AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

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Water Requirements for Livestock

Water is the main constituent of the animal's body, constituting 50 to 80 percent of the liveweight, depending on age and degree of fatness. An animal can lose almost all of its fat and about 50 per cent of its body protein and survive. However, the loss of 10 per cent of its body water can be fatal. Therefore, a successful livestock enterprise requires a good water supply. A good water supply is defined both in terms of quantity and quality of the water. A good water supply is important to the livestock manager because total water intakes are positively related to feed dry matter (DM) intakes.

Water sources

The four main functions of water in the body are:

- to help eliminate waste products of digestion and metabolism (feces of healthy cattle often contain 75 to 85 per cent water)
- to regulate blood osmotic pressure
- a major component of secretions (milk and saliva) as well as in the products of conception and growth
- in the body's thermoregulation as affected by evaporation of water from the respiratory tract and from the skin's surface

Cattle fulfil their needs for water from three major sources:

- free drinking water or snow
- water contained in feed
- metabolic water produced by metabolic activities

The first two are sources of major concern in the management of livestock. Because of the large variation in water intakes, an estimate of water intake of cattle should be made based on production factors, which affect water intake. Water consumption requirements depend on factors such as:

- kind and size of animal
- rate and composition of gain
- pregnancy
- lactation
- type of diet
- level of dry matter intake
- level of activity
- quality of water
- temperature of the water offered
- surrounding air temperature

Most ground or surface waters are satisfactory for livestock

Table 1 shows estimates of good quality water requirements of various classes of beef cattle in different physiological states and in different thermal requirements. Water intake from feeds plus that consumed ad libitum as free water is approximately equivalent to the water requirements of cattle.

Water quality

Water quality is important to livestock, especially with respect to the content of salts and toxic compounds. This is because the quality of water affects the quantity of the water consumed. Most ground or surface waters are satisfactory for livestock. When the drinking water for livestock is not satisfactory, it is most often due to excessive salinity.

Salinity is measured as the concentration of dissolved salts of various kinds. Other factors such as nitrate content, alkalinity or high levels of single toxic elements occasionally cause problems.

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Table 1. Approximate total daily water intake of beef cattle*						
Animal description	**Intakes in liters for temperatures in Celsius (C)**					
	4.4°C	**10°C**	**14.4°C**	**21.1°C**	**26.6°C**	**32.2°C**
Feeders and replacements 2 - 6 months	20.1	22.0	25.0	29.5	33.7	48.1
Feeders and replacements 7 - 11 months	23.0	25.7	29.9	34.8	40.1	56.8
Feeders and replacements12 months and older	32.9	35.6	40.9	47.7	54.9	78.0
Bred heifers and dry cows	22.7	24.6	28.0	32.9	–	–
Lactating cows	43.1	47.7	54.9	64.0	67.8	61.3
Herd bulls	32.9	35.6	40.9	47.7	54.9	78.0

* Adapted from the Nutrient Requirement of Beef Cattle Update 2000, 7th revised edition. National Academy of Sciences – National Research Council.

Water samples for livestock consumption can be analysed to determine the water quality. A chemical analysis determines pH, total salt content (total dissolved solids), and minerals. A bacterial analysis indicates if water contains micro-organisms, such as bacteria. Water samples can be submitted to private laboratories for analysis for livestock consumption. If you are having nutritional problems with your animals, have your feed analysed. You may also want to have a chemical analysis of your water done to determine the levels of nitrates and various minerals such as, potassium, magnesium, sodium and calcium present in the water. Then, balance your ration for the total nutrient intake in the diet including the nutrients in the water.

Microbiology

Water may contain a variety of micro-organisms, such as bacteria, viruses, protozoa and parasite eggs. A coliform bacteria count of over 1/100 ml can cause scours in calves. A count of over 20/100 ml can result in diarrhea in cows and cows going off feed. Water chlorination removes harmful bacteria and other micro-organisms. Protozoa and enteroviruses are more resistant to chlorination than bacteria.

