UNIVERSITY OF FLORIDA
IFAS EXTENSION

Water and Its Importance to Animals[1]

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Water is the most important nutrient in animal feeding and animal health. It is the most abundant ingredient of the animal body in all phases of growth and development. A calf's body contains 75 to 80% water at birth and about 55 to 65% water at maturity. Of all farm animals, lactating dairy cows require the greatest amount of water in proportion to their size because water constitutes 86 to 88% of the milk they yield.

Sources of water include that obtained from the ground or surface, water in the feed supply and metabolic water obtained from the oxidation of fat and protein in the body. Water intake usually refers to free-drinking water plus that available in the feed.

FUNCTIONS

Water is the medium in which all chemical reactions in the body take place. Blood, which contains 80% water, is vital in transporting oxygen to the tissues and carbon dioxide from the tissues as well as being the life support system for the body. In its major functions, water acts as:

- an ideal lubricant to transport feed;
- an aid in excretion;
- a regulator of body temperature; and
- a buffering agent to regulate pH (acidity or alkalinity) of body fluids.

Water's physical properties make it an important factor in the transfer of heat and the regulation of temperature in the body. Since water has a high specific heat (the ability to absorb or give off heat with a relatively small change in temperature), it is ideally suited as a temperature buffering system for the body. A restriction of water intake lowers feed intake, retention of nitrogen, and loss of nitrogen in the feces. It also results in an increased excretion of urea in the urine. Cattle that are gaining weight require more water than those that are losing weight. Animals may lose nearly all the fat and about one-half the protein of the body and survive, but a loss of about one-tenth of the water from the body means death.

Animals need a continuous supply of water for maximum efficiency. Because water functions as a lubricant in the transport of feed and aids in the excretion of waste products from the body, the intake must equal the output lost through urine, feces and evaporation. As an example, during protein metabolism, uric acid and urea are produced and must be removed through the kidneys. Water is needed to

1. This document is CIR1017, one of a series of the Animal Science Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Original publication date October, 1992. Reviewed June, 2003. Visit the EDIS Web Site at http://edis.ifas.ufl.edu.
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dissolve the urea, uric acid, phosphates and other minerals for easy passage through the urinary tract.

WATER INTAKE

The water consumption of dairy animals is influenced by many factors including breed, body size, ambient environment, water temperature, humidity, feed supply, salt, and level of production. Generally, cattle consume 2 to 4 lbs of water for each pound of dry matter consumed and an additional 3 to 5 lbs of water per pound of milk produced. Rations high in salt or protein increase water intake.

Milk production and feed intake decline when water intake is not adequate. At environmental temperatures above 70 degrees F, the animal's respiration rate begins to increase, and increasing amounts of water are lost from the lungs and from sweating. Increased losses of water signal the animal to consume more water to replace the losses.

An equation for estimating water consumption has been proposed by Murphy et al. (References, 6). Factors identified as affecting water intake were dry matter (DM) intake, milk production, sodium intake and environmental temperature. Water intake was predicted from the following:

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Water intake,(lb/day)    = 35.2+1.58×DM intake(lb/day)
                         + .90×milk produced(lb/day)
                         + .11×sodium intake(g/day)
                         + 2.64×weekly mean minimum
                           temperature(degrees C).
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Thus, the equation predicts water consumption will change 1.58 lbs for each 1.0 lb change in dry matter consumed, .90 lb for each 1.0 lb of milk produced, .11 lb for each gram of sodium consumed, and 2.64 lbs for each degree centigrade change in weekly mean minimum temperature (1.47 lbs change for each degree Fahrenheit). Usually, in hot weather dry matter intake and milk yield decline, but water intake usually increases due to effect of increased temperatures, particularly if shade is not available. With shade, location of water in relation to the shade can have a major effect on water intake. Field studies by Bray et al. (References, 1) showed decreased water consumption in hot weather when the water troughs were located in the sun, requiring cows to leave the shade in order to drink.

