

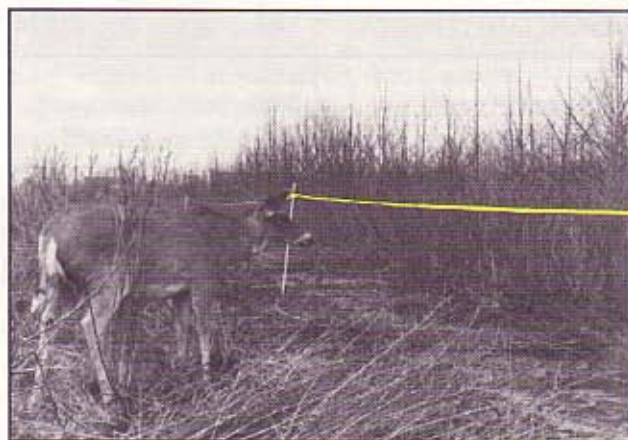
forestry & natural resources

WOODLAND MANAGEMENT

Electric Fences for Preventing Browse Damage by White-tailed Deer

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The white-tailed deer is an abundant species throughout rural Indiana. Some farmers, tree planters, Christmas tree growers, gardeners, and orchardists in the state are likely to continue to experience losses from deer in Indiana. There have been many proposed methods to reduce deer damage. Hunting helps to control the population,



Example of Visible Polytape Fence



Rabbit (R) vs. deer (L) damage on twigs

but may not provide adequate protection in some areas. Deer repellents are prohibitively expensive and time consuming for row and other large acreage crops, and require repeated applications. Electric deer fencing has often been recommended to control deer damage in a relatively inexpensive manner. Such fences, some consisting of a single strand, are designed to present a psychological barrier, rather than a physical one.

Deer can occasionally jump over 8- to 10-foot woven wire fences. Even if these fences were effective, they are extremely expensive and difficult to install. Some fences, therefore, have been designed to attract the animal's attention and actually encourage deer to touch the fence and receive a strong but relatively harmless electrical shock (high voltage/low amperage). In this manner, and similar to the strategy behind many farm stock fences, deer are conditioned to avoid the fence and the food source that lies beyond it.

Is an Electric Fence Necessary?

First, it should be determined whether the damage on crops, orchards, or seedling/ tree stands is serious enough to warrant the costs and time associated with installing an electric fence. To begin, a landowner should make certain that deer damage exists, and if so, to what extent. Deer damage is more likely if the crop is located along the border of a swampy, brushy, or forested area. This type of setting is ideal for deer, because the cover provides for the deers' shelter while the crop supplies food right next door. Inspect the borders or edges of a crop, especially along forested edges, to determine if deer have become a problem. Damage from deer differs from that of other mammals (such as rabbits) on the buds, twigs, and foliage of woody plants. If

Figure 1. Fence Effectiveness.

A comparison of the percent of red oak seedlings browsed on test plots with no fencing, peanut-butter, polytape, and multi-strand high tensile fences conducted at the Southern Indiana Purdue Agricultural Center in Dubois County during the 1990-1991 growing seasons.

