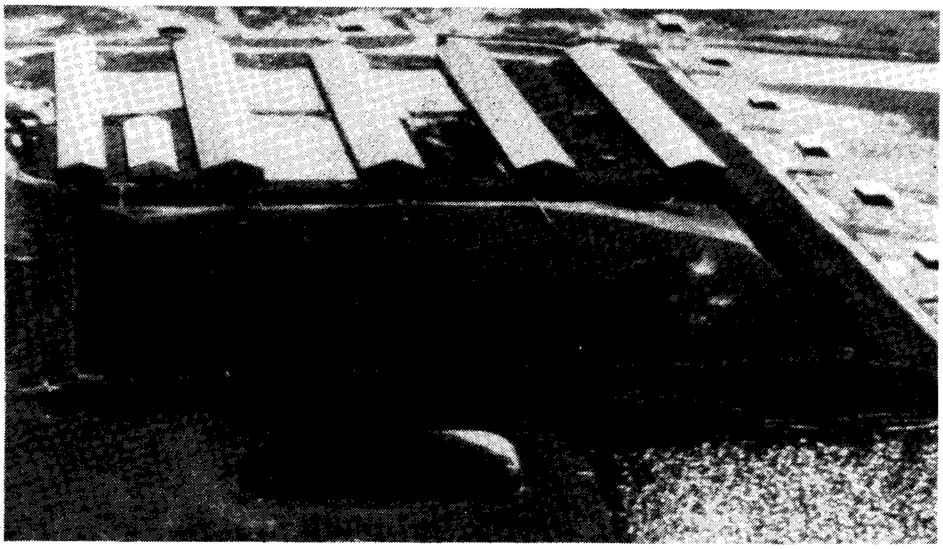
Inside Agroforestry

National Agroforestry Center

Summer, 1996



Lagoons collect waste from livestock facilities like this poultry house. Waste is then pumped and spread onto fields for fertilizer.

Are Trees the Answer?

by Jim Robinson, Agroforester
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When old McDonald had a farm, eeeei-iiii, eeeeiiiii-o. He had a few chickens here, some pigs over there and a few good old cows too. The pastures were green, the air was clear and the water was clean. While this idyllic picture may be a romantic myth it is true that small farms of the past typically did not confine live-stock in large numbers, so the waste pro-duced could be easily utilized on the farm acreage.

To take advantage of economies of scale, efficient use of management, labor and marketing, large confinement sys-tems are becoming the standard in today's agriculture. Large operations such as live-stock feedlots confining 10,000 or more beef animals, confinement dairy opera-tions with 500 animals or more, poultry operations with 80,000 birds in confine-ment houses, and grower pigs of 5,000 animals or more are becoming common place in the agricultural environment.

Instead of randomly distributing their manure on range or pasture, confinement animals deposit all the manure at one central spot. This creates a mountain of manure to be manually redistributed on fields in a manner that the plants utilize the nutrients without creating pollution of our surface or ground water. For many managers animal waste utilization is becoming one of their primary manage-ment concerns.

Typically animal waste has been applied on cropland and pastureland adja-cent to the confinement operations. As the readily available acreage becomes fully utilized, alternative lands are being looked at for possible land application areas. New systems, such as an agroforestry system, that will allow us to safely increase load-ing rates and nutrient utilization, need to be looked at.

(See Answer on page 6)

Trees for Livestock

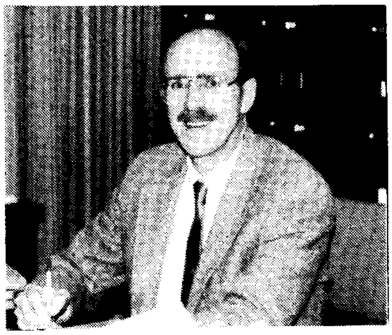
Windbreaks play an important role in the protection of livestock, particularly for young animals and in areas with cold northerly winds during the winter and early spring. By reducing wind velocity and the effects of cold temperatures, live-stock windbreaks can significantly reduce stress on animals, improve their health, and reduce feed energy requirements. This results in better animal health, lower animal mortality, lower feed costs, and increased livestock profits. Windbreaks can also reduce the effects of heat stress to animals during hot, dry summer months.

Properly placed windbreaks can pro-vide benefits to feedlots, livestock pas-tures, calving areas, and forage produc-tion areas. Livestock windbreaks also provide wildlife habitat, protect the work-ing environment in and around the live-stock area, and help to screen noise and odors associated with livestock opera-tions.