Table 1 shows estimated water consumption at various body sizes, levels of milk production and temperatures using the Murphy (References, 5) equation for milking and dry cows. The weekly mean minimum temperature was assumed to be 10 degrees Fahrenheit lower than the mean daytime temperature. Dry matter intake was assumed to change from 30 lbs/day for dry cows up to 48 lbs/day for cows produc100 lbs of milk per day. As an example, a 1400 lb cow producing 60 lbs of milk during tempatures of about 80 degrees F would consume about 25.3 gallons (215 lb) of water daily.

Dry matter intake and moisture content of the feed influence the amount of water consumed. In general, lactating dairy cows will consume 1.5 to 2 lbs of water per pound of increase in DM intake (1.5 lbs in Murphy equation). Davis et al., (References, 2) demonstrate a decrease in water consumption as ration moisture content increased (Table 2).

Diets high in salt, sodium bicarbonate and protein increase water intake. Also, diets high in fiber may increase water intake by increasing the losses of water in the feces.

Environmental temperature and water temperature affect water consumption. Research at Texas A & M (References, 4) has shown cooling water from between 68 and 86 degrees F to below 50 degrees F decreases intake but helps reduce heat stress during summer months. A 1987 summer study, (References, 8) reported that chilled drinking water (86 vs. 50 degrees F) significantly increased dry matter intake and milk yield but had only a slight positive effect on water intake. Florida research thus far has not found benefit from cooling drinking water below the 75 to 80 degrees F temperature of the well water (References, 1).

WATER QUALITY

Water quality is important for maximum performance of dairy cattle. It is estimated that 40% of the nation's livestock are watered from streams, lakes, springs, and impoundments. One should not assume cattle are resistant to the spread of bacterial diseases through the drinking of polluted water.

Contamination of the water supply from barnyard drainage and the presence of nitrates, pesticides, algae and certain parasites such as tapeworms and liver flukes add additional stress to cows. Also, water palatability and odor as well as high levels of minerals such as iron and sulfur reduce consumption.

LABORATORY ANALYSIS

Water quality is measured by laboratory tests performed on water samples periodically drawn from the water supply. This information and/or service may be available through your regulatory agency or health department. If not, consult with your county Extension agent, regulatory agency or service representaabout private or comlaboratories. Basically, the first laboratory tests should include items listed in Table 3.

CHEMICAL TESTS

The chemical tests are a measure of the presence of elements in the water from the earth's soil, sediments and rocks. The elements may be in the form of individual ions, pairs of ions, or complexes of several ions. The principal elements are hydrogen, sodium, potassium, magnesium, calcium, silicon, chlooxygen, sulfur, and carbon.

pH

The pH is a measure of acidity or alkalin Below pH 7 water is acidic; above that value it is alkaline. Water consumed by cattle may range from 6.5 to 8.0. The pH influences taste, corrosivity, efficiency of chlorination, and other treatments.

Hardness

Water "hardness" is generally expressed as the sum of calcium and magnesium. Other cations such as zinc, iron and manganese may also contribute. Hardness of water is classified as shown in Table 4.

Hardness per se is not a problem in livestock drinking water. The concentrations of toxicants in the water are important. Hardness is measured by the amount of soap needed to develop a permanent lather.

Total Dissolved Solids (TDS)

The TDS is a measurement of all constituents dissolved in water. The principal inorganic anions dissolved in water include carbonchlorides, sulfates and nitrates. The principle cations are sodium, potassium, calcium and magnesium. For fresh water, salinity and TDS are equivalent. TDS provides a useful index to the suitability of a water supply for livestock use (Table 5).

Growing cattle tolerate concentrations of salt in water up to 1 percent; higher levels are toxic. As the concentration of salt increases to 1.2 percent, the intake of water increases. Concentrations higher than 1.2 percent reduce the water intake.

