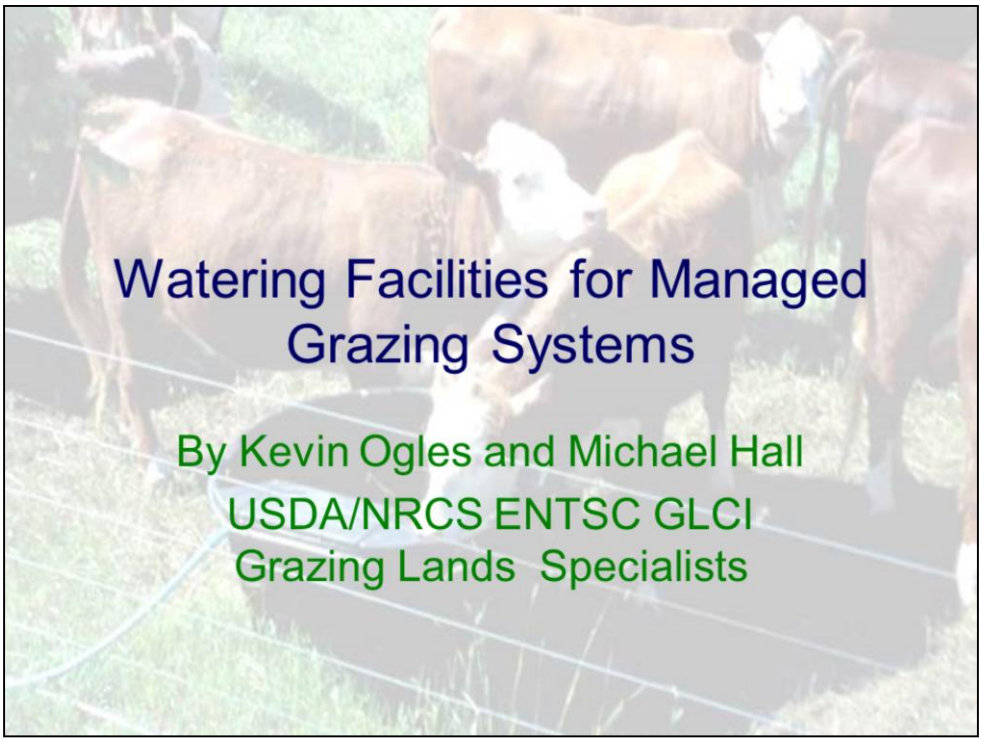

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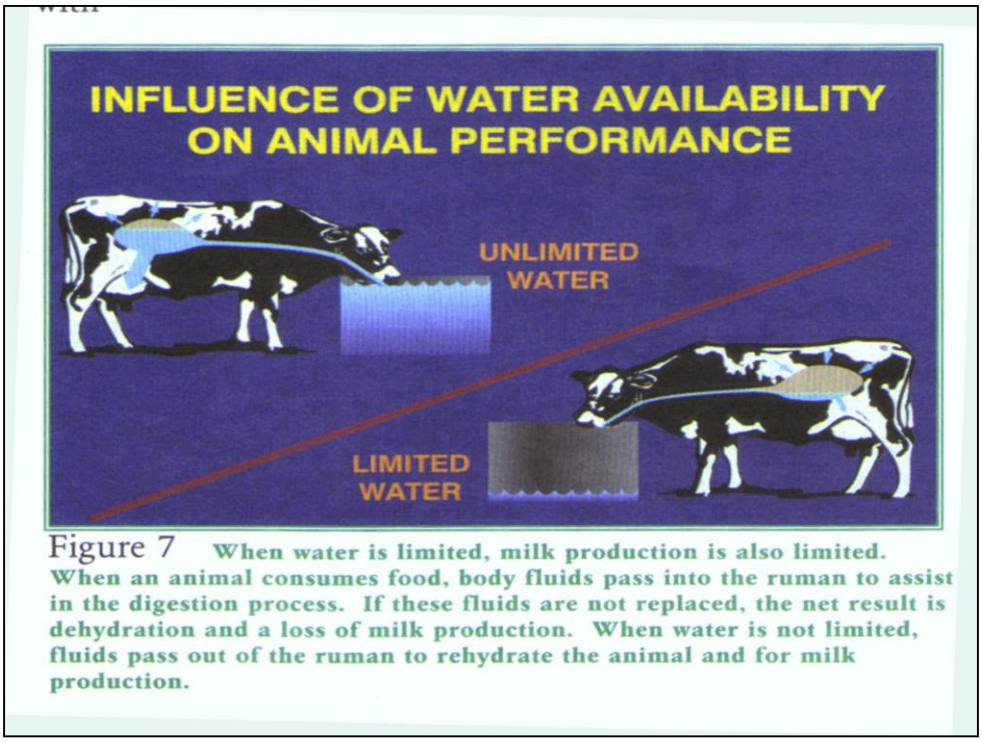
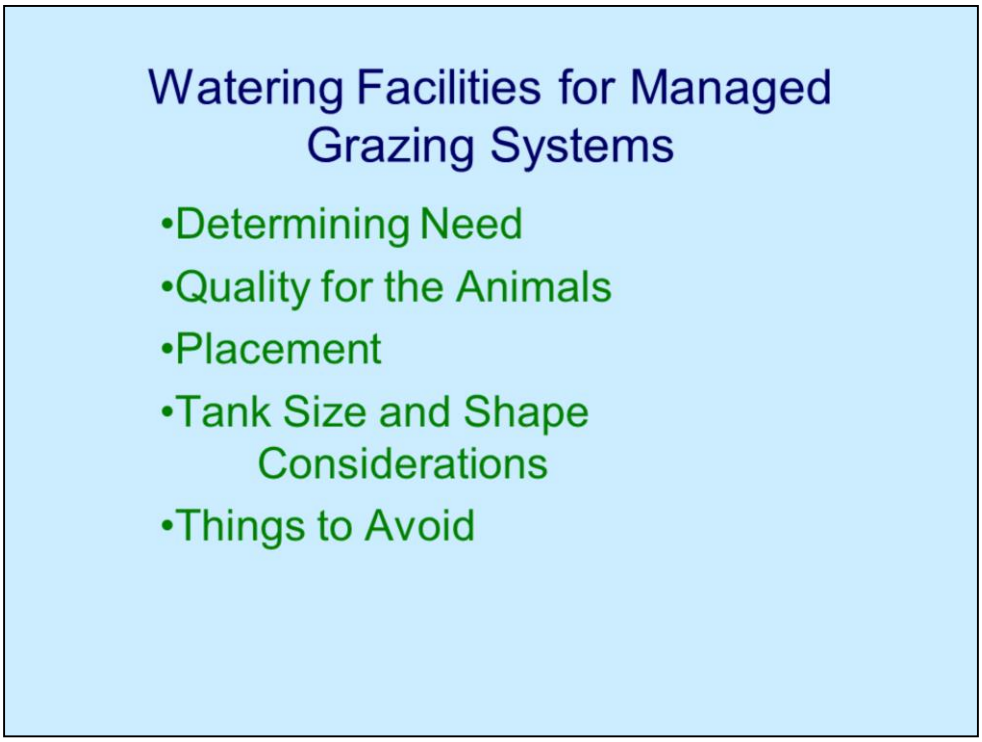


Figure 7 When water is limited, milk production is also limited. When an animal consumes food, body fluids pass into the ruman to assist in the digestion process. If these fluids are not replaced, the net result is dehydration and a loss of milk production. When water is not limited, fluids pass out of the ruman to rehydrate the animal and for milk production.

We see that illustrated here. Water intake is important to all livestock but especially to lactating livestock. The physical and economic impact is the most extreme in high producing dairy cattle, but has an important impact on beef cattle and other livestock.



