CHAPTER 3 ~ FENCING AND LIVESTOCK WATERING SYSTEMS

FENCING FOR CONTROLLED GRAZING

Good fencing is the foundation of good grazing management. It allows the producer to rotate pastures when required and protect the animals against predators. Fences such as stone, rail, page wire and barb wire provide a physical barrier strong enough to discourage or prevent animals from crossing the fence (over, under or through). Electric fence uses a psychological barrier based on electric shock that discourages animals from challenging a physically weaker fence (Gay and Heidel 2003).

Animal species, age, breed and production system are factors that influence the fencing requirements of livestock. Intensively managed grazing systems have different fencing requirements than extensively managed systems (see Chapter 2 for information on grazing management systems). Another factor to be considered is whether the fence is to be a permanent fixture or part of a temporary paddock. Ultimately, the fencing system's projected affordability, maintenance, durability and effectiveness at containing livestock must all be consider when determining the type of fence required (Gay and Heidel 2003).

In a controlled grazing system, careful planning and proper layout of a fence system is necessary to optimize the system's productivity and provide control of the grazing animals. Fencing can be a major capital investment and requires planning to make it efficient and economical.

PERMANENT VERSUS TEMPORARY FENCING

Permanent boundary fences hold grazing animals in the pasture area, while temporary fencing can be used to subdivide pastures into paddocks among which livestock are rotated (Gay, Smith and Groover 2003).

COMMON TYPES OF FENCING

Electric Fence

- Acts as a psychological barrier – livestock must be trained to avoid the fence.
- A power source is needed to provide shocks – typically a wire carries current along a fence and when grounded (touched) by the animal the circuit is complete and the animal receives a shock.
- An energizer regulates the flow of energy in the fence wire by supplying pulses of high voltage (and low amperage) electricity in short duration.
- Can be temporary and/or permanent system.
- Used in combination with offsets, can extend the life of a page wire or rail fence.
- A **good ground** and its maintenance is critical to the effectiveness of the fence.

- A fence line free of vegetation requires less power to maintain adequate voltage levels.

The energizer generates one to two second high-voltage pulses (the current) which are sent through the fence line. When the animal touches the fence, the current flows through the animal, into the earth and back to the ground system completing the circuit and giving the animal a shock.

Solar or battery operated energizers are useful in remote locations, but can be more expensive and require more maintenance.

There are two ways to set up an electric fence system: 1) an all live wire system and 2) a ground wire return system (Figure 3.1). An all live wire system is the preferred method in regions with fairly even rainfall and green vegetation for most of the year. In an all live wire system, the circuit depends on electrons travelling through the animal, into the ground and up into the grounding rods back to the energizer. The ground is a better conductor when it is moist. A ground wire return system depends on the current to go back to the energizer by way of a ground wire. In this situation, an animal touches both a live and a ground wire, which completes the circuit. The ground wire return system is used where there is low rainfall, or if soil conditions are stony, dry or frozen.

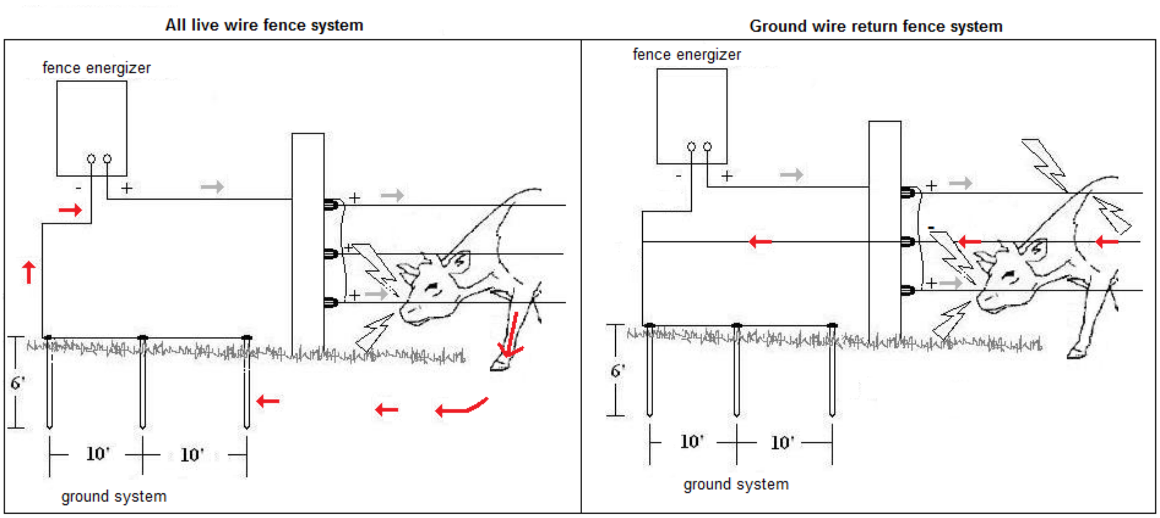

Figure 3.1 Comparison of an all live wire fence system and a ground wire return fence system.