Nitrates and Nitrites

The nitrate content of water in Florida has been less a problem than that occurring on occasion in forages. Both a water and feed analysis are needed to determine the total intake. Corrective action is needed where nitrates-nitrites are occurring in water. Determine the source of the ni The lab results may be reported as potassium nitrate (KNO_3), or as nitrate-nitrogen (NO_3-N).

Nitrate toxicity or poisoning is generally a result of eating forages high in nitrate content. While nitrates themselves are not toxic, nitrites are toxic. Nitrates entering the rumen are converted to nitrites by rumen bacteria prior to entering the bloodstream. There the nitrites convert the oxygen carrying red pigment hemoglobin into a brown pigment called methemoglobin, which will not carry oxygen. As the conversion develops in the bloodstream the animal shows distress and shortness of breath. Symptoms of acute nitrate poisoning are:

- labored breathing;
- rapid pulse;
- frothing at the mouth;
- convulsions;
- blue muzzle and bluish tint around eyes; and

• chocolate-brown colored blood.

When the conversion reaches 70 to 80%, the animal usually dies from asphyxiation. Infusing a bottle of 4% methylene blue solution is the primary therapeutic treatment. Nitrate toxicity from water is most likely to occur when animals drink from ponds or ditches that have been contaminated from run-off coming from heavily fertilized fields.

Since not all laboratories report results of nitrates and nitrites the same, the converfactors in Table 7 may be useful.

Sulfate

While sulfate guidelines are not well defined, levels above 500 ppm for calves and 1000 ppm for cattle may affect water intake. The specific form of sulfate should be identified since some forms are more toxic than others. Hydrogen sulfide is the most toxic form and amounts as low as 0.1 ppm may reduce water intake. Common forms of sulfate in water are calcium, iron, magnesium and sodium. All are laxatives but sodium sulfate is the most potent. Cattle do tend to become resistant to the laxative effect over a period of a few weeks. It appears that iron sulfate depresses water intake more than the other forms of sulfate.

Contaminants and Toxic Elements

It has been recognized for a number of years that cattle are sometimes poisoned when they drink lake water invaded by blue-green algae. Six species of the algae have been identified as potential causes of toxicity. Cattle should be prevented from drinking water from lakes or ponds having heavy algae growth.

Under certain conditions, water may contain levels of toxic minerals that are potentially toxic to livestock. Elements more common are lead, cadmium and mercury. Additional elements are in Table 8.

Bacterialogical and Physical Tests

A reasonable effort should be made to provide animals with a clean and sanitary supply of water if maximum performance is expected. Several studies have shown that bacteria such as *E. coli* are destroyed by the bacteria population in the rumen of the cow. Therefore, though determining the numbers of bacteria such as *E. coli* in the water supply is essential for human consumption, it is of little value for animal consumption.

SUMMARY

Water represents a vital part of the nutrient intake of livestock. In quantity, it is greater than feed intake. Water quality is important for maximum perfor Likewise, the temperature of the water affects water consumption and performance. Cooling the water temperature in high environmental temperatures reduces water consumption, but increases performance. Water troughs should be located in areas where cows have easy access. High levels of milk production are dependent on having plenty of clean, fresh water available. Keeping the troughs clean so that the cows will be more aggresin drinking the water is a recommended practice.

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Table 1. Estimated daily water consumption as influenced by mean daytime temperature and milk production (gal/day).[1,2]

		Degrees Fahrenheit					
Body Wt. (lbs)	Estimate DM Intake	10-40 F	50 F	60 F	70 F	80 F	90 F
Heifers, 200 lbs		2.1	2.3	2.4	2.8	3.2	3.8
Heifers, 600 lbs		6.3	6.8	7.9	9.7	10.5	11.8
Cows, 1400 lbs							
Dry	30	10.0	11.7	13.4	15.2	16.9	18.6
Milk - 40 lbs/day	36	15.5	17.2	18.9	20.6	22.4	24.1
Milk - 60 lbs	40	18.4	20.1	21.9	23.6	25.3	27.0
Milk - 80 lbs	44	21.4	23.1	24.8	26.5	28.3	30.0
Milk - 100 lbs	48	24.3	26.0	27.7	29.5	31.2	32.9

[1]Gallon of water = 8.5 lbs.
[2]Estimation of water intake for cow from equation of Murphy et. al., (5).

