

# Agricultural Engineering

## Temporary Fencing For Rotational Grazing

*Michael J. Buschermohle, Professor  
Agricultural and Biosystems Engineering*

Rotational grazing allows forage crops to renew energy reserves, rebuild plant vigor and give long-term maximum production. With a rotational grazing system, larger pastures are subdivided into smaller areas (often referred to as paddocks) with temporary fencing materials, and livestock are moved from one paddock to another on a prearranged schedule based on forage availability, stocking rate and livestock nutrition needs. The mainstay of a rotational grazing system is flexibility — and nothing gives more flexibility than a highly movable temporary fence for subdividing larger pastures.

### Temporary Fencing Materials

Improved solid state technology and developments in wire for fences have created new possibilities for livestock and pasture management using rotational grazing. A good understanding of the fencing materials that are currently on the market will help in selecting, installing and maintaining your rotational grazing system.

### Temporary Fencing Wire

There are two basic types of temporary electric fence wires on the market: polywire and polytape.

Polywire is a generic term referring to any of several brands of electroplastic twine. Polytape refers to electroplastic ribbon. Polywires and polytapes are made up fine metal filaments braided with strands of polyethylene or polypropylene fibers. The metal carries the shock and the plastic gives the temporary wire strength and visibility.

Most producers subdivide their pastures with polywire instead of polytape. The primary reason is cost. Polywire costs about half as much per foot as polytape. It typically has three, six or nine strands of fine metal filaments that carry the shock. Some manufacturers use aluminum filaments, which make a better electrical conductor compared to typical polywires with stainless steel. The disadvantage of using aluminum is that it can “work harden” over time, which makes the metal brittle and subject to breaking. If you plan to put the fence up and leave it in place, then polywire that uses aluminum filaments will do an excellent job of controlling livestock. However, if you plan to move the fence to adjust the paddock size, which is often the case with rotational grazing, polywire with stainless steel filaments will be more durable and last longer. Stainless steel doesn’t work harden like aluminum, but it is a slightly poorer electrical conductor. As a result, most basic polywire has



six conductive filaments. Some manufacturers also sell polywire with nine strands. It costs more than six-strand polywire, but it has 50 percent more conductivity. Some manufacturers sell nine-strand polywire that contains both stainless steel and highly conductive alloy filaments. It costs more per foot compared to six-strand polywire, but is 100 times more conductive. If you're using polywire for short distances to subdivide a pasture, six-strand polywire is sufficient to do the job. On the other hand, if you want to run polywire for a long distance or for a fence that may become overgrown with weeds and grass, buy a wire that carries more of a shock.

Polytape typically consists of anywhere from five to 15 strands of metal filament woven with strands of plastic to form a flat ribbon. Most polytapes on the market use stainless steel filaments. Polytapes are more visible than polywires, but they cost more per foot and are slightly more difficult to take up and move. If you are getting poor animal control with polywire or visibility is important, such as with horses, you might consider switching to polytape. Having better animal control will offset the additional cost of polytape.

Polywire and polytape won't last forever, especially if you are taking it up and moving it frequently. You may hear reports from producers getting seven to nine years of use from these temporary wires, but five to six years of useful life is more common.

## Color

If an animal doesn't see the wire, it can't respect it. Visibility is critical with temporary fences, especially with poorly trained stock or where wildlife may challenge the fence. Polywire comes in several colors and color combinations: white, orange, orange and black, yellow, and yellow and black. You can buy white or orange polytape. Against a lush green or dried yellow background or at night, white is more visible. Time and time again untrained animals notice white from farther away than any other colors.

## Reels

If you plan to move the fence for any reason, such as changing the paddock size, then a reel is essential. Rolling the wire back onto the spool, onto a stick or around your arm the way you would roll an extension cord simply will not work. You will kink the wire and break the fine metal filaments or you will end up with a big bird's nest of tangled wire. You will spend hours trying to untangle the mess or in most cases you will probably get frustrated and simply throw it away and buy

new wire. If you want to save both time and money, buy a reel that is made specifically to hold temporary fence wire. These reels are made from weather-resistant plastic and will hold one to two spools of polywire or polytape. Plastic reels that are used to wind up extension cords will work; however, they are not as durable and will not hold as much wire. Some producers have built home-made reels for mounting on four-wheelers or other vehicles.