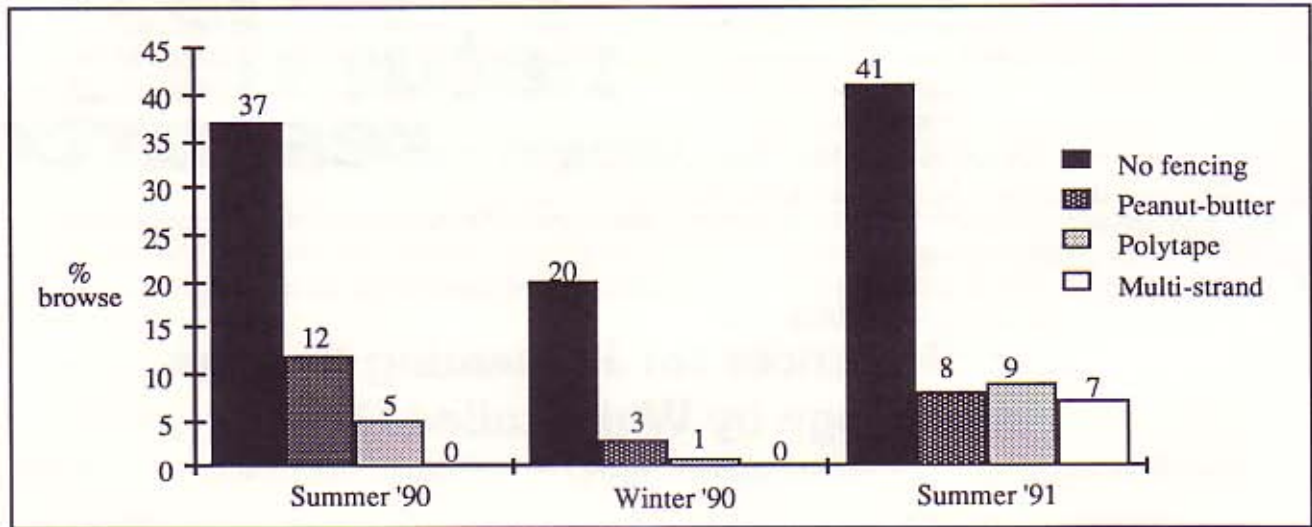


Table 1. Comparison of Fence Alternatives.

Fence type	Peanut-butter	Polytape	Multi-strand high tensile
Effective-ness	Most effective on small to medium acreages (< or =40 acres) Deer pressure: Light to moderate	Most effective on small to medium acreages (< or =40 acres) Deer pressure: Light to moderate	Suited for large truck farms, nurseries, orchards, or high-value crops Deer pressure: Moderate to high
Initial Cost	\$365 establishment cost* \$0.09 per linear foot** \$0.09 /linear ft./yr.***	\$365 establishment cost* \$0.11 per linear foot**	\$882 establishment cost* \$0.31 per linear foot**
Manpower	Easy to construct Materials readily available Periodic maintenance required	Easy to construct Materials readily available Low maintenance	Complicated installation Requires frequent inspection and maintenance
Potential drawbacks	Deer may accidentally knock it down Must rebait periodically May be grounded by vegetation and snow	May be grounded by vegetation and snow	Requires rigid corner assemblies due to high tension May be cost prohibitive

* Approximate cost of tools, initial materials, and labor

** Average cost of each additional linear foot of fencing (materials and labor included)

*** Average annual maintenance cost (materials and labor included)

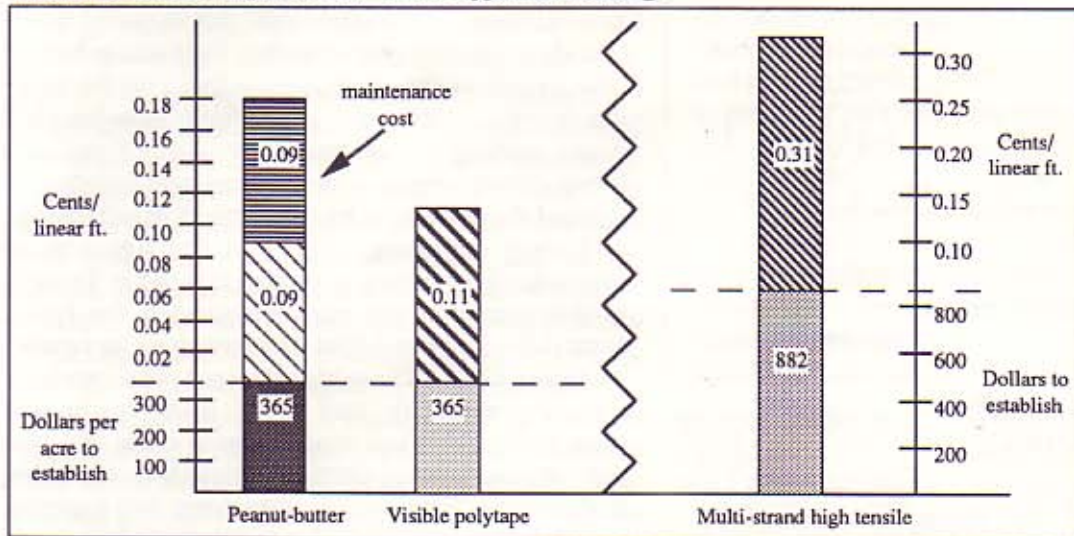
twigs appear as though they were cut cleanly at an angle, rabbit browse should be suspected. Since deer have no upper incisors to clip off a twig or leaf, any vegetation with ripped or ragged ends is likely to be due to deer browse.

