian, often in contact with specialists with experience with toxicants, can diagnose and initiate a treatment program.

With significant petroleum product releases to the environment, the North Dakota Department of Mineral Resources, Department of Environmental Quality and the state veterinarian are notified and will begin assessment of the contaminated environment and may assist with assessment of the animal condition.

Do not allow livestock to return to contaminated areas until appropriate cleanup procedures are taken for protection of livestock. Long-term monitoring of contamination in the environment may be required to protect livestock.

Livestock Water Quality Testing

Table 3 lists the safe levels of potentially toxic nutrients and contaminants in water for livestock. These should be analyzed only when you have good reason to suspect their presence at excessive levels.

Regular screening of livestock water sources is recommended, particularly: 1) if using shallow water sources (ponds, sloughs and shallow wells), 2) during drought and 3) if you suspect a problem with water quality. We recommend the use of an electrical conductivity (EC) or TDS meter and sulfate test strips to screen TDS and sulfate levels.

To ensure your EC/TDS meter is calibrated correctly, refer to "Using Electrical Conductivity and Total Dissolved Solid Meters to Field Test Water Quality" (WQ1923): *www.ag.ndsu.edu/publications/environment-natural-resources/using-electrical-conductivity-and-total-dissolved-solids-meters-to-field-test-water-quality*. If TDS levels exceed 4,500 ppm and/or sulfates levels exceed 800 ppm, a sample should be collected and submitted to a laboratory for additional analysis.

Table 3. Safe levels of potentially toxic nutrients and contaminants in water for livestock.

Element	Safe Upper Limit of Concentration (ppm or mg/L)
Aluminum	5.0
Arsenic	0.2
Barium	10
Cadmium	0.05
Calcium	1,000
Chromium	1.0
Copper	0.5
Fluoride	2.0
Lead	0.1
Molybdenum	0.5
Nickel	1.0
Nitrate	100
Nitrite	33
pH	5.5 to 9.0
Selenium	0.05
Sodium	1,000
Sulfate	500 to 1,000
Vanadium	0.1
Zinc	25.0

Depending on the type of testing, a private individual may be able to take a water sample for water testing or the sample could be taken by a qualified individual for a specific set of tests. For detailed directions on sample collection and submission, refer to "Livestock Water Testing Guidelines": *https://www.ag.ndsu.edu/livestockextension/documents/LivestockWaterTesting-Guidelines_2017_Revised.pdf*

Sample bottles may be available from a laboratory for use in specific tests or, in some cases, empty distilled water or water bottles could be rinsed with water from the suspect source and used to collect a sample. The container should be sealed with tape. The best approach is to contact the testing laboratory to determine the sampling and handling procedures for the requested tests.

Often water testing needs to be performed within a specified time period, so keep in mind transportation to the laboratory when taking water samples.

Water analyses for livestock typically include:

- Total dissolved solids or salinity
- pH (acid or alkaline value)
- Nitrates
- Sulfates
- Additional factors associated with toxicity problems such as mineral or metal concentrations, pesticides, petroleum hydrocarbons or oil field chemicals, or perhaps harmful blue-green algae identification (or algal toxin determination)

No legal limits have been established for bacteria, or more specifically coliform bacteria, in livestock water except for dairy operations (Grade A dairies). For dairy operations, an approved laboratory must test the water supply to make sure it is microbiologically safe for use.

Many commercial laboratories and the NDSU Veterinary Diagnostic Lab provide testing for livestock water quality and specialized testing. Contact an NDSU Extension office for a list of commercial laboratories in the state.

If concerned about livestock disease caused by contaminated drinking water, contact your local veterinarian, the NDSU Extension veterinarian or the NDSU Veterinary Diagnostic Laboratory for a specialist.

NDSU Extension Veterinarian
701-231-7641

NDSU Veterinary Diagnostic Lab
701-231-8307

For more information on this and other topics, see www.ag.ndsu.edu

200-7-15; drought-7-17; 250-5-19; 150-2-21