When planning and designing a wind-break, special attention needs to be given to access, snow storage, and drainage. Each windbreak should be designed to meet the particular livestock operation. A well-thought-out and properly-cared-for windbreak protects livestock in both the winter and summer and will provide eco-nomic benefits to the landowner over the long term. The time spent on layout, site preparation, weed control, and replanting is paid back many times throughout the life of a windbreak.

(See Livestock on page 2)

Inside This Issue



Message From the Manager

A commentary on the status of agroforestry
as reported by Program Manager, Bill Rietveld

"Working Trees" for Livestock

How can trees add value to grazing systems? That's a key question we are addressing as we develop concepts for agroforestry in the United States. The situation is basically the same as for cropping systems: strategically adding trees to the system can help maintain the health of the system, increase productivity, and provide other desired benefits. Agroforestry accomplishes this through the establishment of integrated tree/livestock systems and the application of "working tree" practices.

"Silvopastoral systems" combine trees with forage and livestock in integrated systems that utilize space, growing season, and growth factors more efficiently. For example, many cool season grasses and legumes are just as productive in partial shade as they are in full sun, and in some cases the forage is higher quality than that produced in full sun. The trees also reduce livestock stress from heat and cold. The result is increased, diversified, and stable production, while maintaining environmental protection.

Working tree practices are not integrated systems, but help to solve problems, save money, or make life easier in grazing systems. For example, "outdoor living barns" are tree plantings to provide shelter for livestock during severe weather and vulnerable times such as calving. "Living snowfences" keep drifting snow off roads, or capture snow to fill livestock ponds. "Livestock habitat plantings" or riparian zone restoration projects provide habitat for wildlife and provide buffer zones to filter runoff water from storms.

Not all tree/livestock systems are agroforestry. We are often asked whether forest grazing is agroforestry. The answer is no if it is passive grazing; yes if it meets the following criteria: it must be intentional, integrated, intensive, and utilize the interactions that result -- the four "I's." Agroforestry systems are deliberately established, integrate trees with crops and/or livestock, are intensively managed, and utilize the interactions that result to optimize yields of multiple products. The system design and mix of products are tailored to the landowner's objectives.

To develop appropriate technologies and provide relevant information on trees in grazing systems, the National Agroforestry Center is teaming up with the NRCS Grazing Lands Technology Institute to develop a "Working Trees for Livestock" technology transfer and applications effort. We will seek to work with stakeholders and cooperators to develop and provide useful information, establish developmental projects to fill information gaps, and develop applications tools. The effort will focus on "the right tree/shrub in the right place for the right purpose," and evaluate the benefits to be realized from integrated systems and working tree practices that help maintain the health, productivity, and sustainability of grazing systems.

(Livestock from page 1)

Livestock need protection because as temperatures fall below certain critical zones they must increase their intake of feed in order to get the energy needed to maintain body temperature. If the needed additional energy cannot be obtained, sickness or death can result. (See Table 1)

The effects of wind and cold on livestock can be significant. For example, cattle on winter range require a 50 percent increase in feed energy for normal activities. An additional 20 percent increase in feed energy is needed to overcome the added effects of exposure to combined cold temperatures and wind. Studies in Montana indicate that during mild winters, beef cattle sheltered by windbreaks gained an average of 34 to 35 pounds more than cattle in an open feedlot. During severe winters, cattle in feedlots protected from the wind, maintained 10.6 more pounds than cattle in unprotected lots.

Sheep, however, are more naturally adapted to cold climates. During severe blizzards in areas with little natural cover, windbreaks provide valuable protection for the flock. Newborn lambs are especially vulnerable to cold temperatures and suffer significant mortality rates under cold, windy conditions. Providing wind protection can significantly reduce these losses.

Swine are also poorly adapted to deal with extreme cold or heat. When raised in open confinement in northern areas they are subject to serious temperature stress. Windbreak protection provides significant benefits to producers in the form of reduced feed requirements, increased weight gain, and improved animal health.

Table 1

Coat description	Critical Temperature
Summer coat or wet	59 degrees F
Fall coat	45 degrees F
Winter coat	32 degrees F
Heavy winter coat	18 degrees F

Critical Temperatures for Beef or Dairy Cattle are determined in part by the condition of the coat. Below the critical temperature, livestock must expend more energy in order to keep warm.