The electric fencing systems described in this publication have been proven to be effective in reducing deer damage to grain crops and/or trees in Indiana, (Figure 1), the Lake States, and the Northeastern U.S. However, the first question a landowner needs to address is, "Will the protection provided by this system justify the cost?" Since every situation is unique, the answer

to this question will depend on: (1) the deer density in your immediate area, (2) the value of the crop being produced, (3) proximity of other food sources available to deer in this area, (4) proximity of the planting to cover for deer, (5) the palatability to deer of the crop being planted, (6) the level of loss being experienced, and (7) the producer's level of economic tolerance for deer damage.

Once the decision is made to construct some type of deer fence, the proper fencing system should be selected (Table 1). Consider the following points when choosing the proper fence for your situation.

Figure 2. Cost Comparison of Three Types of Fencing.



The peanut butter fence and polytape fence provide similar levels of protection from deer damage in areas where deer pressure is light to moderate, and will be the most practical choice in most situations in Indiana (Figure 1). The peanut-butter fence is initially less expensive to construct, but it requires daily or at least weekly inspection to insure it has not been knocked down by deer. In addition, rebaiting is required at least every 4 to 6 weeks. This fencing system is most practical when placed around gardens or areas that will be visited and inspected frequently. When fencing is required in remote locations or around larger areas, the polytape fencing system is probably more practical. Rebaiting is not required, and since deer can see it more readily and do not normally knock it down, inspections can be made when replacing the battery about every 4-6 weeks. Because of the lack of periodic maintenance cost and ease of installation, total cost for polytape deer fences are comparable to the peanut butter fence and may actually be cheaper in the long run (Figure 2).

The peanut-butter and polytape fences are not enclosures to deer but are psychological barriers. Deer will occasionally enter the fence area, and some damage may occur. In situations where heavy deer pressure exists (due to a locally high deer density, a highly palatable and preferred crops such as ornamental shrubs like euonymous or yew, and/or a shortage of natural foods in the surrounding area) or where no deer browsing can be tolerated, one of the high tensile fence designs may be appropriate. In Pennsylvania where deer browse pressure is very high, deer have been reported to penetrate the 5 strand and even closer spaced 7 strand vertical fence. In these situations, the slanted or offset high tensile fences may be considered.

Construction of Electric Fences

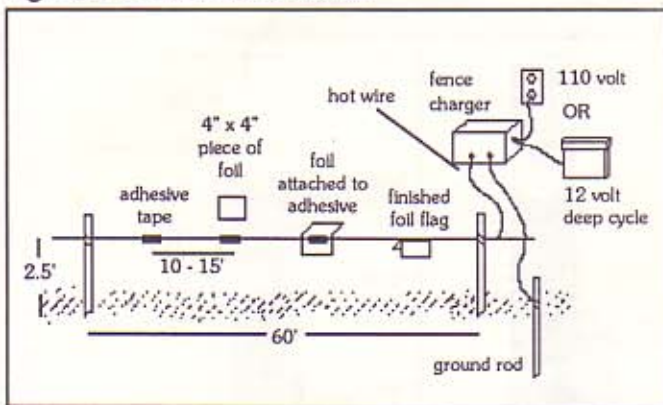
Any fencing system selected will have the following points in common. The greatest cost will be the required tools, and initial equipment (fence charger, batteries, corner posts, and installation costs) needed in all systems. If you already possess some of these items, your cost will be reduced.

An important component (and a large part of the cost) of an effective deer fence is the power source and the fence charger. In locations where 110-volt current is not available, a 12-volt deep cycle battery and a low-impedance "new-generation" charger are usually recommended for deer fences. Such chargers conserve battery life by resisting current drain from grounding weed vegetation growing under the fence. Thus, fences remain charged longer and more reliably, making for a more effective deer deterrent. It is important to use a deep cycle battery which is designed to be charged and drained frequently. The purchase of two batteries will allow for one to be in use while the second is charging.