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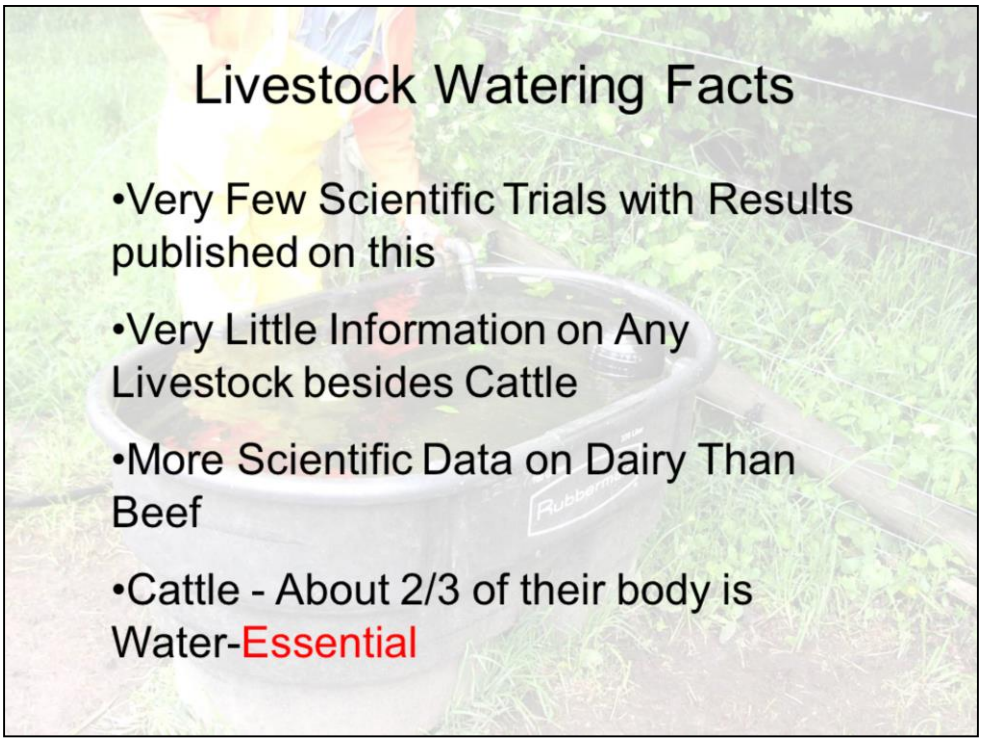

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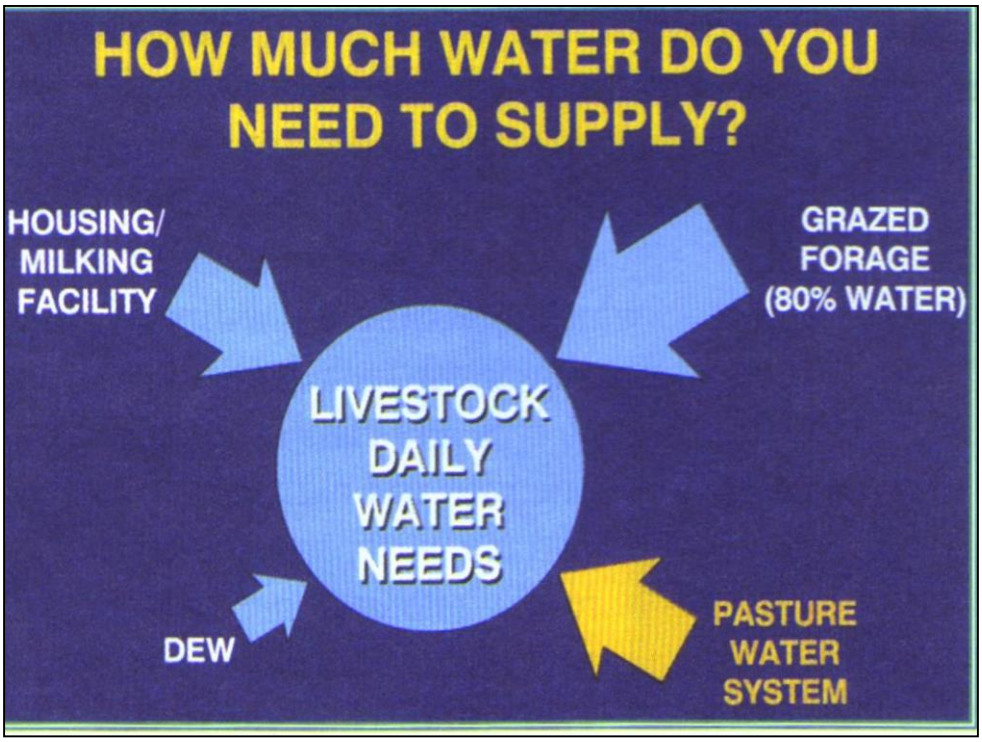


Source: Prescribed Grazing and Feeding Management for Lactating Dairy Cows, New York State GLCI by Hoffman, DeClue, Emmick

How important is water to livestock? **A water deficiency will reduce animal performance <u>more quickly</u> and <u>more severely</u> than will any feed or mineral deficiency!** Lower water intake means lower dry matter intake.

Where does the livestock get the water they need? We can see that here.

Determining Need

How Much?

Animal	Gallons water	Range
Dairy Cow	20	(15-25)
Beef Cow Pair	15	(12-20)
Yearling	10	(6-14)
Horse	10	(8-14)
Sheep	2	(2-3)

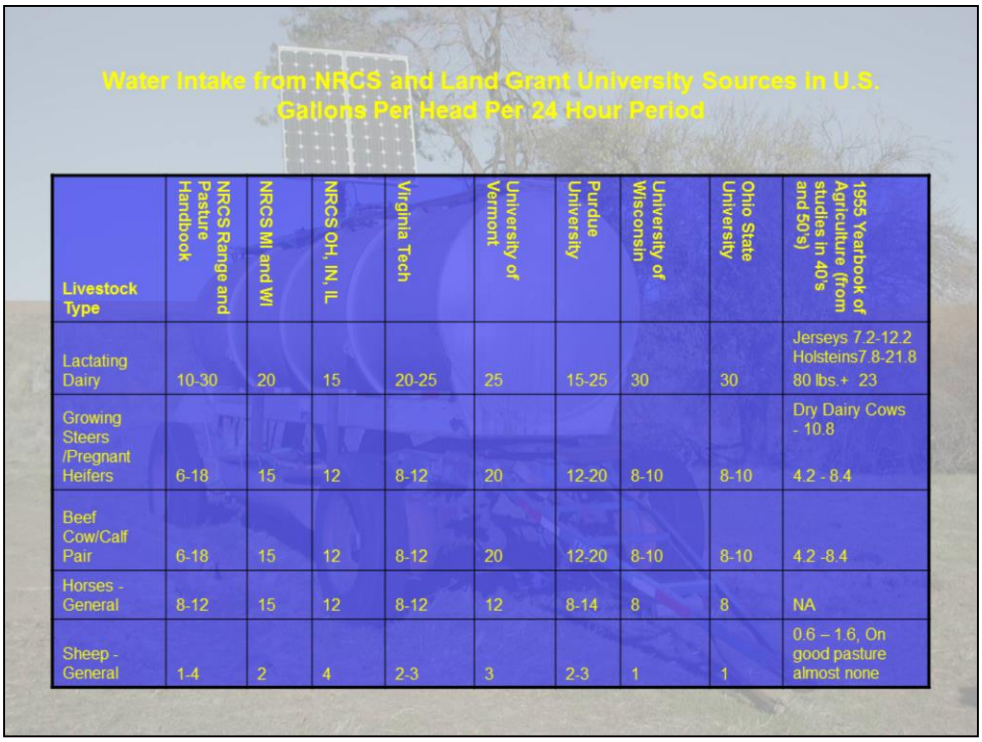
Source: Watering Systems for Grazing Livestock by MSU

How much water can a cow drink at a time? Cows will typically drink water at a rate of about 1 to 2 gallons a minute and will drink from 1 to 3 minutes at a time. If they have been short on water and have traveled quite a distance, the rate and duration of drinking can increase dramatically. Beef cattle can range from drinking **no** water at the pasture tank per day to 40 gallons of water per day in high heat and humidity conditions just trying to keep alive.

Just an interesting fact is that Cattle will defecate about 6 to 12 times a day average and they will urinate 7 to 18 times a day.

This chart which is found in some state's 614 standards shows the average and the range of gallons of water needed per day by species of livestock.