Furthermore, when hogs are raised in confinement buildings with controlled temperatures, windbreaks reduce the amount of energy necessary to heat the building.

Other types of livestock can also benefit from shelter. Milk production in Holstein and Jersey dairy cattle decline at

(See Livestock on page 7)

Development of Silvopastoral Systems in the Northern Temperate Zone

by Terry R. Clason, Forestry Project Leader
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Prior to European settlement, Native Americans managed the forest forage resource by burning twice a year. This practice created an understory habitat that produced an abundant supply of game. Europeans introduced domesticated livestock production to this fire mediated ecosystem. Unlike the Native American spiritual sense of stewardship, early European forage utilization bordered on exploitation rather than sustainability. In time, the need to conserve this valuable forage resource was recognized. Management practices that combined forest and livestock production were developed, spawning the science of forest range management.

The traditional forest range livestock production system relied on native forages growing on commercial forest land. The system required a large land base because timber management practices, burning and thinning, yielded a forage resource of low nutrient and energy content. Forage management practices that involved electric fencing, multi-pasture grazing and rotational burning increased forest range grazing capacity, but livestock feeding supplementation was still necessary when grazing native forages. Thus, native forage resources restrict commercial livestock production on forest range grazing management systems.

> *"Silvopastures are intensively managed timber, forage, and livestock interactions that simultaneously produce forest-related commodities and a high quality forage resource."*
>
> *—Terry Clason*

Lack of a dependable forage resource combined with a shrinking land base, increasing management costs, social awareness, and environmental constraints stimulated interest in growing non-native improved forage species under forest conditions. The deliberate integration of improved forage crops into a timber and livestock production system is called silvopastoral management. Silvopastures are intensively managed timber, forage, and livestock interactions that simultaneously produce forest-related commodities and a high quality forage resource. Forest-related commodities are any products or services derived from a multiple use forest management system. Since forest range is a component of multiple use forest management, silvopastoral forage management practices must provide a grazing resource that ensures livestock production continuity under a forest canopy. A successful silvopastoral system combines tree and forage crops that have compatible management requirements. In general, coniferous trees are better suited to silvopastoral systems than hardwood trees. They adapt to a variety of growing sites, grow faster, and have conical crowns that permit more light to reach the forest floor. The forage crop should be a perennial plant (warm or cool season), shade tolerant, responsive to intensive management practices, and thrive under heavy utilization.

Brahma crossbred stocker cattle grazing costal bermudagrass in a 22-year-old loblolly pine plantation.

Silvopastures can be developed in two ways: 1) planting an improved forage in a coniferous stand, or 2) planting conifers in a pasture. Improved forage crops can be established in any maturing coniferous stand regardless of age, species composition, or tree stocking density providing planting techniques include tree overstory reduction, hardwood brush removal, and seedbed preparation. In coniferous stands of a marketable size, tree stocking density can be reduced by commercially thinning to a residual density of 100 trees/acre or a maximum basal area of 60 ft^2/acre. Sapling age or younger stands should be precommercially thinned to 100 trees/acre. Depending on size and species composition, hardwood brush removal can be accomplished with either herbicides or heavy grazing pressure. Seedbed preparation procedure must include a prescribed burn in stands age 10 or older fol-

(See Silvopastoral on page 7)

Feedlot is "Paradise" for Nebraska Cattle

The cattle at "Paradise Feeders" near Stanton, Nebraska really do have it made, hence the name "Paradise" — and so does co-owner, Tom Feller.

In 1992 Feller was looking to build another feedyard when a parcel of land came up for sale which had already-established rows of trees planted on it. The trees were originally planted in the 1930's or 1940's to keep the sandy soils near the Elkhorn River valley, from blowing. Five one-row, red cedar windbreaks each 1/2 mile long, line the property that Feller purchased. And, it was here that Feller built "paradise."

Coupling his own experience with advice from local residents who had windbreaks of similar age, size, and type about snow drift and air movement, Feller constructed 10, eight to 10 acre pens that each hold about 300 cattle in between the windbreaks. Each pen is about 100 feet from the trees on both sides.

Feller contends that this setup is almost like a building. He says, "I have the benefits of an outdoor feeding area but the environment of a building." The cattle don't get cold when the cold northwesterly winds that inevitably hit Nebraska each winter blow. So he never has to worry about them, even in the worst of blizzards. Furthermore, because of his pre-planning, Feller has never had a problem with snow drifting into the lots. He says, "sometimes a little snow will get onto the alleys, but nowadays with payloaders it has never presented a problem for us to get the cattle fed.