The figures and tables that follow contain specific instructions, materials required, and costs of each fencing system. The cost of initial equipment needed for any fence, regardless of size, is listed first. Some of these items may already be on hand, thus reducing the overall fencing costs. An estimate is given for the cost per linear foot for each system. This will enable you to estimate the cost for your unique situation. Designing a fence in a way that reduces corners and perimeter will also reduce total cost.

"Peanut-butter" Fence

Figure 3. Peanut-butter Fence.



The "peanut-butter fence" is a baited fencing system developed in Minnesota in the late 1970's (Kinsey, 1976), and has been shown to be an inexpensive and effective deer fence under a number of field conditions. This type of fence system is most effective in small to medium sized areas (about 40 acres or less), with low to moderate deer pressure.

The system consists of a single strand of electrified #17 gauge wire, suspended about 30" above the ground by 4-foot fiberglass rods at 60-foot intervals (Figure 3). Heavy gauge aluminum foil "flags" (4" x 4" foil squares folded over the wire) are attached to the wire at approximately 10-15 foot intervals using double-sided adhesive, electrical, or carpet tape. The underside of these flags and the wire are then baited

with peanut butter, encouraging nose-to-fence contact by deer. Problems with this type of fence include replacing wind-torn foil flags and rebaiting every 4 to 6 weeks. Also, deer sometimes fail to see the fence at night and will occasionally knock it down, adding to maintenance costs and reducing fence effectiveness. Snow cover and weeds that contact the fence can also reduce its effectiveness.

Though expenses may vary among suppliers, an example of necessary expenses is listed in Table 2. In this example, the cost to establish the fence, regardless of the amount of acreage to be fenced, is around \$365. The additional cost per linear foot, including materials and labor, is approximately nine cents. Annual maintenance costs are also estimated to be nine cents per linear foot, assuming that maintenance is conducted every 4 to 6 weeks.

Several studies have been conducted to determine the effectiveness of peanut-butter fences. It was found to reduce deer browse damage on apple seedlings in New York (Porter, 1983), where growth on protected seedling plots was double that on control plots. It also reduced damage on corn plots in Wisconsin (Hygnstrom and Craven, 1988). This type of fence reduced browse from 41% of red oak seedlings in control plots to 8% of seedlings on fenced plots in Indiana (Figure 1).

Table 2. Peanut-butter fence costs (estimated in 1991\$).

Initial startup costs	
Tools (tester, steel "T" post driver, battery charger)	(71.00) (255.00)
Materials (gate handle, low impedance charger, deep cycle battery, charger & battery box, lightning protector)	(25.00)
Labor (approx. 2.5 hours for installation)	
4 corners (materials [T post, insulator], and labor [3 min. to establish each])	<u>(13.60)</u> 364.60
Total startup costs	
Additional cost per linear foot	
Materials (wire, insulators, rods, foil, tape, peanut butter)	(0.05)
Labor (1/4 hours for installation of 1 line post and materials)	<u>(0.04)</u> 0.09
Total cost per linear foot	
Annual maintenance per linear foot	(0.01)
Materials (peanut butter, foil, tape)	
Labor (0.5 hours per 60' section [assumes maintenance every 4-6 weeks])	<u>(0.08)</u> 0.09
Total maintenance costs per year	
Grand total (assuming 4 corners)	
\$365 + \$0.09/linear ft./yr.	

To Build a Peanut-Butter Fence:

1. Identify and clear the fence line of vegetation. It is best to clear and maintain at least 10 feet of open space on the outside of the fence for greater visibility to the deer. Minimize corners to increase strength and reduce costs.
2. Establish electricity on the site and install the energizer and grounding system.
3. Install wooden or steel T posts as corner posts.
4. String one strand of wire around the posts (30" high), applying light tension.
5. Set 4-foot fiberglass rods (or steel posts with insulators) along the wire at 60-foot intervals.
6. Attach the wire to insulators on the rods at 2.5 feet above the ground and apply about 50 pounds of tension.
7. Attach a 4x4" foil strip approximately every 20 feet with double-sided adhesive, electrical, or carpet tape.
8. Apply peanut butter (or a 1:1 mixture of peanut butter and vegetable oil for better spreadability) to the underside of the foil and fold the foil over the tape.
9. Connect the wire to the positive (+) post of a well-grounded fence charger. Test the entire length for adequate voltage.
10. Check the fence weekly for damage and grounding by vegetation.