Amperage, Voltage, Wattage, and Joules

It is often easiest to understand the terms used in electric fencing systems by comparing an electrical system to a water system. *Amperage* is a measure of current, like the flow of water through a pipe. *Voltage* is the difference in electrical potential between two points in an electrical circuit, or similar to water pressure in the pipe. *Wattage* is a measure of the rate at which electrical energy is transferred by an electric circuit (amperage x voltage). Wattage is comparable to the rate of water flow times its pressure which equals the pump horse power. Fence controllers can be energy rated by their wattage per second, or the *joule* output.

In electric fence systems, voltage typically ranges from two to 10 kilovolts (kv), but it is not the voltage itself that deters animals from touching the fence. Instead, it is the joules, or quantity of energy, that passes through the animal. However, voltage is important because a certain amount is required to overcome resistance (such as wool) and allow the energy to flow. The minimum voltage should be above 3.5 kv to be effective for most large livestock, but sheep and other livestock with heavy coats require a higher voltage (above six kv). Most problems with low voltage are due to insufficient ground or insufficient system components which are grounding out the system.

Finally, pulse rate and intensity are important for safety. Some energizers range from 0.003 to 0.03 second pulses and these should be avoided. The longer pulse time allows heat to build up and can potentially create arcs. The pulse should be very intense and last for only 0.0003 seconds so fire risk is greatly reduced. Energizers with short pulses are called low impedence energizers and are more expensive but worth the money. For a more detailed description on electric fence ratings and terminology, see:
http://www.pakton.com.au/terminology%20and%20units1.html

Proper Grounding

The key to an effective electric fence system is the grounding component. It is said that 90% of all problems with electric fence systems are due to an improper ground, and this is understandable considering the ground is half of the entire system. Ground rods catch the returning electrons like a radio antenna catches radiowaves. As such, care must be taken in determining their location and layout. The ground rods should be placed about two metres (six feet) in the ground and spaced about three metres (10 feet) apart, preferably in a moist area. The minimum number of rods for any system is three, but this number will increase as the total system energy rating increases. A good rule is to add another rod for every five joules (so a 12 joule energizer would require three ground rods, while a 25 joule energize requires five rods), but with more rods the better the chance to complete the circuit, especially in dry soils. Also be sure to use one continuous ground wire to connect every ground rod.

Gallagher Electric Fencing™ has a good rule to remember:

- 4 meters between ground rods
- 3 ground rods minimum
- 2 meters minimum in length
- 1 wire to join all the ground rods

It is important to routinely test the charge on both the fence and the ground system using a voltage meter. There is a range in the quality of voltage meters that can be purchased, but it is wise to invest in a good meter, preferably one that shows the direction of a fault. This will greatly shorten the time and effort required to search for the fault in the fence. Along the fence, the voltage should be between three and eight kv, depending on the size of system required. To test the ground system, measure voltage in the ground wire running between the energizer and the first ground rod. The optimum reading is zero volts, but if it reads more than 500 volts, then the system is insufficiently grounded.

Reducing Resistance

- The leadout (the section of fence from the energizer to the main fence) can be electrified and should be the same number of wires as the main fence. One strand can be used, but then must be sized for low resistance. Remember, the heavier the wire or thicker the diameter (guage), the lower the resistance.
- Do not connect different metals; this will cause rapid corrosion and cause high resistance. Specifically, do not join steel and copper.
- Correctly connect charged wires together (Figure 3.2). Do not twist wires together, instead use clamps, and limit the total number of connections and clamps. Increasing the total number of joints will increase resistance.

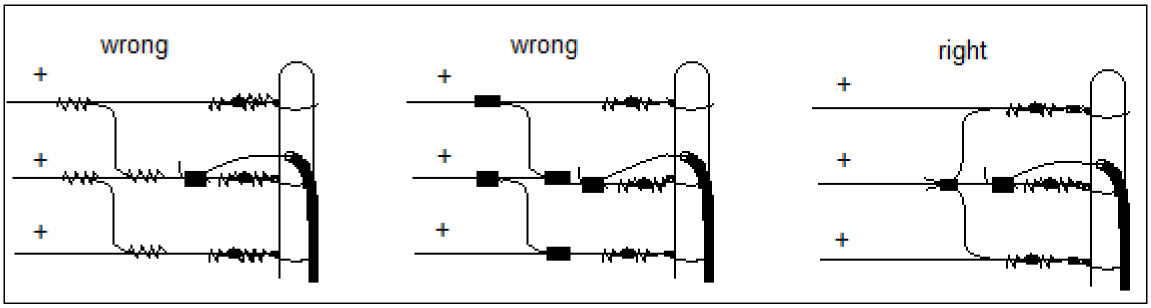

Figure 3.2 Limiting joints in the fence limits resistance problems.