Not only are the windbreaks a benefit to the cattle's environment but they help maintain, and sometimes increase, weight gain. Feller says "If we have a bad winter with lots of wind, I still get about three pounds of gain per day, whereas a normal feedlot without trees might only get 2.8 pounds of gain per day. And, that .2 difference on 100 days is 20 pounds. When you multiply 20 pounds by $.80 per pound that equals about $16.00 extra profit per head.

Now, you may be wondering what happens to the cattle during the summer months when there is little air movement in the pens because of the windbreaks. Well, the cattle move out and corn moves in! This year Feller says that he is going to have "one heck of a corn crop." He's heard that his trees equal half of the value of a pivot. This is because windbreaks reduce evaporation losses and improve a crops' water-use efficiency, increasing crop yields. The windbreaks also reduce damage to seedlings from wind-blown soil. Furthermore, the corn grows in a place that's rich in nutrients from the manure that the cattle have left behind. This is a definite plus in a place so sandy that it's normally hard to grow corn.

Feller believes that another benefit of the windbreaks is that as spring rolls around there is no ground cover and with sandy soils you would normally have to worry about blowing sand. But, because of the trees this isn't a problem either.

Of course, as with any operation there are a few problems, especially when you don't use a particular area full time. Number one is that Feller doesn't have all the equipment and permanancy of a normal feedlot setup. The other is that this year Feller will have to haul manure because of the buildup in some areas he will have. But, since this feedlot is located in a sandy-soil area where it's hard to grow corn, he has a lot of neighbors who are more than willing to take the extra manure.

Feller says, "The two systems really work well together. If I could find another set-up like this I would do it again." He is a believer in trees as he has already planted over 3,000 trees at another feedlot. He says that because of the work involved to get the trees started some of his hired men think he's crazy, but we know better!

Thank you Tom for your foresight and planning. It's landowners like you who serve as leaders for others.

Located near the Elkhorn River valley in Nebraska, "Paradise Feeders" is truly paradise for feedlot cattle.

Five, one-row windbreaks line Fellers property, making room for 10 lots that each hold about 300 cattle. In the summer, corn takes the place of cattle.

Diversification of Enterprises on Grazing Lands

by Dr. Larry D. Butler
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Cash income from grazing lands has traditionally been from the sale of livestock and livestock products. The owners of grazing lands are breaking with traditions and are considering the various opportunities for increasing profits and diversifying their enterprises on their grazing lands with alternative and supplemental enterprises and nontraditional uses.

The Natural Resources Conservation Service (NRCS) Grazing Lands Technology Institute (GLTI) is responsible for acquiring, developing, adapting, and transferring enterprise technology to the NRCS for field office use with land owners and managers. Dr. Larry D. Butler is the GLTI enterprise diversification specialist who devotes full-time to this responsibility.

The number and kind of enterprises for any land unit depends upon the resources available. Each land unit must be assessed to recognize its potential and enterprises must be tailored to the individual grazing land operation. The selection of an additional enterprise or significant change to an existing enterprise should be done following an inventory of existing conditions and resources and after an evaluation of the effects the enterprise will have on the resources and the total grazing land operation.

Grazing land owners have numerous reasons to diversify their enterprises, among them are:

- Current enterprise is not making an acceptable profit
- Desire to increase income
- Financial risk can be reduced
- Increase or better distribute cash flow
- Utilize available resources: such as labor, facilities, and natural resources
- Change operations because of regulations
- Take advantage of a consumer desire or need
- Enable the next generation of family members to remain on the farm or ranch
- Personal preference to operate a different business

Grazing lands enterprises are developed around existing farm and ranch resources and must be managed to maintain and/or improve the resources upon which they depend. A few enterprise examples are: working ranch vacations; hunting; photo safaris; bird watching; bed & breakfast inns; fishing; silvopastoral systems and other agroforestry products; camping; and historic tours.

There are several alternative opportunities for increasing profits on pasture land, in addition to grazing cattle.

Recreational opportunities can be developed to supplement existing farm and ranch resources.