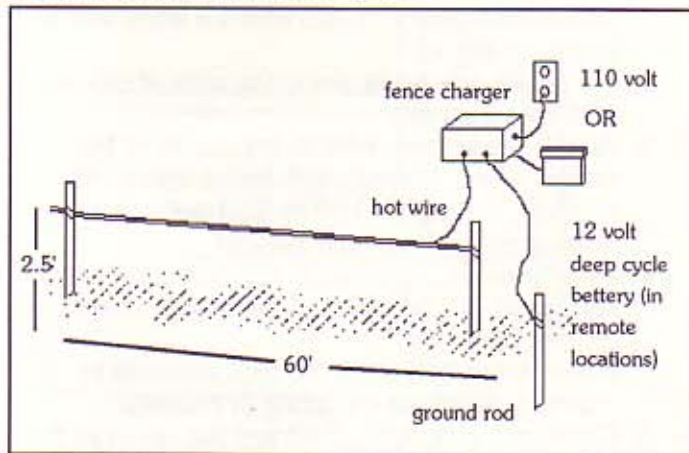
Like the peanut-butter fence, the visible polytape is effective for small to medium size areas (about 40 acres or smaller), with low to moderate deer pressure. This fence system consists of an electrified single strand of brightly colored polytape suspended about 30" above the ground in the same manner as the peanut-butter fence (Figure 4). This material is a unique blend of strong plastic fibers with interwoven strands of stainless steel wire. The plastic carries the tension and the wires carry the electric current. Out of curiosity, deer are apparently attracted to the strand of bright yellow or orange plastic. They make contact while investigating it, and learn to stay away. Peanut butter can also be applied directly to the tape to increase its attractiveness to the deer. Because of its high visibility, deer can see this fence even at night, and do not render it ineffective by temporarily breaking it down, as

can happen with the peanut-butter fence. An additional advantage of a polytape deer fence is that it does not have to be baited. Because of the lack of periodic maintenance costs and ease of installation, total costs for polytape deer fences are comparable to those given previously for the peanut-butter fence example (Table 3).

There are a number of polytape products on the market which may be available at your local farm supply dealer. The major differences between products are the material the conductive filament is made of, the number of strands of filament, how tightly filaments are woven, and the polytape color. Copper and aluminum filaments are better conductors, but can become brittle over time. Stainless steel filaments are now the most common type in use because they do not work harden. However, steel requires more strands for the same level of conductivity per tape. Because it is important for the deer to see the fence, yellow or white polytape should be selected for the highest possible contrast with background vegetation.

The Wisconsin study measuring fence effectiveness (Hynstrom and Craven, 1988) found that polytape fences were effective in protecting crops from deer browse. Similarly, results indicate that polytape fences are effective in reducing deer browse damage to red oak seedlings in Indiana (Figure 1).

Figure 4. Visible Polytape Fence.



To Build a Polytape Fence:

1. Identify and clear the fence line of vegetation. It is best to clear and maintain at least 10 feet of open space on the outside of the fence for greater visibility to the deer. Minimize corners to increase strength and reduce costs.
2. Drive fiberglass or steel (with insulators) "T" posts 2 feet into the ground at the corners.
3. Use square knots or half-hitches to make splices or to secure the polytape to corner posts.
4. Set 4-foot fiberglass or steel (with insulators) rods along the wires at 60-foot intervals.
5. Attach the strand of polytape line to insulators on the rods 2.5 feet above ground level and apply 50 pounds of tension.
6. Connect the polytape to the positive (+) post of a well-grounded fence charger. Test the length of fence for adequate voltage.
7. Check the fence weekly for damage and grounding by vegetation.

Table 3. Visible polytape fence costs (estimated in 1991\$).