Table 2. Effects of diet moisture content on DM intake and source of water intake.

	Moisture content of diet (%)			
Intakes	**30.7**	**42.6**	**48.3**	**53.6**
DM, lb/day	43.3	40.0	37.6	32.6
Water, gal/day				
Drunk	17.8	15.7	13.8	11.2
Feed	3.7	5.5	5.3	4.8
Total	21.5	21.2	19.1	16.0

Table 3. Laboratory analysis useful in determining water quality.

Chemical	**Bacteriological**	**Physical**
1. pH	1. Total bacterial plate count	1. Color, odor, turbidity
2. Hardness	2. Coliform presence orabsence	
3. Total dissolved solids		
4. Nitrates and nitrites		
5. Calcium and magnesium		
6. Sulfates and chlorides		

7. Iron and sulfur

Table 4. Classification of water by hardness content[1]

Hardness range (mg/liter)	**Description**
0-60	Soft
61-120	Moderate
121-180	Hard
180	Very hard

Table 4. Classification of water by hardness content[1]

[1]Natl. Acad. Science, Washington, D.C. 1980.

Table 5. Two classifications on quality of water in terms of total dissolved solids (TDS).

Description	Concentrations of TDS (mg/liter)	
Fresh water	0-1,000	No problems
Brackish water	1,000-10,000	Risk
Salty water	10,000-100,000	Unsafe
Brine	> 100,000	Unsafe
Slightly saline	1,000-3000	Satisfactory
Moderat. saline	3,000-5,000	Possible diarrhea
Very saline	5,000-7,000	Avoid usage
Approach. brine	7,000-10,000	High Risk
Brine	> 10,000	Unsafe

Table 6. Levels of nitrate in water and expected response.

Nitrate in water (ppm)*		
NO_3	NO_3-N	Comment
0 - 44	10	Not harmful
45-132	10-20	Safe if feed is low in nitrates and nutritionally balanced
133-220	20-46	Could be harmful over long period of time.
220-660	40-100	Possible losses, risky for dairy cattle.
660-800	100-200	Increased possibility of losses, unsafe.
Over 800	Over 200	Unsafe. Do not use.
*1% = 10,000 ppm		

Table 7. Nitrate and nitrite expressions and conversion factors for converting from one form of expression to another.[1]

	Form B				
Form A	N	NO_2	NO_3	KNO_3	$NaNO_3$
Nitrate-Nitrogen (N)	1.0	3.3	4.4	7.2	6.1
Nitrite-Nitrogen	1.0	3.3	4.4	7.2	6.1
Nitrate (NO_3)	0.23	.74	1.0	1.63	1.37
Nitrite (NO_2)	0.3	1.0	1.34	2.2	1.85
Potassium Nitrate (KNO_3)	0.14	.64	.61	1.0	.84
Sodium Nitrate ($NANO_3$)	0.16	.54	.72	1.2	1.0
[1]Form A x factor under form B = Form B.					

Table 8. Recommended limits of concentration of some potentially toxic substances in drinking water for livestock.[1]

Item	mg/liter or ppm Upper limit	Item	mg/liter or ppm Upper limit
Alumi	5.00	Lead	0.10
Arsenic	0.20	Mercury	0.01
Cadmi	0.05	Molybde	0.50
Chromi	1.00	Nitrate-N	100.00
Cobalt	1.00	Nitrite-N	10.00
Copper	0.50	Selenium	0.05
Fluoride	2.00	Zinc	25.00

[1]Nutrients and toxic substances in water for livestock and poultry. National Academy of Sciences. 1974.