## Posts

There are four basic kinds of posts generally used for temporary fences. Plastic posts are more convenient to use where you are moving the fence frequently, because they have built-in treads to "step" the posts into the ground. The pre-molded loops provide plenty of flexibility for a variety of wire spacings. They are slightly more expensive than other temporary posts and have a life expectancy of three to five years.

Fiberglass rods are better suited for situations where you won't be moving the fence very often. They are less expensive than plastic posts and can last up to 20 years. They are easily driven in the ground with a hammer, but they do take a little longer to install than plastic posts. Fence suppliers sell a cap to place over the end of the rods to keep them from splintering when you drive them in. A spent shotgun shell also works well and doesn't cost anything. Some producers have made a mini-post driver from a 1/2-inch diameter piece of steel pipe with a cap on one end. Wire clips or plastic insulators that slide on the rods hold the wire in place.

Many producers use 4-foot long, 3/8" metal rebar posts. They are cheaper and last longer than plastic or fiberglass posts. You drive them in the ground with a hammer. Slide on plastic insulators hold the wire in place. They are not flexible like plastic or fiberglass posts and will bend if the fence is hit by deer.

Metal "t" posts are stronger and last longer than the other temporary posts, but they cost more and require more labor to install and remove when changing the paddock size. However, since they are not flexible like the other posts, they do work well as corner posts or when making sharp turns in the fence line.

## Electric Fence Chargers

Most producers will agree that touching an electric fence is very unpleasant. The experience for animals is the same. The severity, or the amount of shock the animal feels, depends on the voltage and amperage as well as the duration of the shock. It takes a minimum of 700 volts to produce a shock

sufficient enough to control short-haired breeds of cattle, pigs and horses, and a minimum of 2000 volts for long-haired cattle, sheep and goats. Commonly, the best fence chargers will deliver 4500 to 7000 volts.

It is important to realize that voltage level only determines whether or not a shock will be delivered to the animal, and is not a measure of how much shock will be felt. If the voltage is adequate to deliver a shock, the effectiveness will then depend on how much shock is produced (shock intensity). The energy output in a shock pulse is an indicator of shock intensity. It is related to the combination of amps, volts and pulse on-time, and is measured in joules. A joule is a measure of energy equal to a watt for one second. High joule values indicate high shock intensities. The joule rating can range from less than 1 for small battery-operated chargers to about 40 for the most powerful models. Remember, double the joules and you'll double the shock.

There are two types of electric fence chargers on the market: high- and low-impedance. Impedance means leakage. Generally speaking, high-voltage chargers with long pulses are high-impedance chargers. Chargers with long pulse lengths can cause current to arc and heat to build up in the wire. This can cause fire and melt polywire and polytape where it comes in contact with weeds and grass. Avoid using high-impedance "weed-chopper" type chargers. These chargers leak current too readily. Any weeds or grass that touch the fence will drain the power to the extent that little or no shock is felt by the animal.

Low-impedance chargers are better suited for use with rotational grazing systems because they resist leakage. Because they resist leakage, they have the capacity to power long distances of single or multi-wire fence. Low-impedance chargers put out an intense pulse which lasts for 0.0003 seconds or less, which eliminates heat buildup in the wires.

If your fields are near a 120-volt power source, your best choice is an AC-powered charger. AC chargers usually have higher joule ratings and require no battery maintenance. Operating costs are reasonable, averaging 50 to 75 cents a month.