Adapted from www.agf.gov.bc.ca/resmgmt/publist/300series/307300-1.pdf

Maintenance

In order to ensure that the fence works well, make sure that livestock are trained to respect the charged wire before putting livestock in an electrified pasture. To accustom the livestock to the charged wire, install it inside a large loafing area, such as a turnout pen, and leave livestock to become familiar with the electric fence.

The greater the fence load or the amount of vegetation touching the fence along its length, the more power is required to maintain the correct voltage levels. Vegetation touching the fence reduces its effectiveness. In order to eliminate this problem, begin with high voltage to burn off the vegetation, which means never shutting off the power, or trim under the fence as necessary to eliminate or at least reduce the amount of vegetation that comes in contact with the fencing wire. Herbicides can also be used to eliminate the herbage under the fence line.

Uses of Electric Fences

The biggest advantage of electric fencing is that it can be used as a permanent or temporary structure and can be used both on the boundaries of pastures and as a divider within pastures. In most situations, electric fences can be easily modified to adapt to pasture needs.

Permanent electric fence structures require heavier gauge high tensile wire (12.5 gauge is commonly used). Usually, permanent electric fences are used as boundary fences but they can also be used to divide a pasture into long term paddocks. On flat land, posts should be placed at 15 to 30 m (50-100 ft) interval with the hillier the terrain, the closer the fence posts should be installed. If desired, fence droppers can be placed every 7.5 metres (25 ft) to prevent wires from being easily spread apart. Insultimbers ™ , which are high-density wood posts that do not conduct the electrical charge, can be used along long stretches of fence line instead of wood posts and insulators.

The number of wire strands required in a fence system depends on the class of livestock being confined as well as the location of the fence (see Figure 3.3). For example, cattle next to the barn may only require a fence of only two or three wires. In contrast, a boundary fence that is being designed for sheep close to a forest may require a predator control fence of five or six wires. A boundary fence is really the last line for the livestock to cross before leaving the property, so it should be very strongly constructed.

A permanent electric fence used to divide a pasture into paddocks requires fewer wires than a boundary fence. In this case, the purpose of the fence is to keep the animals within a section to use the forage efficiently not for the protection of the livestock. Cattle trained to respect electric fencing are easily contained with one strand of high tensile wire, whereas sheep will stay in place with three strands once they are trained.

Temporary electric fencing is generally used to subdivide larger paddocks or pastures into smaller ones or to create grazing strips These fences can be constructed with any type of electric fence wire, including polywire, 12.5, 14 or 16 gauge smooth wire or polytape since animal security is not the primary concern. The most important consideration is to choose material that is easy to move but will not easily break. Polywire is very light and easy to move but does not have a long lifespan. The wire is held up with movable posts and connected to permanent fences with either gate handles or reels. Sometimes producers try to overcome the problem of frequent breakage by tying the ends back together, but the more connections made in the line, the higher the resistance becomes. After several breaks, it is best to replace the wire.