Initial startup costs	
Tools ("T" post driver, pocket knife, battery charger, tester)	(71.00)
Materials (gate handle, low impedance charger, deep cycle battery, charger and battery box, lightning protector)	(255.00)
Labor (approx. 2.5 hours for installation)	(25.00)
4 corners (materials [T post, insulator], and labor [3 min. to establish each])	<u>(13.60)</u>
Total startup costs	364.60
Additional cost per linear foot	
Materials (polytape, insulator, rods)	(0.09)
Labor (5 min. for installation of 1 line post and materials)	<u>(0.02)</u>
Total cost per linear foot	0.11
Grand total (assuming 4 corners)	\$365+\$0.11/linear ft.

Multi-strand High Tensile Electric Fence

High tensile fences are more sturdy and effective, but also have a high initial cost (Table 4) and require rigid corner assemblies. This type of fence is probably only cost effective for protecting orchards or other high value crops from moderate to high deer pressure. It is constructed with five to seven strands of smooth, 12.5 gauge high tensile wire spaced eight to twelve inches apart on rigid brace assemblies installed at corners, gates and ends of the fence (Andelt et al., 1986) (Figure 5). Spacing between wires may be varied to accommodate heavier deer pressure. This can be accomplished by adding additional wires and tightening the bottom two spaces to 8" and the next two spaces to a minimum of 10", with 12" spaces thereafter. This wire configuration entices the deer to step between the wires. Alternating wires are charged, thus giving the deer an effective shock. Eight foot wooden or fiberglass line posts are placed along the set of wires at 60 to 100 foot intervals, and fiberglass battens of the same height

can be placed at 30 foot intervals to maintain wire spacing. Though this type of fence is sturdy, it requires frequent checks for damage or tension loss. In the example provided in Table 4, the initial cost to establish this type of fence is approximately \$880, plus an estimated additional cost of 31 cents per linear foot (including labor and materials). These costs may vary among suppliers. Your supplier can provide information on required components and detailed instructions for assembly.

Generalized steps for building a multi-strand vertical fence:

1. Identify and clear fence lines. It is best to clear and maintain a 6 to 12 foot open area outside the fence for greater visibility to the deer. Attempt to minimize the number of corners and gates needed.
2. Establish electricity on the site by installing the energizer and grounding system.
3. Install the rigid corner assemblies at corners, gate openings, and points where a fence section begins or ends.
4. Set 8-foot line posts along the wire at 60- to 100-foot intervals.
5. Attach the bottom wire to insulators at 10 inches above ground level, install springs (if needed), and apply 150 to 250 pounds of tension using the in-line strainer.
6. Attach remaining wires to insulators and install springs at 22, 34, 46 and 58 inches above ground level.
7. Place 5-foot battens at 30-foot intervals to maintain fence wire spacing (if needed).
8. Connect the bottom, third and top wires to the positive (+) post of a well-grounded, low-impedance fence charger.
9. Connect the second and fourth wires from the top directly to the ground rod.

Table 4. Multi-strand vertical fence costs (estimated in 1991\$)

<u>Establishment costs</u>	
Tools (tester, strainer handle, crimping tool, battery charger, spinning jenny, fence pliers, high tensile wire cutter)	(190.00)
Materials (strainers, tension springs, low impedance charger, deep cycle battery, box for charger and battery, lightning protector, splicing sleeves)	(300.00)
Labor (approx. 4 hours for installation)	(352.00)
4 corners (materials [posts, wire, and insulators], labor [5 hours for each corner])	882.00
Total establishment costs	(0.18)
<u>Additional cost per linear foot</u>	
Materials (wire, insulators, post, battens)	(0.13)
Labor (2.5 hours for installation of 2 line posts and materials between them)	0.31
Total cost per linear foot	
Grand total (assuming 4 corners) \$882+\$0.31/linear ft.	

Figure 5. Multi-strand high tensile fence.