If the fence you plan to electrify is not near a 120-volt power source, you have no choice but to use a battery-operated (DC) charger. Low-impedance DC chargers do an excellent job of confining animals and are very dependable. Some DC chargers have a battery and recharging system (photo-voltaic panel) built into the unit. Others operate on a separate 12, 24 or 36 volt (1, 2, or 3, 12-volt batteries) system. With these systems you can either recharge the batteries with a standard battery charger every two to six weeks depending on the

type of charger and the amount of use, or you can buy a solar pack to keep the batteries charged. Deep-cycle batteries are best suited for battery-operated chargers. They can be discharged and recharged repeatedly. Batteries designed for use in automobiles are not designed to be discharged and recharged and thus will not last as long as deep-cycle batteries. Once totally discharged, car batteries will only recharge up to 60 to 75% of their original capacity.

## System Layout

### Water

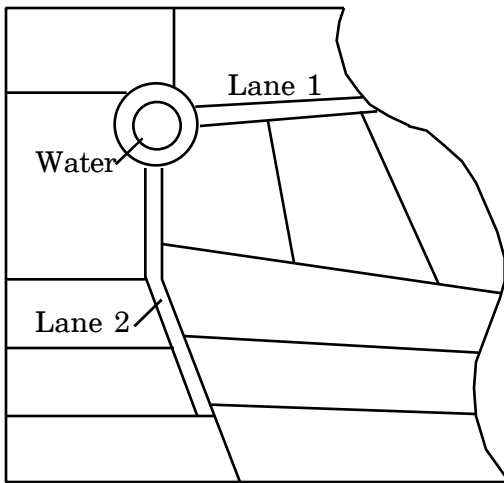
Water is an essential part of a grazing plan, and the more accessible water is to livestock the better. The distance to water is an important consideration when designing a rotational grazing system. The shorter the distance animals have to travel to water, the more water they will drink and the less energy they will burn traveling back and forth from the paddocks to the water source. Both of these factors will have a positive influence on animal performance. Ponds, wells, creeks, springs or public water sources can be used to supply water to livestock. Regardless of the source, it must be capable of supplying enough clean water throughout the entire grazing period to meet livestock needs.

The method by which water is supplied to animals in a rotational grazing system will vary greatly from farm to farm and may even vary on an individual farm. Two systems that can be used to bring water to livestock are permanently installed water lines running to a series of water troughs in the paddocks, or temporary water systems, such as plastic pipe on top of the ground that uses portable tanks. If it is not feasible to bring water to the livestock, then fencing can be designed and installed to move animals from the paddocks to a water source. The most common method is to build a lane that joins a series of paddocks to the water source.

### Shape of Paddocks

Livestock like to travel fence lines to locate their boundaries or places where they might escape. In doing so, available forage is wasted by trampling and deposition of manure and urine. Square paddocks (or shapes that approximate a square) are the most efficient compared to other shapes (pie-shaped, fan-shaped, narrow rectangles) because animals can obtain their daily feed with a minimum of time, effort and trampling of the pasture. Rectangular paddocks may also be used as long as they are no more than four times as long

as they are wide (Figure 1). If the paddock is long and narrow, cattle will graze closest to water and shade then graze young regrowth from the same area before intensively grazing the far end of the paddock. Although sometimes it is necessary to use other paddock configurations, in particular when fence lines have to follow natural land forms or boundaries, the use of circles, triangles or other shapes should be kept to a minimum. Avoid paddocks that funnel down to a narrow area at the gate. This concentrates animals to a narrow lane arrangement and increases the tracking and erosion problems. Wherever possible, fence across rather than up and down slopes.



**Figure 1. Paddock Layout**

### Gates

Locate gates so they do not interfere with the natural movement of livestock as they travel to and from the barn, water, shade or handling facilities. Generally, gates should be located in the corner of the paddock that is closest to the direction the livestock need to travel. If not, although some of the livestock will find their way out of the paddock, some animals will end up trapped in a corner without a gate trying to figure out how to tear the fence down.

### Lanes

Lanes should be constructed so that livestock can be easily moved from paddock to paddock, to the water supply and to the handling facility or barn. Locate lanes on a contour where little change in elevation is necessary along the route. This will help prevent gullies from forming along the animal traffic lanes. It is important to make lanes wide enough to spread the animal traffic out and to get hay-making or other machinery through, but not so wide that valuable grazing land is

wasted. A width of 16 to 24 feet for lanes is usually sufficient. In heavy traveled areas, geotextile material anchored to the ground and covered with crushed stone, concrete or other materials may have to be used to prevent livestock from turning the lane into a mud hole. Being able to get livestock to the pasture is as important as producing the forage in the pasture.