How often does a cow come to water? Beef cows will travel to water 2 to 5 times a day in the Midwest. If the distance to water is great and the environment is dry, cows visit watering sites less frequently, but stay longer. The average beef cow walks 3 to 4 miles a day according to MO research. On cool, rainy days cattle may consume no supplemental water at all, particularly if pastures are lush. The closer to the water source the cattle remain, the more often they will visit, and each visit will be of shorter duration. Sheep may not come to a water source at all if there is lots of water on the plants or there is consumable snow available.



Livestock Type	NRCS Range and Pasture Handbook	NRCS MI and WI	NRCS OH, IN, IL	Virginia Tech	University of Vermont	Purdue University	University of Wisconsin	Ohio State University	1955 Yearbook of Agriculture (from studies in 40's and 50's)
Lactating Dairy	10-30	20	15	20-25	25	15-25	30	30	Jerseys 7.2-12.2 Holsteins7.8-21.8 80 lbs.+ 23
Growing Steers /Pregnant Heifers	6-18	15	12	8-12	20	12-20	8-10	8-10	Dry Dairy Cows - 10.8 4.2 - 8.4
Beef Cow/Calf Pair	6-18	15	12	8-12	20	12-20	8-10	8-10	4.2 -8.4
Horses - General	8-12	15	12	8-12	12	8-14	8	8	NA
Sheep - General	1-4	2	4	2-3	3	2-3	1	1	0.6 – 1.6, On good pasture almost none

Sources cited in table

MN NRCS uses 0.02 gallons per pound of live body weight. This coincides closest with MI and WI NRCS but is really off on dairy and sheep by large numbers. Some states use 30 gallons per day per AU (1000 lbs. live wt.).

In the 1955 Yearbook of Agriculture data, the range of gallons is given to coincide with 5 to 30 lbs. of milk production per day in Jerseys and with 20 to 50 lbs. of milk production per day in Holsteins – repectively.

Iowa State did a study showing when it was 80 degrees F or more, Dairy cows consumed - 17.9, 24.7, 38.7, 45.7, and 16.2 gallons of water per hd/per day at 20, 60, 80, 100 and dry pounds of milk production per day – respectively. The cows wt. ranged from 1400 to 1800 pounds.

Note: Converted from pounds of water in the 1955 Yearbook of Agriculture. Remember that 1 gallon of water weighs 8.3453 pounds.

Self-Explanatory

Table 5.1 Daily water intake of dairy heifers under various temperature conditions.

Air temp. (degrees F)	lb water/ lb TDN	lb TDN/ day	gal water/ day
35	4.7	10.3	5.8
50	5.2	9.2	5.7
70	7.2	9.2	7.9
80	9.0	8.8	9.5
90	22.2	6.6	17.6
95	24.8	6.4	19.0

Sources: University of Missouri researcher James R. Gerrish and Missouri NRCS specialists Maurice Davis published in a document titled "Water Requirements & Availability".

This table shows what can happen to livestock water intake when temperatures go up. You can see that providing lots of water in hot weather to dairy heifers can have a significant impact on their health. Younger cattle also consume more water than mature cattle will. Lactating cattle consume more water than non-lactating cattle will.

In going to the THI – if we use average weather relative humidity for July (because it has the highest humidity with the highest max. air temperatures with the lowest wind speeds) the 80 degree air temperature would be in the 'mild' stress category and the 90 and 95 degree air temperature would be at the low and high end of the 'moderate' heat stress category.

Thermoneutral Zone of Cattle

- TNZ is when cattle are comfortable when certain weather conditions are ideal for their bodies to function and grow with the least amount of inhibitors.

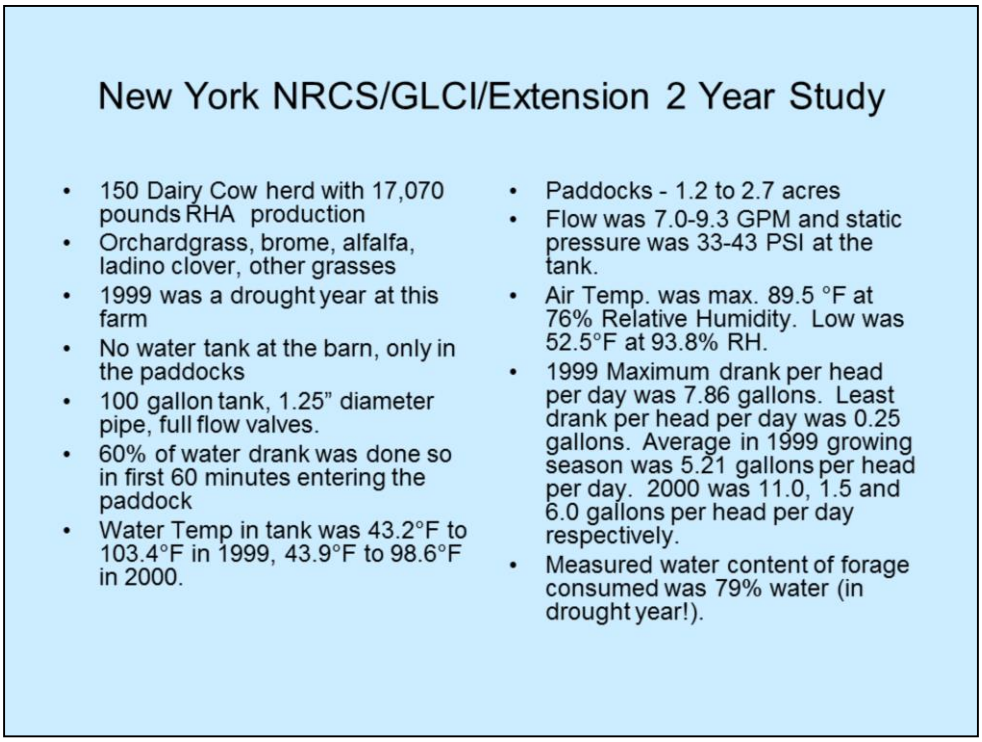
- Conflicting U.S. Information
- Beef Cattle data shows both
- 45°F to 74°F and 20°F to 70°F
- For Dairy Cattle
- 41°+F to 68°F
- Sheep ?
- Horses?

No reliable data for sheep or horses' TNZ.

U.S. and Canada Studies on Temperature Effect on Water Intake In U.S. Gallons Note: Wt. of Cattle Unknown and Relative Humidity is Unknown

	At Daytime High to Next Temp. Break	40.2 °F	50.4 °F	58.3 °F	70.3 °F	80.2 °F	90.3 °F, CN dept of ag. got these at 81°F	≥ 88 °F or HOT hot" not defined on VT website"
Canada Dept. of Ag.	Beef Pregnant Heifers							
Canada Dept. of Ag.	Beef Cows at Peak Lactation		10.0	10.1	11.6	12.4	15.6	
Alberta (province) Dept. of Ag.	Beef Pregnant Heifers	6.0	6.5	7.4	8.7	8.7	8.7	
Alberta (province) Dept. of Ag.	Beef Cows at Peak Lactation	11.3	12.6	14.5	16.9	17.9	16.2	
Iowa State Virginia Tech	Beef Pregnant Heifers							14.5 20-25
Iowa State Virginia Tech	Beef Cows at Peak Lactation							16.5 20-25

Self-Explanatory



Water made up 80% of the plants being grazed and never varied by more than 3% in any sample taken

Dan & Ann Carey	year 1999	5.2 gallons/cow/day
Dan & Ann Carey	year 2000	6.0 gallons/cow/day
LU-An-Ca Farm	year 1999	7.9 gallons/cow/day

Robert DeClue, NY Area Grazing specialist, states: "I should alert you about some facets of the study at my in-law's (Lu-An-Ca Farm). The most important is that I didn't obtain the Neptune T-10 analog water meter until mid-June of that year. As such, it did not capture the early part of the grazing season. One would assume that when environmental conditions were cool and moist the heifers did not require additional water in their diet to fight heat stress. Also at that period, it was more likely for the heifers to consume "free water" in the act of grazing due to presence of either morning frost or dew and occasionally water clinging to the exterior from rain. If those assumptions are even close to reality, then the missed data would have shifted the average daily per head consumption lower. The question of course is how much lower. Also the number of days included in the analysis is relatively small, so the data set is consequently diminished."

Referring back to the THI chart, in 1999, 6 days had mild heat stress, 2 days were moderate heat stress and none were severe. All other days in 1999 were in the TNZ. The 2000 data about appears the same – 5 days of mild heat stress and 1 days of moderate heat stress. NOTE: This is about the same latitude as much of New England.