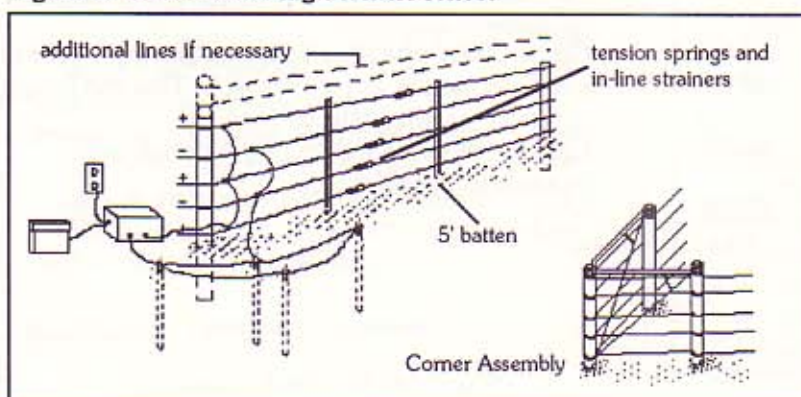


Figure 6. Slanted seven-wire fence.

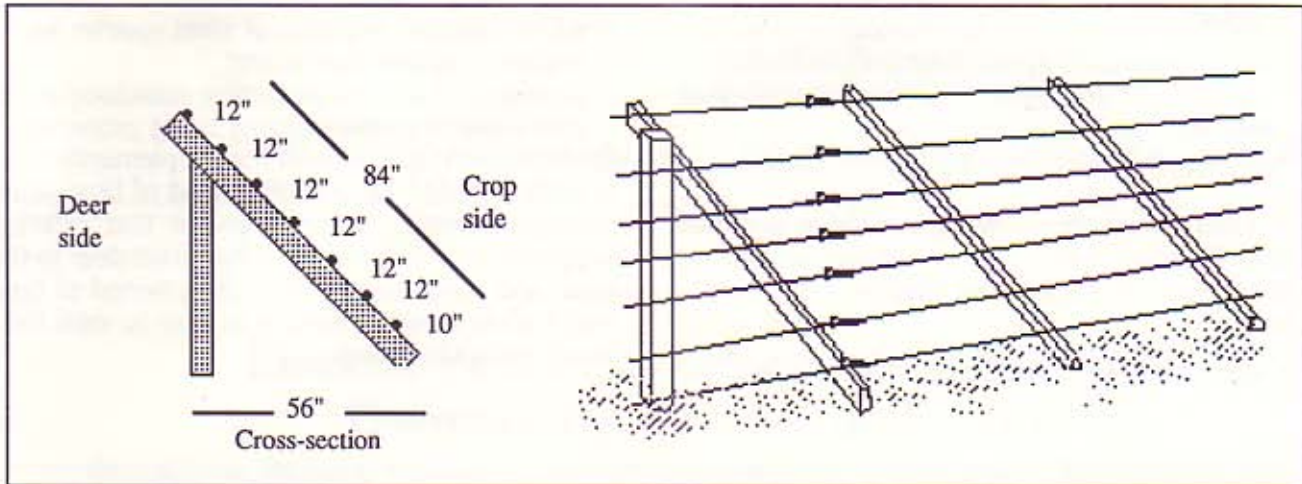
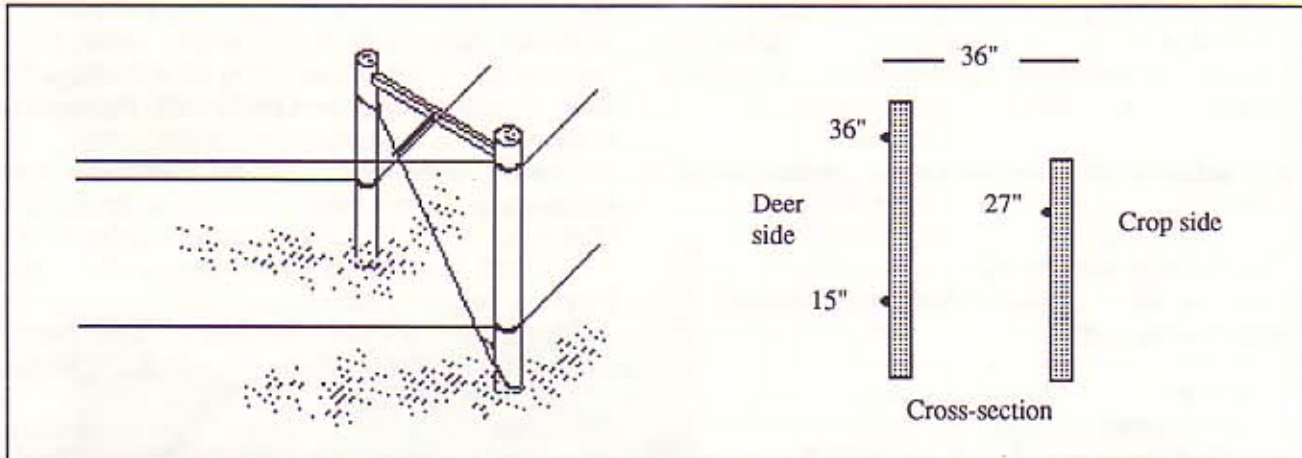


Figure 7. New Hampshire three-wire offset fence.