Salinity

All water contains dissolved substances. Most of these are ions of inorganic salts. The most predominant of these are calcium, magnesium, sodium chloride, sulfate and bicarbonate. Occasionally, the levels of salts are high enough to cause harmful osmotic effects that result in poor performance, illness or even death in animals forced to drink them (see Table 2). Various salts have slightly different effects, but these differences normally are of no practical significance. While sulfates are laxative and cause some diarrhea, their damage to animals seems no greater than that of chlorides. In the same way, magnesium salts are usually no more of a problem than calcium or sodium salts. The effects of various salts seem to be additive, meaning a mixture of them causes the same degree of harm as a single salt of the same total concentration.

Some observations can be made relative to saline livestock waters:

- Increasing salinity may actually cause an increase in water consumption. Animals may initially refuse to drink the water due to the salty taste.
- At very high salt concentrations, animals may refuse to drink for many days. This is followed by a period where they drink a large amount at one time and become suddenly sick or die.
- Younger animals are more prone to harm from salinity than are older animals.
- Any factor causing an increase in water consumption such as lactation, high air temperatures or exertion increases the danger of harm from saline waters.
- Animals seem to have the ability to adapt to saline water quite well, but an abrupt change from low salinity to high salinity water may cause problems. A gradual acclimatization is tolerated.
- When animals suffering from the effects of saline water are given low saline water, they make a rapid and complete recovery.
- Salt is sometimes used in the feed to regulate feed intake. In this case special care should be taken to supply a low salt content water.

Table 2. Guide to the suitability of saline waters with various concentrations (ppm = mg/L) of total soluble salts (TSS)	
Total dissolved solids (mg/L or ppm)	**Rating**
< 1,000	Electrical conductivity is less than 1.5. Excellent for any class of livestock.
1,000 - 2,999	Electrical conductivity is between 1.5 and 5. Satisfactory for all classes of livestock. May cause mild and temporary diarrhea in animals not accustomed to the high salinity.
3,000 - 4,999	Electrical conductivity is between 5 and 8. Satisfactory for livestock, but may cause temporary diarrhea and be refused by animals not accustomed to it.
5,000 - 6,999	Electrical conductivity is between 8 and 11. Reasonably safe for beef and dairy cattle, sheep, swine and horses, but avoid use for pregnant and/or lactating animals.
7,000 - 6,999	Electrical conductivity is between 11 and 16. Avoid using this type of water if possible. Probably unfit for swine. Older cattle, sheep, horses and even swine may subsist on it for long periods. This type of water is not recommended for pregnant, lactating and young animals, or older animals that are subject to heat stress.
> 10,000	Electrical conductivity is greater than 16. Not recommended for any class of livestock under any circumstances.

Nitrates

Nitrates need to be discussed together with nitrites. Nitrates are occasionally found in toxic levels in water. Nitrites are also found in water, but seldom at toxic levels. The presence of nitrates or nitrites in water often indicates contamination of the water supply with fecal material or seepage from a septic field. Nitrates themselves are not very toxic, but when reduced to nitrites, problems can develop. Nitrites that get into the blood stream convert the red pigment, hemoglobin, to a dark brown pigment, methemoglobin. Hemoglobin is responsible for carrying oxygen from the lungs to other tissues of the body. Oxygen cannot be carried in the methemoglobin form. When about 50 per cent of the hemoglobin is in the form of methemoglobin, the animal shows signs of distress suggesting a shortage of breath. Above this level, respiratory distress may result in death. At 80 per cent or more, the animal usually dies from a type of suffocation. Table 3 categorizes the levels of nitrate in water.

Table 3. Guide to the use of waters containing nitrate for livestock	
Nitrate content[1] (ppm nitrate nitrogen)	**Comments**
Less than 20[2]	Nitrate levels above this level may be detrimental to poultry performance. Research evidence indicates that nitrate levels greater than 10 ppm may impact broiler performance as measured by poor weight gains, health problems or poor flock performance.
Less than 100	Experimental evidence to date indicates that this water should not harm cattle, sheep, swine and horses.
100 to 300[3]**	Water containing over 100 mg/L of nitrate is a potential health hazard with feed containing high nitrates. When feeds contain nitrates, this water can add greatly to the nitrate intake making it dangerous. Ruminants are the most susceptible because bacteria in the rumen convert nitrate to the much more dangerous nitrite. Pigs are less susceptible because this conversion doesn't occur to the same extent.
Over 300[4]	This water, when fed with feed containing high nitrates, can cause typical nitrate poisoning in cattle and sheep. Its use for these animals is not recommended. This level of nitrate contributes significantly to salinity. Also, because experimental work with levels of nitrate nitrogen in excess of this are meager, the use of this water for swine, horses or poultry should also be avoided.