## Installation

### Wire

The fine wires used in polywires and polytapes have a high resistance to current flow. Even large powerful chargers can't pump enough energy through the wires for very long distances. For this reason, the maximum effective distance you can charge a 6-strand polywire is about 1/2 mile from the charger. You can power up to a mile of polywire by placing the charger in the middle of the fence and going 1/2 mile in each direction. It is best to run a single, electrified-strand of barbed wire or high-tensile wire along the perimeter of the pasture and run the temporary wire off this feeder wire when subdividing large pastures. Do not use standard polywire or polytape as a feeder wire because it won't carry a sufficient charge. Never put two chargers on the same fence.

Generally, only one strand of polywire is needed for cattle and horses (sheep may need two or three strands). The wire should be installed 30-32 inches off the ground. This spacing may not hold calves effectively; however, it won't upset the cows as long as the calves are within sight. It may actually prove to be a benefit since calves can graze on the fresh forage in front of the cows.

Be careful not to overstretch the wire. If it is overstretched, the metal filaments will break and short the wire. Depending on the terrain, posts can be up to 100 feet apart.

### Grounding Electric Fences

A majority of electric fence problems are the result of poor grounding. For an animal to receive a shock, it must complete a circuit. With temporary electric fences, this circuit consists of one "hot" wire and a soil ground return. The charger condenses electricity to generate a high-voltage pulse. From there, it travels through the wire, through the animal, to the soil back to a ground rod and then up the ground rod back to the charger. That is when the animal feels the shock.

The grounding system for an electric fence is a little like a radio antenna. With a radio, the bigger the antenna, the better the reception. Likewise, your electric fence charger requires a good grounding system to collect enough electrons from

the soil to complete a powerful circuit and produce the shock felt by the animal. The shock felt by the animal from a poorly grounded system in most cases will be inadequate to keep the animal from walking through the fence.

The first step in establishing a good grounding system is to check the manufacturer's recommendations. Most manufacturer's recommend a minimum of three, 6-foot long galvanized ground rods to properly ground their electric fence chargers. More powerful units may require up to eight or 10 rods. They should be driven 5 1/2 feet into the soil and spaced a minimum of 10 feet apart (Figure 2). Locate ground rods so they are:

- highly visible,
- near permanent moisture,
- not likely to be damaged from or cause injury to livestock,
- do not interfere with mowing or cultivation.

Where rocks prevent driving rods, bury a long (20+ feet) galvanized pipe in a trench as deep as possible for a grounding system.

Connect the charger to the ground rods with an insulated cable or 12 1/2-gauge galvanized wire. Use one continuous wire and firmly attach the wire to each rod with ground rod clamps. Simply wrapping a wire around the ground rod makes a poor connection. Do not install your grounding system within 50 feet of any utility company ground rods, telephone ground rods or any underground telephone and power lines to reduce the chance of lightning damaging your charger.