Other High Tensile Fences

High tensile fence systems have been developed that take advantage of a deer's limited ability to judge three-dimensional barriers. One example of these systems is the slanted seven-wire fence developed by Cary Arboretum in Millbrook, NY (McAninch et al., 1983)(Figure 6). It resembles the vertical fence, but it is slanted to a thirty to forty-five degree angle. Another, less expensive fence of this type is the New Hampshire three-wire fence (Craven and Hygnstrom, 1986) that consists of two sets of fence lines set 36" apart (Figure 7). The outer fence line holds two wires at 12-15 inches and 36-43 inches from the ground, while the inner fence has one line at 25-30 inches from the ground. Additional lines can be added to both fence lines for increased effectiveness.

General Recommendations

- Establish fence and charge it before planting any crop.
- Use fiberglass or treated wood posts.
- Get lightning arrestors to protect chargers.
- Purchase fence chargers of high quality which are approved by Underwriters Laboratories (UL).
- Gates should be electrified and well-insulated. Depending on the type of fence installed, gates can range from a single strand of electrified wire with gate handles to electrified panels.
- Electric fences should not be installed along fencerows or old fences that deer can jump. At least ten feet should be clear of brush or other obstacles on the outside of the fence, so that the deer are walking when they encounter the electric fence.
- Install the grounding systems and fence charger before constructing the fence. While the fence is not being worked on, energize completed parts to begin protecting the area.

- Wires should slide freely through insulators on the fence posts. The fence needs to be flexible to resist deer hits and accommodate expansion and contraction during temperature changes.
- Attach warning signs to the fence at 300-foot intervals or less.
- Keep the fence charger on continuously.

Deer fences should be considered as one available tool used to reduce deer browse damage on a crop. Fencing will be most effective when coupled with:

- legal hunting to reduce local population densities,

- habitat modification to reduce the attractiveness of the area to deer,
- when possible, selection of plant species less preferred as deer foods, and
- provision of a more preferable deer food in an area away from the planting being protected.

Providing food may work if the supplemental food is **only** supplied for a short period of time when damage is most likely (be aware that offering supplemental food may actually attract deer to the area, and supplying it over a long period of time might allow a higher density of deer to exist than would naturally occur).

Suppliers

Most of these materials are readily available and may be obtained from contacting your local farm supply dealer.

For additional information or professional advice:

County Extension Agent
(See your local telephone directory to contact your county agent)

IDNR Division of Fish and Wildlife,
District Wildlife Biologist
402 W. Washington St., Room W273
Indianapolis, IN 46204
(317)232-4080

USDA-APHIS Animal Damage Control
Entomology Hall, Room B14
West Lafayette, IN 47907-1158
(317)494-6229

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Craven, Scott and Scott Hygnstrom. 1986. Controlling Deer Damage in Wisconsin (G3083). University of Wisconsin-Extension, Madison, WI.

"Fences that Keep Deer Out." Progressive Farmer. August 1983.

Hygnstrom, Scott and Bill Baxter. Deer Damage Control in Nebraska (EC 91-1773). Nebraska Cooperative Extension.

Kinsey, C. 1976. Tests of Two Deer Barrier Forms. Minnesota Wildl. Res. Q. 36(3):122-138.

McAninch, Jay B., Mark R. Ellingwood, and Raymond J. Winchcombe. 1983. Deer Damage control in New York Agriculture. New York State Department of Agriculture and Markets, Albany, NY 12235.

Suggested publications

IDNR Management Series No. 10. Controlling Nuisance Game Mammals.

IDNR Management Series No. 19. Deer Damage Control.

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