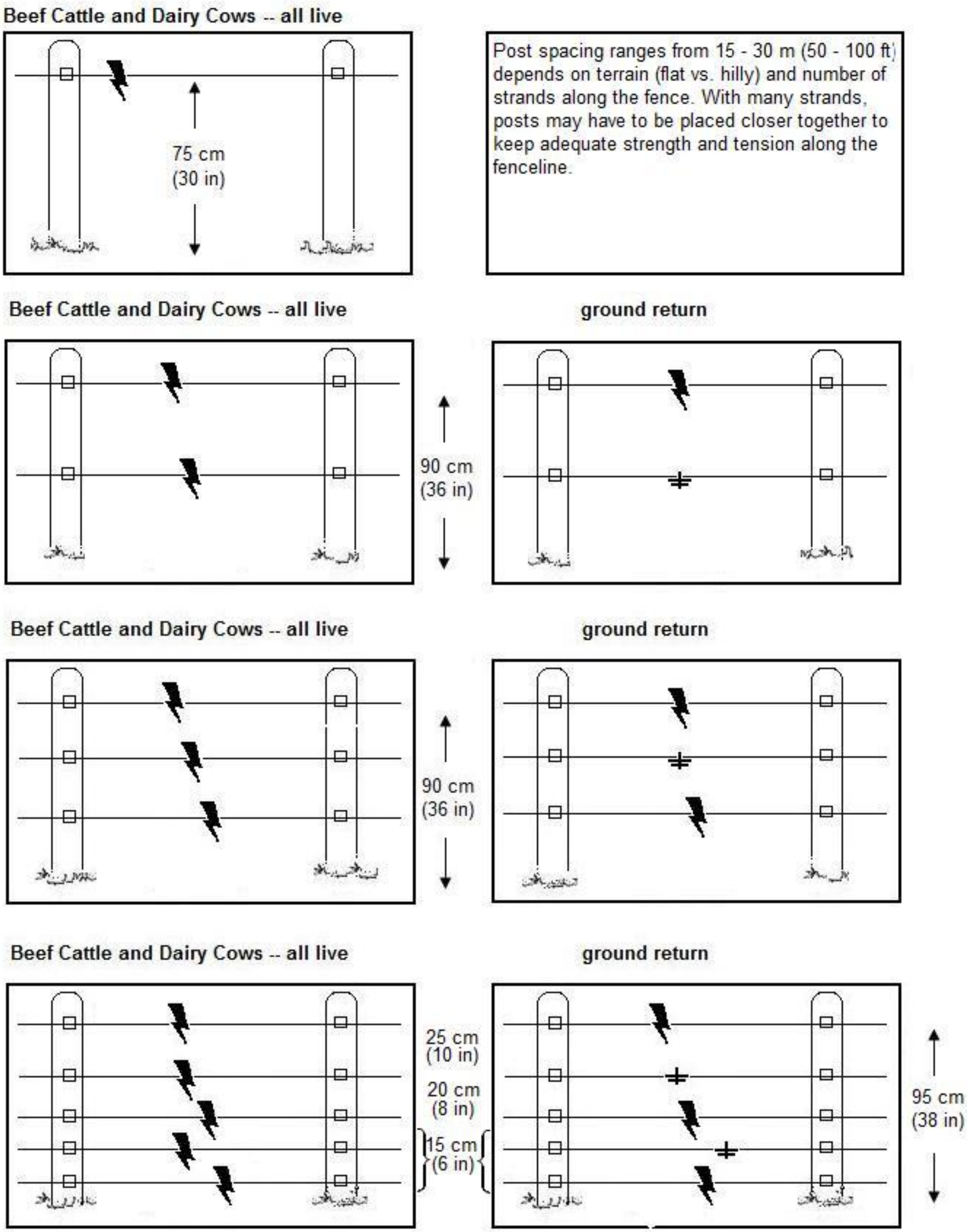

Figure 3.3 Adapted from Gallagher Power Fence Systems Manual

Moving Electric Fences

There are several devices designed for both polywire and high tensile electric fences that help make moving front and back temporary fences in a rotational system easier.

For polywire fencing use one or more reels suspended by step-in posts to easily wind, unwind and move the fence (see Figure 3.4). The most common posts are step-in posts made of steel or fiberglass.

High tensile wires can be easily moved to the next section in a rotational grazing system using a tumble wheel. Tumble wheels roll easily over the ground and then attaches to the side fences with gate handles.

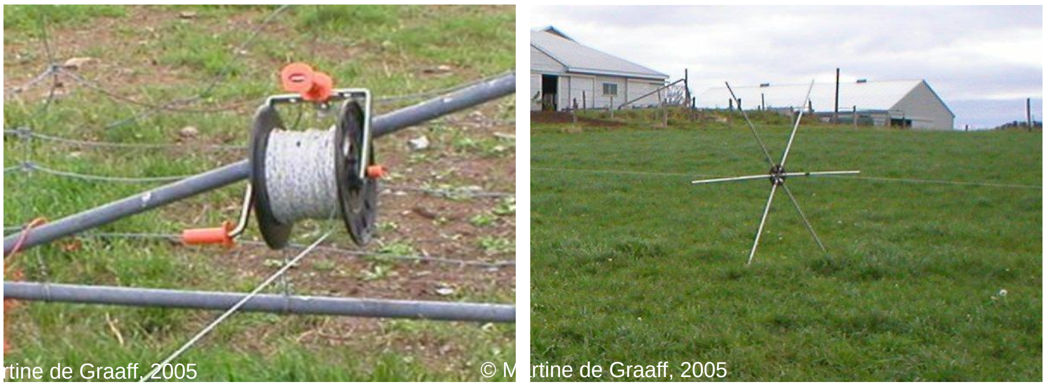

Figure 3.4 A reel and a tumble wheel used to easily move temporary fencing

Electric Net Fencing

Electric net fencing is a portable type of fencing that is made of a nylon-coated wire mesh so it is highly visible. It is very light with the stakes built in making the netting easier to set up and move. This type of fencing is useful to subdivide pastures, especially for mature sheep, since it is both a physical and psychological barrier. It is also useful for keeping predators out. The net fencing comes in a variety of mesh diameters. Mesh fence heights range from 85 – 120 cm (33 to 48 inches). It is generally sold in rolls of 25 – 50 m (80 – 165 feet). Electric net fencing should be electrified at installation. Caution should be used with lambs as they can get caught in it and sustain severe injury or death. Electric net fencing has to be kept clear of brush and other debris that has blown into it and it helps to clip the grass underneath the fence to prevent grounding out.