Thermal Heat Index

- Cattle shed heat
  - primarily through evaporation from the skin and through respiration (breathing)
  - The higher the humidity and the less amount of wind (speed) the harder for the animal to get rid of the heat.
- On high end of TNZ
- Heat Stress in Livestock is a combination of Temperature, Relative Humidity, and Wind Speed
- The Mesonet Cattle Stress Index is a tool that is used the measure the THI (but leaves out wind speed!)
- Anything at 71 THI or below is in the TNZ (until freezing conditions mentioned later)

Our discussion today will not talk about the situations below the TNZ. We will concentrate today on the situations above the TNZ in temperature and humidity. This is the area where the livestock are under heat stress. A formula that considers temperature and humidity has been devised by some of our land grant universities. It is called the Thermal Heat Index.

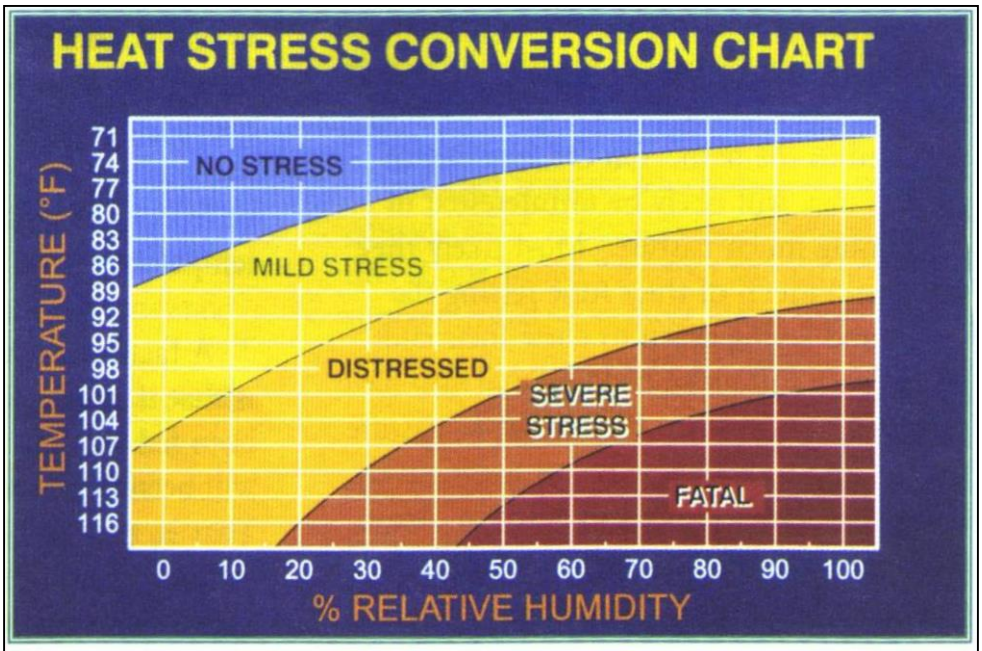


Figure 21 The amount of heat stress a cow feels depends on the combination of temperature and humidity.

Source: Prescribed Grazing and Feeding Management for Lactating Dairy Cows, New York State GLCI by Sullivan, DeClue, Emmick

Livestock must have water easily available when they are under stress from a combination of high temperatures and humidity. We see these conditions occur every summer. It just varies how many days are like this each year.

This chart is also called the Thermal Heat Index chart by some land grant universities.

Some research shows that for every 1-degree rise in temperature (Fahrenheit) above 50 degrees, cattle need an additional quart of water. But as we will see this does not always hold true. A study in New York on lactating dairy cattle, that need large amounts of water, used only an average of 8 gallons of water per head per day!

Thermal Heat Index

- THI of 72 through 79 is Mild Stress – H2O intake slight+
- THI of 80 through 89 is Moderate Stress or the animals are “Distressed”. Management actions should be taken to help the livestock relieve the heat, such as shade and providing lots of water.
- A THI of 90 or More puts the livestock under Severe Stress and all measures should be taken to cool them. Besides providing water and shade, use misters, mister fans, or other measures. A few percentage points (increase) change in RH at this level and the heat could be fatal to them. I could not find records of this happening in the East Region.

Self-Explanatory

Cattle Windchill Chart in ºF

Actual Temp	MPH ↓	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
Equiv. Temp	Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	5	48	37	27	16	6	5	-15	-26	-35	-47	-57	-68
	10	40	28	16	3	-9	-22	-34	-46	-58	-71	-83	-95
	15	36	22	9	-5	-18	-31	-45	-58	-72	-85	-99	112
	20	32	18	4	-10	-24	-39	-53	-67	-81	-95	110	129
	25	30	16	1	-15	-29	-44	-59	-74	-88	-103	118	133
	30	28	13	-2	-18	-33	-49	-64	-79	-93	-109	125	140
	35	27	11	-4	-20	-35	-52	-67	-82	-97	-113	129	145
	40	26	10	-5	-21	-37	-53	-69	-84	-100	-115	132	148
	45	25	9	-6	-22	-38	-54	-70	-85	-102	-117	135	150

Self-Explanatory

Average Number of Days with an Average Maximum Temperature of 90°F or More (+ avg. THI score) and Average Wind Speed

Max. Temps mostly occur in July; Wind in July-Aug.	Central and Western UP	Eastern UP	Northern Lower	Central Lower	Southern Lower
Hot Days	4 THI=74	2 THI=72	4 THI=75	6 THI=77	9 THI=76
Wind	No data available	7.7 – 8.5	7.0 – 7.8	6.7 – 7.5	7.5 – 8.8

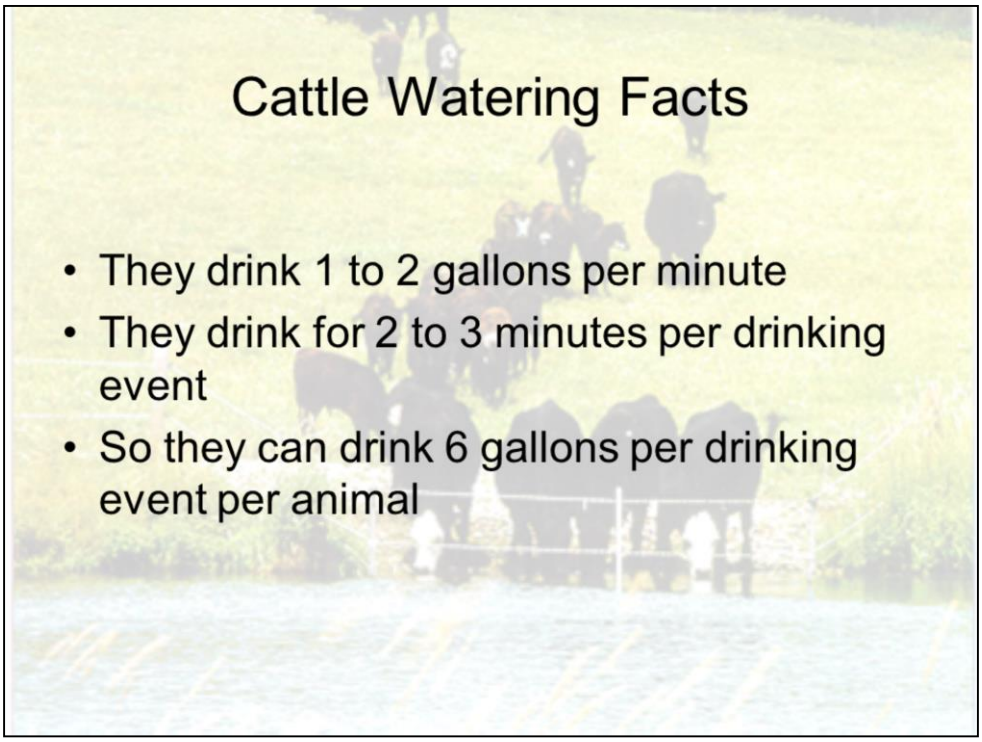
Note that most of these days that would be normally in the low to mid range of a ‘Moderate Stress’ Thermal Heat Index. So the reading for cattle would be pushed down intto the ‘Mild Stress’ THI reading because of the average wind speed for the months of July and August.