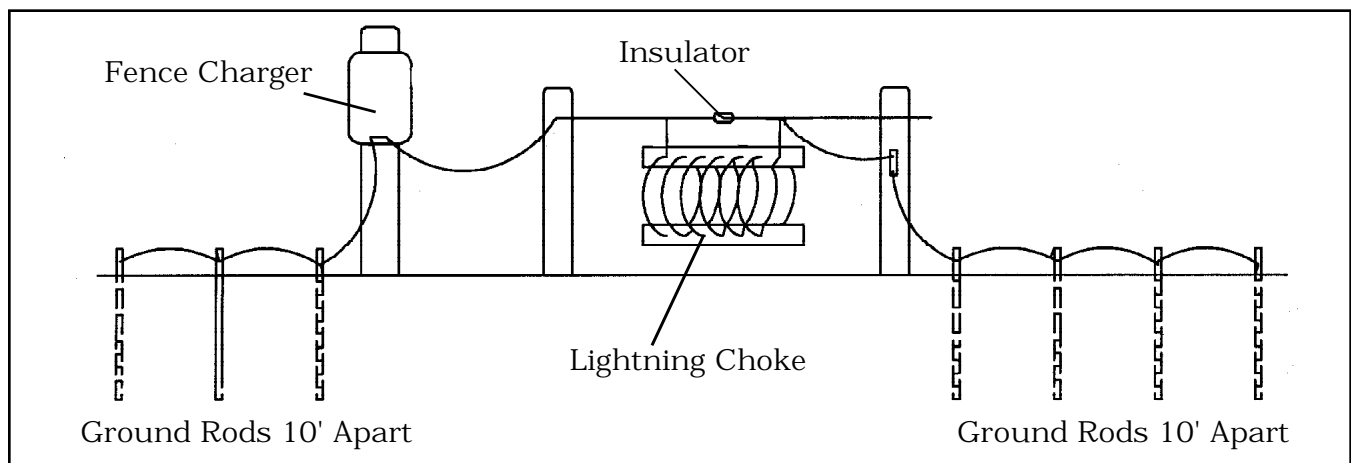
### Testing the Effectiveness of Your Grounding System

You can test the adequacy of your current grounding system using a voltmeter and the following procedure:

1. Lean several metal "t" posts against a hot fence wire and the soil about 100 yards from the ground rods to simulate heavy vegetative growth. Use enough metal post so that your voltmeter shows less than 1,000 volts in the hot wire.
2. Connect one lead from your voltmeter onto the ground rod furthest from the charger.
3. Make a firm connection with the other voltmeter lead to the soil (it may help to push a stiff wire several inches into the ground and connect the voltmeter lead to the end of this wire).
4. If the voltmeter reads more than 500 volts, then you may have the following problems:
  - Not enough ground rods (this is the most common problem),
  - Ground rods too close together,
  - Poor connections between ground rods.

### Lightning Protection

Electric fence chargers are easily damaged by lightning strikes. Whenever possible, disconnect the charger from the power source and the fence during a thunderstorm. If this is not always possible, a few precautionary measures can be used to help prevent or lessen the damage caused by lightning strikes. If you are using an AC charger, the cheapest and probably the most effective measure to prevent damage caused by lightning is to plug your charger into a surge protector. Manufacturers have been reporting for several years that most of the damage to AC chargers is caused by the tremendous power surge coming through the power line and not through the fence wire itself. Having a surge protector between the AC power source and your charger in all likelihood will totally prevent or at least lessen the damage to your charger from lightning.



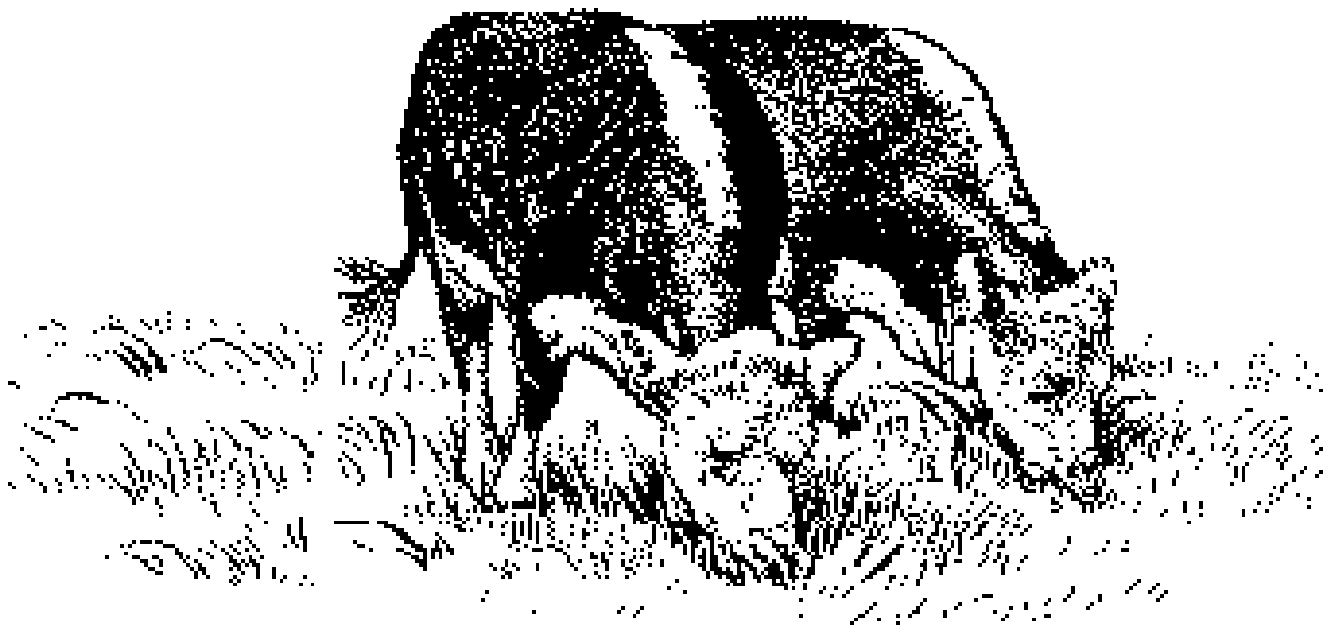
**Figure 2. Grounding Procedures for Electric Fence Chargers**