Electric Fence Hints and Troubleshooting

- 90% of all electric fence problems have to do with incorrectly grounding the system
- having a mix of electrified and other types of fencing on a farm is less effective since livestock may test the electrified fence more often; using an offset electrified fence around the inside perimeter of page and barbed wire fences can be useful in mixed fencing systems
- when looking for electrical faults in an extensive fence system, use switches installed at junctions and gateways to turn sections of pasture fencing on or off
- build gates so that they are charged only when connected; this prevents fence drainage if it lies on the ground
- use a voltage meter with a fault direction indicator to more easily find electrical faults

- **never charge page or barbed wire - it can be very dangerous if livestock or people get caught or tangled in it**
- reduce the number of wire connections as they will reduce the total voltage on the fenceline
- run insulated wire underneath the gate to prevent it from being damaged (see Figure 6.5)
- electrified fences should be kept charged throughout the pasture growing season to prevent grounding out through vegetative growth

Figure 3.5 Wire run through water hose underneath gate

Page Wire Fencing

Page wire is used for permanent perimeter fencing to control livestock, protect crops and enclose pastures. Page wire is sold by rolls [1 roll = 20 rods, 1 rod = 5 m (16.5 ft)] and comes in both one m (39 in) and 1.2 m (48 in) heights. The 1.2 m type is used more often, but the one m fence can be used for small livestock. They come in 9-strand panels and range from nine to 12.5 gauge. Corners must be constructed correctly for maximum strength (see Figure 6.7). Anchor, corner and stretch posts must be made of wood.

Post spacing varies between four to five m (13 – 16 ft). Post lengths vary with page wire fencing height. Generally, for cattle a 2.4 m (eight ft) post is used with 1.5 m (five ft) above ground.

Benefits of page wire include its security and visibility to livestock. However, this form of fencing is costly to purchase (three times the cost of electric fencing), and results in higher installation costs due to increased labour requirements, equipment and material necessary for on-site construction (Stone and Leahy 1999). Also, it cannot be used to temporarily subdivide pastures, and incorporating electric fencing can be difficult. This results in a fencing system with little adaptability. Furthermore, it can be easily damaged by snow loading and animals reaching over the top.

Barbed Wire Fencing

As permanent fencing, barbed wire is less expensive than page wire, but more maintenance is required. Several strands of barbed wire can be used on interior and perimeter fencing, with posts spaced five m (15 ft) apart. Barbed wire is stretched tight during installation and stapled securely to each post. The number of wires used depends on the class of livestock being fenced in or out, and can range from two wires spaced 60 cm (24 in) from the ground and 45 cm (18 in) apart to four wires, with the bottom strand 30 cm (12 in) above the ground and each subsequent wire above spaced at 25-30 cm (10-12 in) intervals.

Double strand 12.5 gauge barbed wire is the standard type and comes in 400 m (1,300 ft) rolls. Barbed wire is used where a lot of repelling action against livestock is required. However, the barbs make it hard to handle and the fence is susceptible to permanent damage and sagging. Barbed wire fencing should not be tightly stapled to each post to allow for occasional tightening of the wire. The spacing of a 4-wire fence will not be able to contain small animals. Barbed wire fencing also contributes to an increased risk of wildlife injury (Stone and Leahy 1999).

While barbed wire fencing is an effective method of keeping livestock in, it does have limits on predator control. It is easily damaged by snow load although animal pressure (i.e. when livestock reach over it) is not an issue as it can be with page wire.

OFFSET FENCING

Offset fencing is used to increase the longevity and effectiveness of existing non-electric fences by protecting the non-electric fence from livestock. Offset fencing is also used to carry a charge from non-electric fences to electrified ones. For example, a large non-electrically fenced pasture can be subdivided into smaller temporary paddocks with electric fencing by running an electric line along the exterior fence and connecting it to the interior electric fence. This way the permanent fence does not have to be replaced with an electric fence, and it is also protected from animal pressure.

Offset fencing consists of brackets attached to either the posts or the existing fence wire, and these brackets hold an electrified wire at two-thirds the height of the animal being contained (see Figure 3.6). It also reduces damage to animal hides as it prevents the animals from rubbing against the non-electrified fence.

Figure 3.6 Offset fencing can be used on existing permanent fencing to reduce animal pressure.