Recommendations Based on These Findings

- Water Intake for Livestock in a Managed Grazing System, when applied according to our 528 standard, should be credited by the water (as high as 80%) in the grazed forages.
- When Livestock drink water (have access) from a water source at the barn/parlor/yarding area, this should be included when calculating the water supplied to the animals when designing the tank size in the paddock.
- When Livestock are expected to be in 'Moderate Heat Stress' THI (or Higher) for a only a few days of the total grazing season, a contingency plan of action should be followed for those few days. We do not recommend sizing the tank for only 2% of the grazing season for example.
- When Livestock are in 'Moderate Heat Stress THI (or Higher) for several days (AL ex. - 25% or more of the Grazing Season), High Water Intake Rates should be used in the tank designs.

Self-Explanatory

Self-Explanatory



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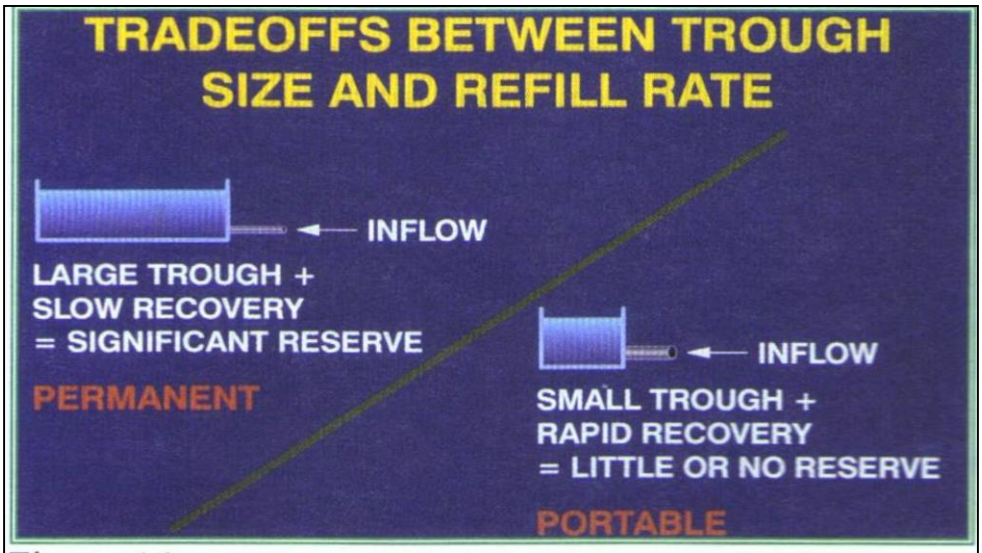


Figure 14 There are two opposite approaches to dispensing water. One is providing a large trough with a low flow of water to replenish draw down by cows. A contrasting approach is a small tough with a quick recharge capability, which allows more management flexibility due to the trough's portability.

Source: Prescribed Grazing and Feeding Management for Lactating Dairy Cows, New York State GLCI by Sullivan, DeClue, Emmick

Now let's talk begin to talk about the **HOW of supplying water to livestock.** We must account for: **Animal individuality, succulent forage, instinctive herd behavior (water proximity), and quick recharge (fresh)** So we need to know:

- **How much water we need per head per day.**
- **What our water source will be.**
- **What our delivery system or distribution network will be.**
- **And the dispensing facilities or animal access facilities (tank, stream).**

•There are two schools of thought to providing water to livestock. One is to have the livestock always close to a smaller tank with a delivery system that has fast flow and can refill the tank quickly. The other is to have a large tank which can be close or farther away from the livestock with a slower flow and a slower refill time to fill the tank.

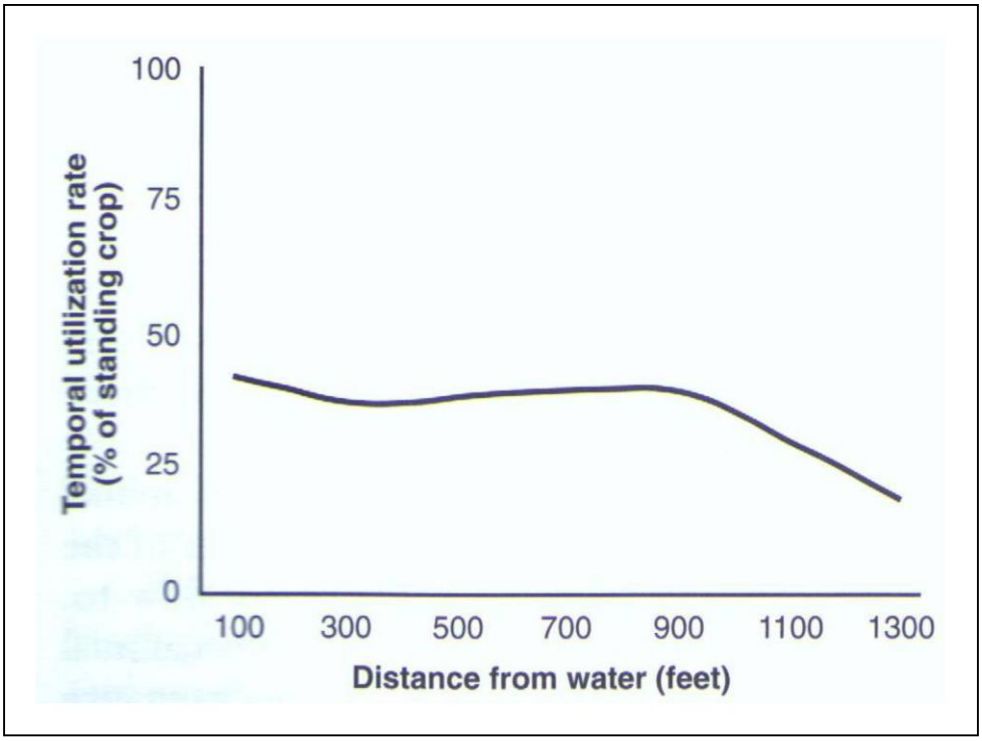
Most of the time a well with your typical electric 110 volt pump is the most reliable and lowest overall cost type of system. It is usually capable of pumping through a pipe system to a tank or tanks in every paddock. The system must be capable of lifting the water to the highest tank/trough and

overcome friction by water flow in the pipe.

When we can provide portable water tanks in every paddock closer than 900 feet from any point in the paddock then we do not have nutrients build up in the soil like we do at permanent large tank watering sites. This herd is being adequately watered with a less than 100 gallon capacity tank.

Self-Explanatory

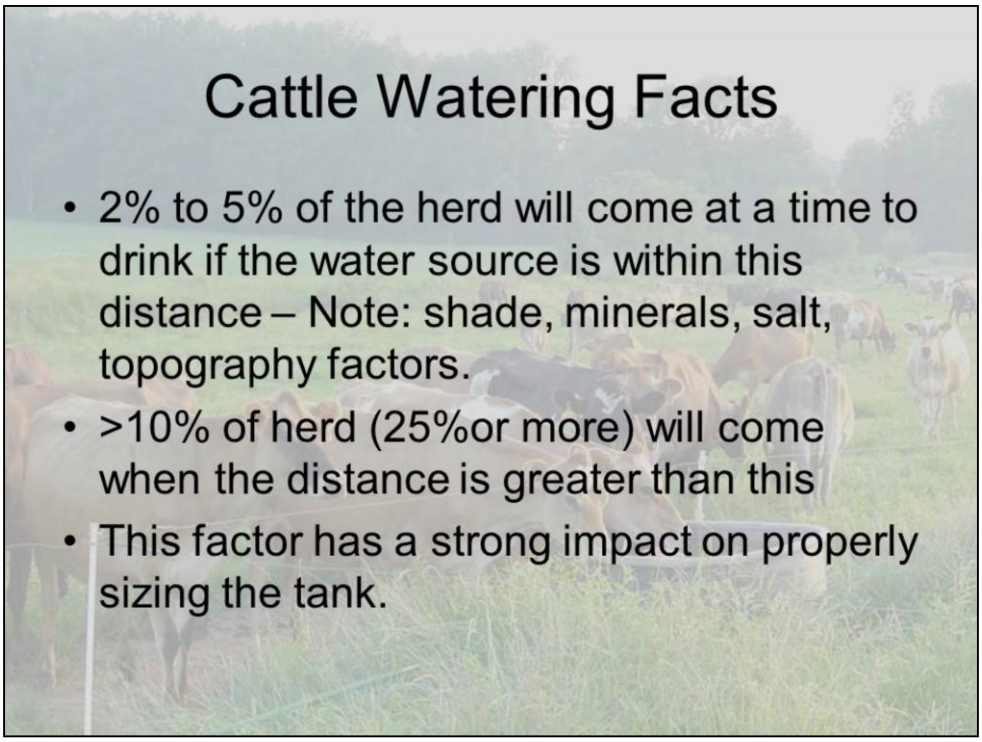

Determining Need
• Animal Behavior Impacts?