1 Includes nitrite nitrogen.

2 S. Wakins. Water quality and sanitation. Proceedings Poultry Service Industry Workshop, 2004.

3 Less than 443 ppm of nitrate or less than 607 ppm of sodium nitrate.

4 Over 1,329 ppm of nitrate or over 1,821 ppm of sodium nitrate.

In ruminant animals, bacteria in the rumen convert nitrate in the feed or water to nitrite, which can diffuse into the blood stream. Nitrate toxicity from water is unusual, but the combination of nitrates in feed plus those in water should be watched to avoid problems. The conversion of nitrate to nitrite is not a major problem with monogastric animals.

Alkalinity

Many and perhaps most waters are alkaline. Only in a very few instances have water samples been found to be too alkaline for livestock. Alkalinity is expressed as either pH titratable alkalinity in the form of bicarbonates and carbonates (see Table 4). A pH of 7.0 is neutral, below pH of 7.0 is acidic and above 7.0 is alkaline. Most waters have pH values between 6.8 and 8. At a pH of 8, water would be considered mildly alkaline. This also means that the water contains mainly bicarbonates and few carbonates. As the pH increases, the level of alkalinity rises. At a pH of 10, water is considered highly alkaline with carbonates present. Most waters have less than 500 ppm of alkalinity (assayed as calcium carbonate) and as such are not harmful. High levels of alkalinity can cause physiological and digestive upsets in livestock. The precise level that causes problems is not well defined. As a general rule, waters with less than 1,000 ppm are considered satisfactory for all livestock and poultry. Above that level it may be unsatisfactory. For adult animals little harm may occur at concentrations less than 2,500 ppm unless carbonates exceed quantities of bicarbonates.

Algae

Occasionally, heavy algae growth occurs in stagnant or slow flowing bodies of water. Some species of algae, mainly the blue-green algae, can under certain circumstances be toxic to livestock.

These single cell or chain-like groups of cells are free floating and green, blue-green or brown in colour. They commonly appear as small specks or "grass clippings" in the water. The blue-green algae are single cell cyanobacteria that produce a microcystin toxin. The algae thrive in warm, stagnant water that is high in nitrogen and phosphorus. The largest release of toxin occurs when the algae dies. Cooler, rainy or windy weather can cause an algae kill. Early symptoms of poisoning are muscle twitches, scouring, photosensitivity and loss of co-ordination. If sufficient quantities of the toxin are consumed, paralysis and respiratory failure occurs rapidly. Animals are not able to breathe and suffocate to death within minutes. Thus, animals are usually found close to the suspect water source.

Removing animals from affected areas is the only sure method of preventing poisoning. Care should be taken to limit the growth of algae in water for livestock consumption.

Toxic elements

On rare occasions natural water may contain or become contaminated with certain toxic elements such as arsenic, mercury, strontium, cadmium or radioactive substances. While these may harm animals, the major concern is that they do not accumulate in animal products used for human consumption. Analyses for these elements are only done when there are good reasons to suspect their presence.

Interpreting water analysis

Water analysis results have been expressed in several ways. The interrelationships of the common ones are listed below:

- One part per million (ppm) means one pound per million pounds of water
- For all practical purposes milligrams per litre (mg/ L), milligrams per kilogram (mg/kg) and parts per million (ppm) mean the same thing
- One grain per gallon is equivalent to about 17 parts per million

Table 4. Guide to the interpretation of levels of alkalinity in water

Alkalinity (ppm) (assayed as $CaCO_3$)	Nature of alkalinity	pH	Comments
Less than 500	Mostly bicarbonates	6.8 - 8	Most water samples fall in this range and are not harmful.
Up to 1,000	Mostly bicarbonates	7 - 8	Considered satisfactory for both livestock and poultry.
Above 1,000	Carbonates present	8 - 9	May be unsuitable for livestock particularly young animals.
Less than 2,500	Carbonates present	10	May do little harm in adult animals, unless carbonates are present in excess of bicarbonates.

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