Bracing Corners and Ends

Regardless of the type of fence being used, the recommendations for corner and end section assembly and installation are the same. Corners and end sections must be correctly constructed for maximum support of the fence as properly tensioned fence wires exert a great amount of force on the assemblies. Though both are similar in construction, a corner assembly is used when tension comes from two or more sides, while an end assembly is used when tension only comes from one side.

The most common type of corner brace assembly is the H brace because of it`s strength and relative ease of construction (see Figure 3.7). A corner post will need a brace assembly for each direction that the fence joins to it. Notice that the brace wire is placed in the direction of pull. End and gate braces are similar in design. If the length of fence from the corner post is greater than 60 m (200 ft), a double bracing system should be installed.

Anchor, corner and stretch posts must be made of wood.

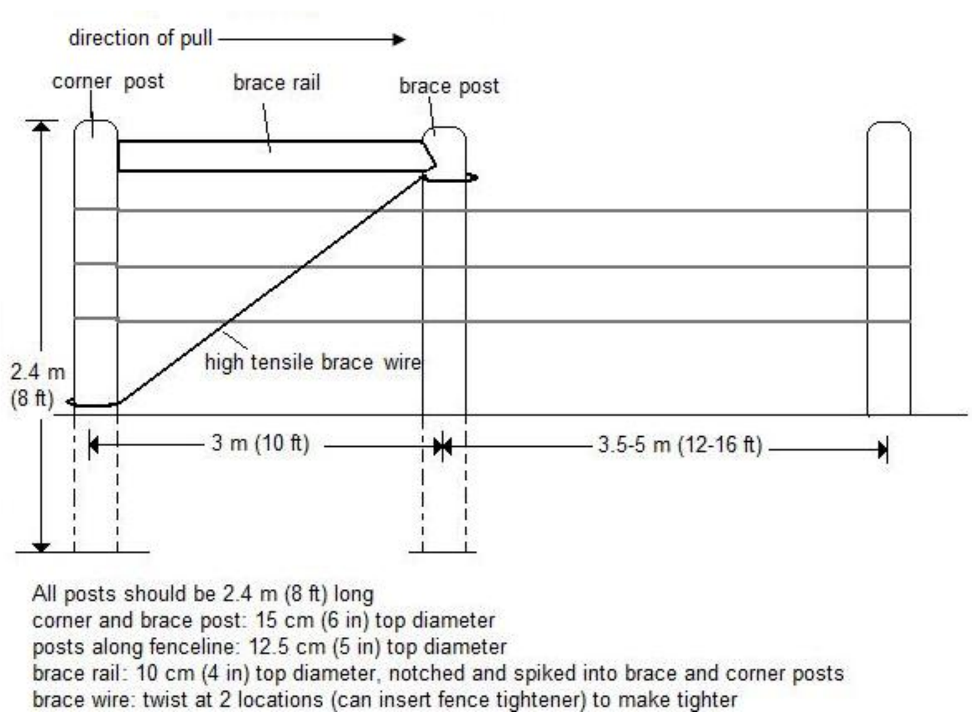

Figure 3.7 The "H" brace is the most common type of corner bracing.

Gates

Gates should be 25% wider than the widest tractor and implement that must pass through. Gates should be placed at corners or fence intersections since livestock tend to follow the fence when herded out. This location will also reduce the total number of braces that will need to be built.

COMPARISON OF TYPES OF FENCING

Table 3.1 has summarized the characteristics of the most available types of fencing for easy comparison. Although fence costs may change, the table illustrates the relative costs of several fencing types.

Table 3.1 Comparison of Different Fencing Types

Fence Type	Advantages	Disadvantages	Relative Cost	Best For
Barbed wire	• easy to install	• animal injury possible • high maintenance • not predator proof • not movable	Medium	Cattle in combination with other fencing.
Electric high tensile	• inexpensive • long life • easy to install • predator control	• maintenance • some training required	Initially medium to high Wire cost is low	All classes of livestock.
Electric polywire	• inexpensive • easy to install • easy to move	• not predator proof • short life • less durable	Low	For all classes as interior or temporary fencing
Electric netting	• psychological and physical barrier • predator control • easy to install • easy to move	• expensive • animal injury of concern • less durable	High	Small livestock; and temporary fencing of small areas.
Page wire	• physical barrier • predator control	• expensive • high maintenance • not movable	High	All classes for permanent fencing.

LIVESTOCK WATERING

Direct livestock access to streams or ponds has been the traditional method of watering. While this method may be suitable for low density use, both animal and environmental problems may arise.

Impacts on livestock include reduced health, production and rates of gain and a greater chance of injuries. Impacts on the environment include erosion of banks, siltation of watercourses, loss of vegetation and habitat, nutrient build-up in water, and an increased growth of algae and bacteria, which can all have negative effects on aquatic life and water quality.