Source: U of Missouri research shows that **if** beef cattle travel more than 700 to 900 feet from water, utilization of the forage goes down significantly! Basically a 160 pasture only had 130 acres of pasture used. Even in the arid West, beef cattle did 77% of their grazing within 1200' of the water source in a 2000 acre "pasture". When water and shade exist in a pasture, P and K are concentrated in these areas since 90% of the P & K nutrients are recycled in the manure and urine So a **long-range goal** of all graziers should be water in every paddock.

How close should the water be to the livestock? Research in Missouri has shown that if the animals are farther than 700 - 800 feet from the water source (for beef cattle) or 600 feet (for dairy cattle) then the whole herd comes at once to drink. When the herd comes as a group to drink it is an instinctive protection mechanism. Nobody wants to be left "way out there" all alone. After the "boss" cow drinks first and is ready to go back and graze, the most submissive cows will leave with the herd without drinking! A New York (Cornell) study showed that dairy cows need water 500' or closer to avoid the "herd affect". When closer than these “best forage utilization distances, then only about 3 to 5% of the herd come at one time to drink. NRCS in New York wants water for dairy cows 300' or closer. It is better to have the water closer than farther away when in

doubt. In the Midwest, the maximum distance stock should travel to water is a quarter mile.



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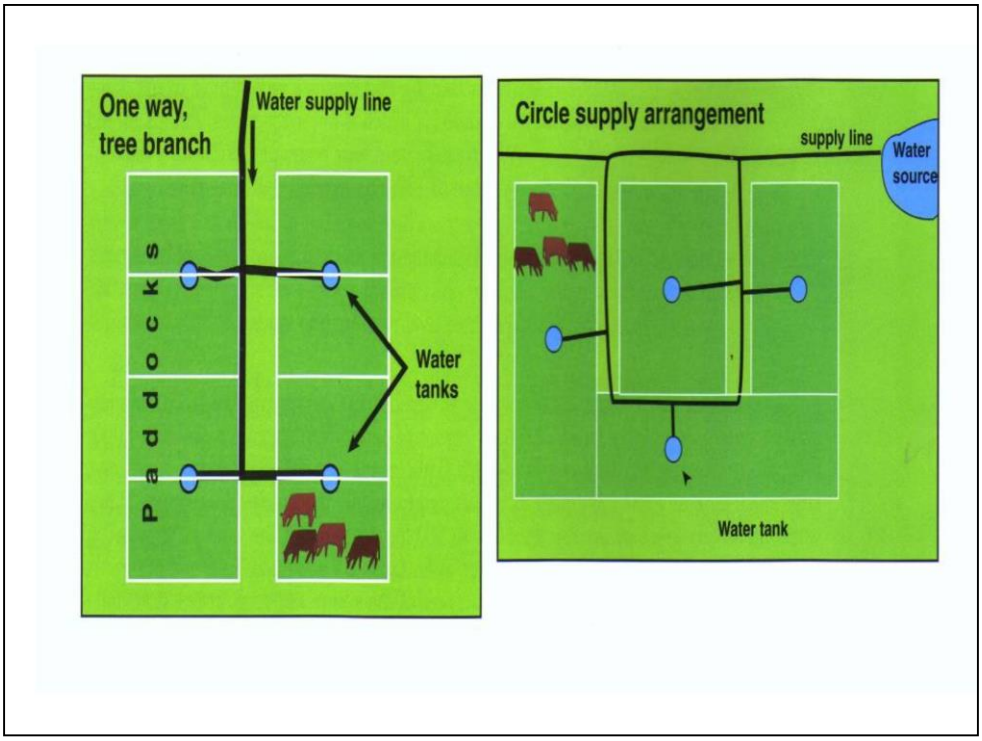


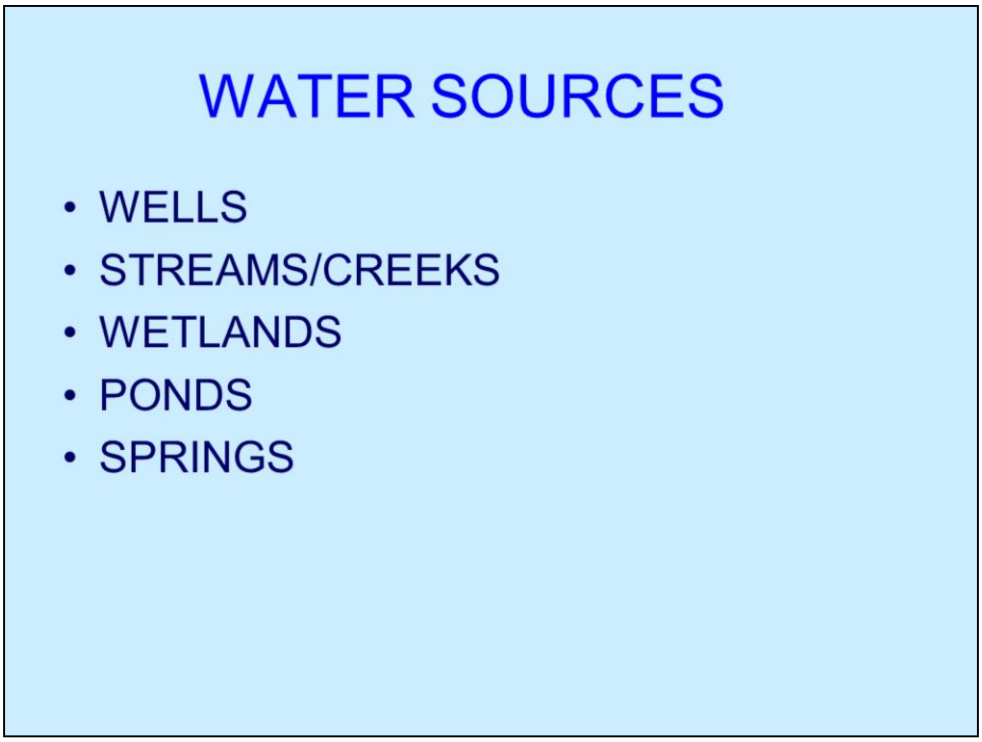
Source: Watering Systems for Grazing Livestock by Ben Bartlett and MSUE Let's talk about layout. There are some things to keep in mind. We need to determine: 1. What the animals need in water (gallons per day) 2. What our water source is by paddock 3. What are distribution system will be (pumps, pipes by type, gravity, large supply tanks) and 4. What are dispensing facility will be (designed stream access site, large permanent tank, small moveable tank) then we can talk about how we get it there. Sometimes the shortest distance is not always the best route. Try to keep pipes and tanks level as possible.

What should we keep in mind about fencing across tanks as in the layout on the left?