Lightning arrester and choke assemblies (Figure 2) offer some protection from lightning coming in on the fence wire. Lightning is always looking for the easiest path to ground. For this system to offer the most protection, the grounding system of the lightning arrester and choke assembly must be better than the grounding system for your charger. In other words, if your charger is connected to three ground rods, your lightning protection system must be connected to a minimum of four ground rods if you want the maximum protection available from this system.

## **Training Livestock to Electric Fences**

Livestock should be trained to respect electrified temporary fences. Because livestock are curious by nature, keeping the training area small will reduce the time it takes animals to discover the fence on their own. It will also minimize the time needed to gather and return the animals that get out during training and reduce the time

required to build and mend the training fence. Livestock generally do not know how to react the first time they are shocked. Some back up, while others bolt ahead and go through the fence. When they investigate the fence the second time, they are usually prepared to back up. Most livestock, if sufficiently shocked, will not challenge an electric fence a third time unless forced to do so. If an individual animal continues to challenge the fence, cull the animal.



# *a U.T. Extension Reminder...*

Rectangle Acres	Length of Field (ft)	Width of Field (ft)	Length of Fence Required
1	264	165	858
1	330	132	924
1 1/4	330	165	990
2 1/2	660	165	1650
4	528	330	1716
5	660	330	1980
6	990	264	2508
7	1320	231	3102
8	1320	264	3168
9	1320	297	3234
10	825	528	2706
15	1320	495	3630
20	1650	528	4356
25	1320	825	4290
30	1320	990	4620
40	1650	1056	5412
50	1650	1320	5940
60	1980	1320	6600
70	2640	1155	7590
80	2112	1650	7524
100	2640	1650	8580
120	3168	1650	9636
140	4620	1320	11880
160	5280	1320	13200
320	6600	2112	17424
640	6600	4224	21648

Square Acres	Length of Side of Square		Length of Fence Required	
	Feet	Inches	Feet	Inches
1	208	9	835	-
2	295	2	1180	8
2 1/2	330	-	1320	-
3	361	6	1446	-
4	417	5	1669	8
5	466	8	1866	8
6	511	3	2045	-
7	552	2	2208	8
8	590	4	2361	4
9	626	2	2504	8
10	660	-	2640	-
20	933	5	3733	8
25	1043	7	4174	4
30	1143	2	4572	8
40	1320	-	5280	-
50	1475	10	5903	4
60	1616	8	6466	8
70	1746	2	6984	8
75	1807	6	7230	-
80	1866	9	7467	-
100	2087	1	8348	4
120	2286	4	9145	4
140	2469	6	9878	-
160	2640	-	10560	-
320	3733	7	14934	4
640	5280	-	21120	-

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