Figure 3.8 An example of a poor source of water; environmental degradation and a decrease in livestock production can occur

Effects of Poor Water Quality

Livestock can be significantly affected by high levels of coliform bacteria (especially *E. coli*, which indicates septic waste or manure in the water). Cattle weight gain can be reduced by 20-30 percent with the consumption of contaminated water. A recent survey of pasture watering sources in Nova Scotia found some surface waters to have in excess of 100,000 colony forming units/100 mL of water. Livestock generally prefer clean water over contaminated water, and cool water over warm or icy water. Several studies have shown that cattle prefer drinking from water troughs rather than streams or ponds. Ramps and crossings can be used to reduce riparian damage provided they are well-designed and constructed.

Water Requirements

Table 3.2 gives water requirements for several types of livestock. (To calculate per-hour herd intake, multiply the given number by the herd size and divide by 24.)

Table 3.2 Average daily water intake by livestock

LIVESTOCK TYPE	INTAKE§	
	Litres	Gallons
Cow –calf pairs	55	12
Dry cows (both dairy and beef)	45-55	10-12
Growing cattle* (150-350 kg)	20-40	5-10
Growing cattle* (350-550 kg)	30-55	7-13
Dairy cows	75-95	12-20
Sheep, goats	10	2
Horses	30-45	6-10

§ On days over 25°C, intake can increase by 50-100%.

**** Finishing cattle may require more***

Alternatives to Watercourse Access

There are many ways to provide water for livestock while preventing them from entering water sources. There may be several options for a particular site, so before choosing a watering system, there are some details that should be considered.

To determine the right system for you, know:

- daily total water volume required
- number of livestock
- distance from barn water or electrical supply (accessibility)
- water source specifications (type and location)
- pasture location(s) and conditions (remoteness, topography, riparian features)
- grazing intensity (intensive or extensive)
- time available for labour (maintenance, reliability of system)
- financial feasibility

TYPES OF WATERING SYSTEMS

Pipeline from a Well

This is the preferred method of watering livestock in Nova Scotia. The source of water usually feeding a pipeline system (Figure 3.9) is a drilled or dug well, however any other source can be used as long as there is electricity available for a pump to move the water. Wells can provide high volumes of quality water, are very reliable, and pipe can be laid out over a long distance, depending on the head.

Figure 3.9. Pipeline system: consists of main line with

connectors to tubs in paddocks

The waterline diameter is usually 1 inch, but if pumping uphill, reduce the pressure loss by using a larger waterline. Waterlines can either be buried below the frost line or kept above ground, but then need to be emptied before freezing. In rotational grazing systems, plan the layout of the paddocks to best accommodate the waterline and insert several quick disconnect couplings so that a water tub can be quickly emptied and moved to the next paddock. Cost will depend on the distance of waterline installed, and any excavation costs associated with burying the line.

Gravity Flow

This is a simple system in which the force of gravity is used to bring water from the source to the watering site and into a water tub (Figure 3.10). Since no power is required, this system can be used with almost any surface water source and anywhere there is adequate slope (the source should be at least 1.5 m higher than the water tub; this increases as the distance increases).

The pipeline should be as straight and level as possible to prevent air locks, but the risk of air locks increases as distance increases. The diameter of the waterline should be at least 1.25 inches for grades over one percent, but if pressure drop is a problem, then up to 1 ¾ inches diameter may be required. The daily volume is completely dependant on the source (i.e. flow from spring or volume of pond).

Figure 3.10 Gravity flow system: source feeding waterline at top of hill and is delivered at water tub

Solar Powered Pumps

Solar powered pump systems use solar energy to either charge batteries which run a 12-volt pump (Figure 3.11), or as a direct system which operates the water pump directly. The intake of the water hose can be placed in a stream, pond or shallow well and the outlet should run to a water tank. Three days worth of reserve in either batteries or as a water reservoir is recommended for extended periods of cloud; solar panels can recharge during cloud but at a much reduced rate. The water tub can be fed by gravity from the water tank or reservoir.

Figure 3.11 A simple set up of a solar panel, batteries and a submersible pump

Suppliers can help with the system design including panel(s), batteries (optional), pump, controller and float switch. This system also has the potential to power an electric fence at the same time it is powering a water pump. Solar direct systems are at least double the cost of battery operated systems.

There is a large range of system sizes. Systems can pump as little as 200 L/hour (4,000 L/day) to as much as 5,000 L/hour (120,000 L/day) or more (the latter was tested at an 8 foot vertical lift and 16 foot horizontal with a 102 watt solar panel). In general, 100 watts is the minimum wattage of a panel required to operate a pump with sufficient volume. If higher flow rates of water are required, panels can easily be added to the system to increase its power output and drive a larger pump. This system works well in more remote areas, since the water reserve only needs to be checked every few days. Theft or vandalism may become an issue. The panel, batteries and water tank can be placed on a trailer and moved to another area of the farm.