Self-Explanatory

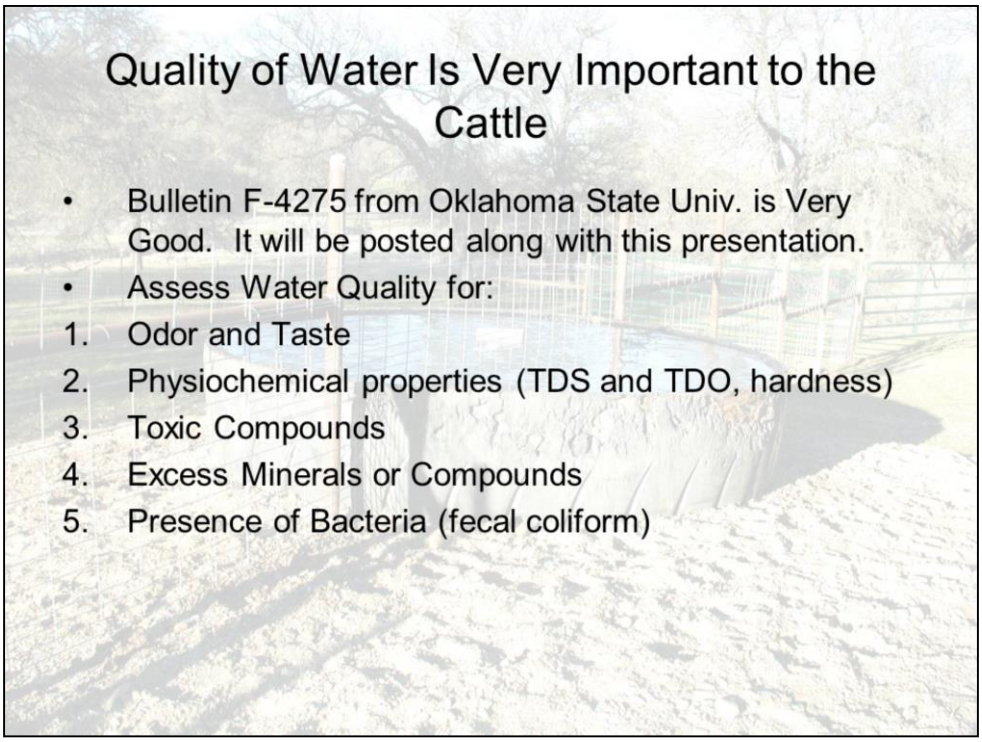
Self-Explanatory

Bad quality drinking water for these cattle!



Now we are going to look at advantages and disadvantages of various sources of water. We ALWAYS recommend testing the water. We will talk about what we test for in a few moments. We want to mention one of the disadvantages of ponds, where the cattle drink is where the algae, high harmful bacteria levels, etc. are. That's why when using a submersible pump in a pond water source you should suspend the pump on a rigid pipe below the float at least 2' under the surface, 3' or 4' is better. These sites are also usually low in the landscape so mud can be a problem if the pond is not installed correctly. However, these can work with proper installation, quick recharge (such as a spring), and they provide habitat for other wildlife. **Springs** can be good water sources **if** they have a near constant flow rate so they are dependable with good water quality and the overflow can be controlled to protect resources. These things cannot always be found with springs. If they are good sources of quality water, etc., they can be the least costly water source. **Streams and creeks** can be good sources **if** our Prescribed Grazing and Livestock Access and Stream Crossings standards are followed and the stream has good quality water with year round flow with moderate speed. **Wells** are the most often used and most dependable source. But they can be very expensive if the site needs 100 feet depth or more to water. **Wetlands** have to be exceptional with very specific unique conditions that would allow them to be a water source for livestock. It is very rare that they should be used as a livestock drinking water source. **Rural Water Systems** are becoming available in some areas and might be the

best source where available.



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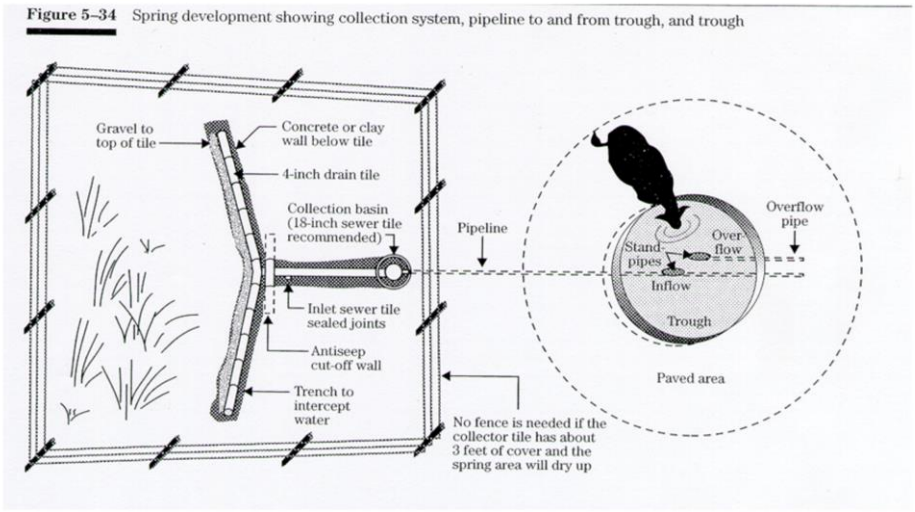
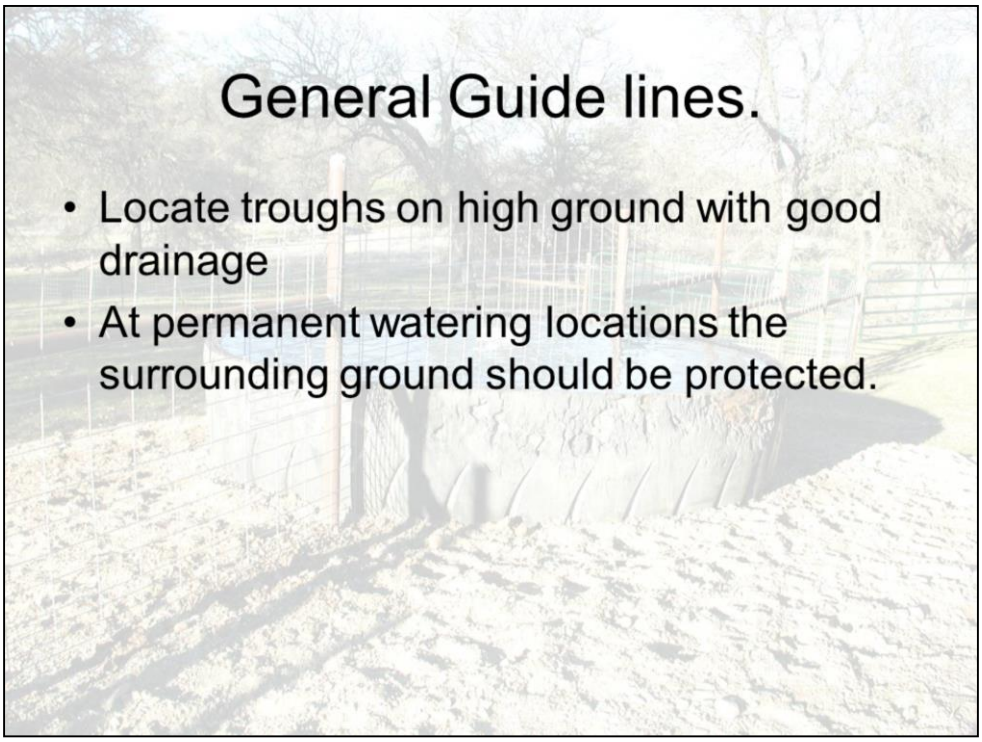


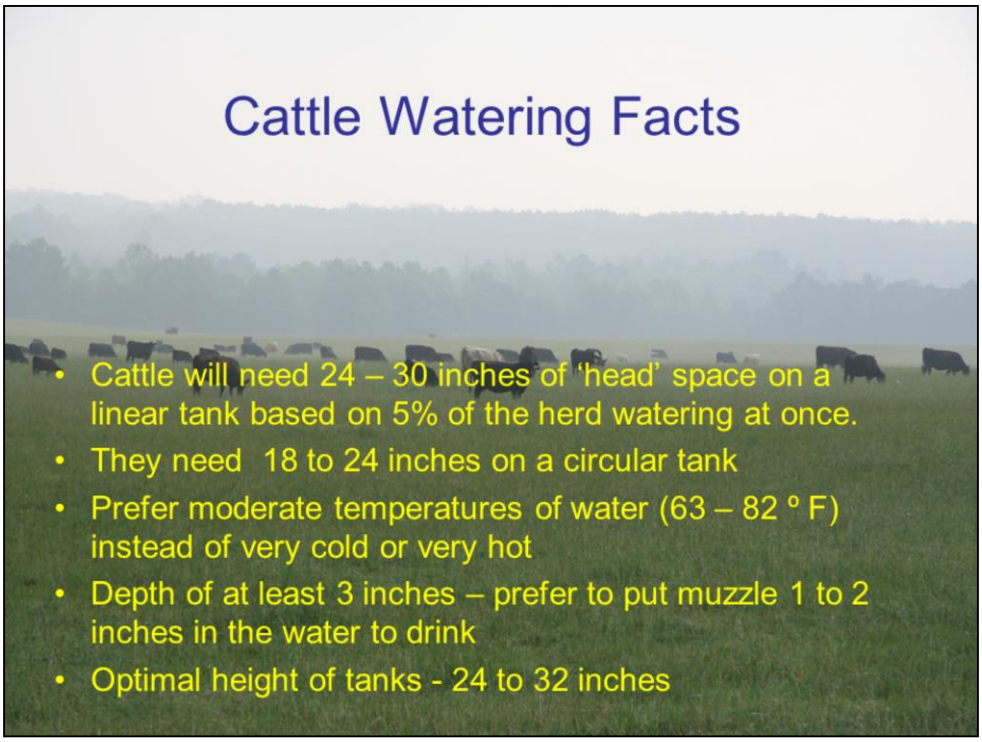
I just wanted to point out that the need to fence the livestock out of the spring is important. Make sure the overflow pipe is installed and designed correctly. Note the large tank needed for slow recovery. Note the paved area since this is a permanent tank.


Watering Facilities for Managed Grazing Systems
Placement
Tank size and Shape considerations



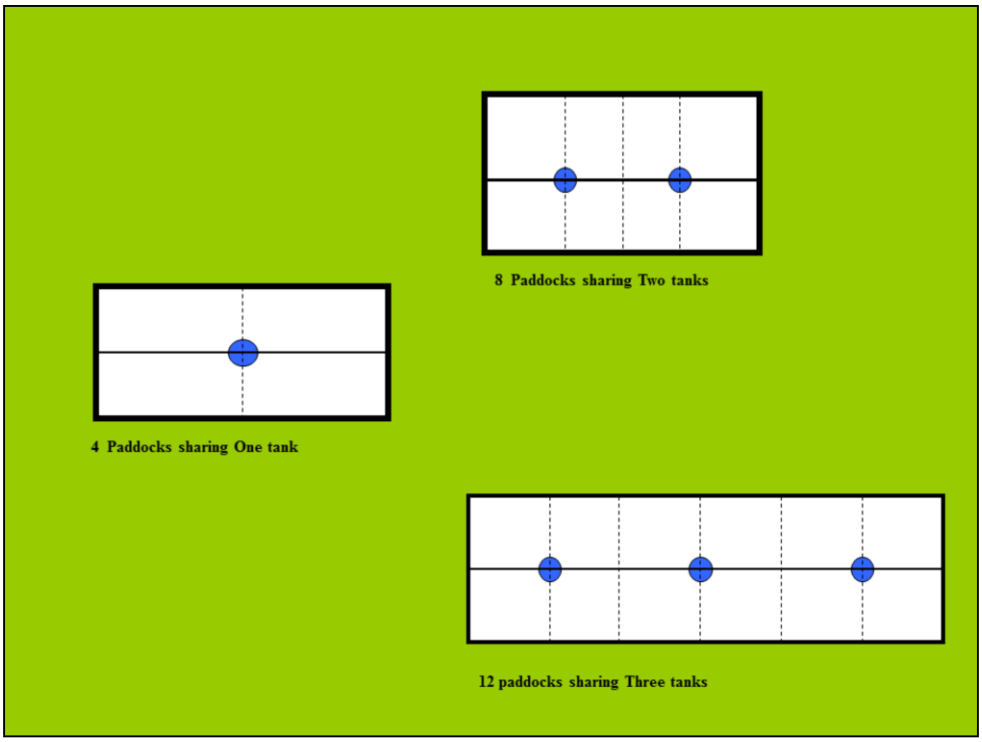
Always plan to locate the trough on a location higher than the surrounding ground. Good drainage will aid in maintaining the site.

Use of gravel and geotextile material is a common method of protecting ground around the trough.


Cattle Watering Facts
• Cattle will need 24 – 30 inches of 'head' space on a linear tank based on 5% of the herd watering at once.
• They need 18 to 24 inches on a circular tank
• Prefer moderate temperatures of water (63 – 82 º F) instead of very cold or very hot
• Depth of at least 3 inches – prefer to put muzzle 1 to 2 inches in the water to drink
• Optimal height of tanks - 24 to 32 inches

As you can see there is more room for animals around the tank place vertical to the fence line than the tank placed horizontal with the fence.

As noted by the heavy traffic in front of the tank, animals will not take the chance of making contact with the fence at either end of the tank.



When planning water tank location remember to take into account future uses. Remember to consider whether or not the location will accommodate future changes. Flexibility is the key, will the location allow easy subdivisions. *ONE TANK with properly placed quick connect hydrants may be best for the producer*. As Long as water is available in each paddock increased pasture utilization and nutrient distribution can be expected.

When planning the placement of a tank always consider how to maximize it's use. By opening and close gates this tank provides water to multiple pastures.

This tank portable tank placement allows less than half of the perimeter to be effective utilized by the animals; but because of the pasture size and animal behavior the entire herd does not attempt to drink at the same time.

Small tanks with high flow rates can provide adequate water, although if the electric fence comes in contact with the metal tank it will not be utilized and animals will avoid even after the problem has been corrected.

Unlimited access to streams and ponds can cause damage.

Ponds and streams are common sources of water for livestock. Problems often result when livestock are improperly managed resulting in symptoms such as stream bank erosion.

In many areas C/S is available to fence cattle out of streams and to develop semi-permanent stream crossing. Evaluate all management alternatives before allowing a C/S program to dictate a course of action.

Access ramps 20’ wide can usually accommodate herds up to 100 animals.

In many areas C/S is available to fence cattle out of streams and to develop semi-permanent stream crossing.

Insure adequate rim space is available for the number of animals to be watered. BEEF HOUSING and EQUIPMENT HANDBOOK recommends 2 feet of perimeter/ 25 head.

Missouri recommends 1.5 inches of space / animal in the herd. A 3 foot dia. tank will have a 113 inch circumference, providing adequate space for 75 head.

Watering Facilities for Managed Grazing Systems

- Things to Avoid.

"Hold up, Niles. It says here, 'These little fish have been known to skeletonize a cow in less than two minutes.' … Now *there's* a vivid thought."

So here is the modern day system being installed today. High Density Polyethylene (HDPE) pipe that is UV resistant is run on top of the ground along fence lines so livestock will not step on them. The state's engineering standards will dictate details but most systems should be 100 psi to 160 psi rated. Then there will be "snap on" couplers or valves every few hundred feet or less. The producer may run flexible garden hose from the main HDPE pipe and coupler to the float valve on the tank if the diameters needed are small enough. These hose diameters should be the same as the pipe or at least as the design calls for. These valves are very important. **First**, they control the amount of water used or wasted. **Second**, they determine how much water is delivered to the animals. Sometimes water flow is restricted by buying the cheapest valve possible. Some valves restrict flow by as much as 80%. These should only by used on designed large water reservoir/slow recharge systems. Typically a "full flow" float valve will be used. These float valves simply have a larger opening to allow more flow when triggered but they are more expensive than smaller diameter valves. This tank happens to be a smaller poly tank. Tanks can be made of concrete, steel, fiberglass and plastic. The NRCS state standard will give guidance in detail. **The disadvantage of the small plastic tanks is IF they are not set level the water will shift to one side, bow out the tank, and leak**. Let's evaluate this set up. . . . The paddock's farthest point may be less than 600 feet to the tank. What are some things that could improve in this slide?

Large tanks are needed when supply rates (gals/min) are low.This tank and the one following can provide water for a large number of animals. With low tank walls this tank was retrofitted with a barrier to prevent livestock from entering the tank. The pad is too small for the size of the tank in this picture or the heavy use area is not being properly maintained.

Placement of tanks in remote location offer unique challenges in water delivery.

Solar-power pumps are viable alternatives, however cost often makes this option undesirable for most location. Cost of running power lines can make them an attractive option.

Placing tanks on steep slopes or near streams should be avoided.

Picture taken in the hot, humid SouthLots of bad management here – total access to water, poor quality water and no other shade source.