Wind Powered Pumps

Both mechanical and compressed air pumps are used, however the latter is more economical and requires less maintenance (Figure 3.12). The intake of the water hose can be placed in a stream, pond or shallow well and the outlet should run to a water tank. A water reservoir holding three days' water supply may be necessary in case of several calm days, however normally very little wind is required to drive the pump. The water tub can be fed by gravity from the water tank or reservoir. Since there is only one moving part, there is almost no maintenance required, other than to check on water levels in the trough or reservoir.

Figure 3.12 A 12-foot windmill driving a water pump with compressed air

One manufacturer of compressed air windmills reports a maximum of 16,000 L/day pumped at a 10 foot lift (horizontal or vertical) and 6,000 L/day at a 21 foot lift, with 5-8 km/hr winds. When tested with a 75 foot horizontal and 6 foot vertical lift, the windmill could pump at least 300 L/hr (7,200 L/day). Most regions of Nova Scotia regularly have enough wind. There is an automatic shut off at wind speeds higher than 35 km/hr.

Nose Pump

This is a diaphragm pump powered by livestock, and yields 0.5 to 1 L per stroke. The maximum number of cattle that it can water is 20 cow-calf pairs. Nose pumps are easily set up by placing the intake hose into the water source, like a stream or pond. When the cattle are moved, simply haul the hose out of the water and take the nose pump with them. Winterized versions cost more. A two-day training period is required to allow cattle time to become familiar with the pump. Where nose pumps are permanently fixed, installing a pad or trough underneath the pump can reduce mess and can provide water to very young calves that otherwise cannot operate the pump (Figure 3.13).

Figure 3.13 It is preferable to place a pad underneath the nose pump to avoid a mucky drinking area

As hose length increases, so does the force required, so a distance of 6-10 m is considered maximum for best results. The amount of lift will depend on hose length, but is generally not more than several metres. Other than needing to prime the pump once in a while, there is little maintenance required. These pumps are very reliable and can be used in more remote locations.

Water Powered Pumps

Both the ram pump and the sling pump are powered by water. Neither is used much in Nova Scotia because they require specific water source conditions. The ram pump requires a minimum of 1 metre fall to drive it, while the sling pump needs a minimum water depth of 40 cm and current speed of 0.6 m/s to operate. Water source factors such as flow rate, fall and lift requirements will all determine the amount and rate of water delivered. Both pumps have been reported to pump up to 6,000 L/day or more, and the ram pump can lift several hundred feet, depending on the initial fall.

Hauling Water

Hauling water consists of a tank mounted on a trailer or vehicle that supplies water by gravity to a water tub. The flow of water is then controlled by a float valve. Tanks generally hold several thousand litres of water, so that they only have to be refilled once every couple of days (Figure 3.14). This system is practical when no other water source is available to the grazing area. It can be used with a rotational grazing system by moving the trailer at the same time as the animals are moved. Like smaller troughs, algae can grow inside tanks, especially in the hottest part of the summer.

Figure 3.14 Typical tank used to haul and store water in more remote areas

Pumps Powered by Battery and Fuel Generators

There are many types of pumps that can be run by portable batteries or gas engines. They are useful as backup power sources or when providing water in remote areas. However these can be more labour intensive as the power source needs to be attended to regularly. Theft may also become an issue. Here again, a water tank can store water and then feed a water tub by gravity. An alternative to having the batteries or generator constantly running a pump is to routinely visit the site with the power source and fill a water tank that can store a large quantity of water.

SYSTEM COSTS

Table 3.3 shows cost ranges for each system. The costs include the pump and all immediately associated components of the pumping system; they do not include water troughs, floats or any pads that may be required at the watering site. There is also the possibility of excavation costs, which will depend on the size of the task, as well as the soil type that is worked on. Large water tanks or reservoirs to store several days' worth of water will also add to the total cost of the system.

Table 3.3 Cost of alternative watering systems

Type	**Cost of System ($)**
Well	3,000 - 20,0000
Pipeline	*1,000+
Gravity flow	*1,000+
Nose	400-500
Solar	§1,500+
Wind	§1,500+
Ram pump	500+ and fuel
Gas engine generator Battery powered	Batteries and Charging system

**Cost depends on total distance of system.*

§ May have to add cost of reservoir (if needed)

Costs associated with a pipeline system include: a float (under $20); plastic tubs which range from $150 to $250 depending on the size, while metal tubs can cost $100 (or less for used); and waterline (less than $1.50 per foot for 100 psi pipe).

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