The Grazing Lands Technology Institute will be issuing a newsletter about grazing land enterprises. If you would like to receive the newsletter or if you have information about a unique grazing land enterprise or other information that you would like to share, please contact: Dr. Larry D. Butler, Enterprise Diversification Specialist, Grazing Lands Technology Institute, Natural Resources Conservation Service, PO Box 6567, Fort Worth, Texas 76115. E-mail address: lbutler@ftw.nrcs.usda.gov

Science Confirms Soil Protection Techniques

For years publications and workshops sponsored by the National Arbor Day foundation have warned about soil compaction around trees and offered suggestions about how to prevent it. The problem is particularly important when vehicles are used near trees during construction. When the soil is wet, even parking cars on a lawn near trees was believed to cause compaction. Now the concept has been proven by a controlled scientific study at Davis, California, and reported in the *Journal of Arboriculture.* The bulk density of soil, a measurement that indicates the porosity of the soil or its absence, was determined at 35 plots on a fallow field. Each plot was then covered with a protective layer of materials such as wood chips, gravel, or plywood. Next, a heavy piece of construction equipment was driven over all plots, including an unprotected control plot. Findings showed what tree experts have said for years. A six-inch layer of wood chips or other material protected the soil from compaction. A sheet of plywood by itself did little to help, and soil not protected at all was significantly compacted to at least four to five inches in depth. Compacted soil was detected to over 14 inches in depth, but the damage was not as severe. Since most tree roots are found in the top 12 to 18 inches of soil, protective layers around trees are clearly important for helping roots thrive in a healthy environment that includes pores for the passage of oxygen and moisture.

Source: Adapted from Arbor Day, March/April, 1995

(Answer from page 1)

Agroforesters, from the National Agroforestry Center, environmental engineers from the Natural Resources Conservation Service, and scientists from the Agricultural Research Service studied the application of poultry litter application under four different land management senarios. One senario was the application of the litter on fescue pasture.Two silvopasture agroforestry senarios were evaluated: one had a fescue understory with an overstory of loblolly pine managed to maintain the canopy at 10 to 25%, and the other had an understory of fescue with an overstory of loblolly pine at 25 to 45%. The fourth senario was a loblolly pine forest plantation. Poultry manure application rates selected for analysis were 0, 5, 10, 15 and 20 tons per acre respectively. They used the Environmental Policy Integrated Climate (EPIC) model and the Almanac program to analyze the fate of the nutrients from the four scenarios and the potential water quality impacts. The analysis was done for a thirty year period.

In order for an agroforestry system to be accepted it must provide improved economics, improved environmental benefits, or improved management opportunities over existing alternatives. The trees are therefore managed to maximize the production of the grass. The added tree biomass production increases the potential demand and utilization of nutrients. Also in the agroforestry system the root systems of the grass and trees provide two tiers with the grass roots being shallower than the tree roots. The grass and tree roots intercept the nutrients after they enter the soil profile and the deeper tree roots intercept any nutrients that percolate below the grass roots. In theory this will provide an increased residence time of the nutrients in the plant root zone and improved nutrient utilization by the plants. The agroforestry systems analyzed are called alley cropping because the trees are established in wide spaced rows or alleys to allow for ease in application of poultry litter similar to the application on pasture. The application and even distribution of manure is a major management obstacle in forest plantations.

The EPIC model results showed that there was a decrease in the loss of nutrients to surface and ground water when comparing an agroforestry system with the fescue only system.

Nitrogen movement below the root zone increased significantly when the application rate exceeded 10 tons per acre per year on the fescue pasture (0% canopy) and at an application rate of 20 tons/ac, 45.1 lbs/acre of N was moving past the root zone with potential to pollute the ground water. The agroforestry and forestry alternatives never exceeded 3.8 lbs/ac N moving past the root zone. See Table 1.

The agroforestry senarios (10 to 25% canopy and 25 to 45% canopy) showed about a 25 to 30 % reduction of nitrate in runoff water at different application rates compared to the fescue pasture alternative (0% canopy) and about a 10% reduction over the forest scenario (>45% canopy). See Table 2.

One of the implications is that an agroforestry management system permits is a higher application rate without contaminating water quality. Another possibility might be to expand traditional cropland and grassland application areas into forest plantations by adding grass to the understory and managing a thinner canopy than traditional forestry would prescribe. These options may permit the increase in numbers of confined animals, improve the economics of the operation, and protect the environment.

The next step is full-scale application of agroforestry systems to test the model results. If this research validates the model results, then management recommendations for animal waste land application can be developed.

This is one example of how trees can add value to livestock operations.

Table 1

N percolation below the root zone with various application rates

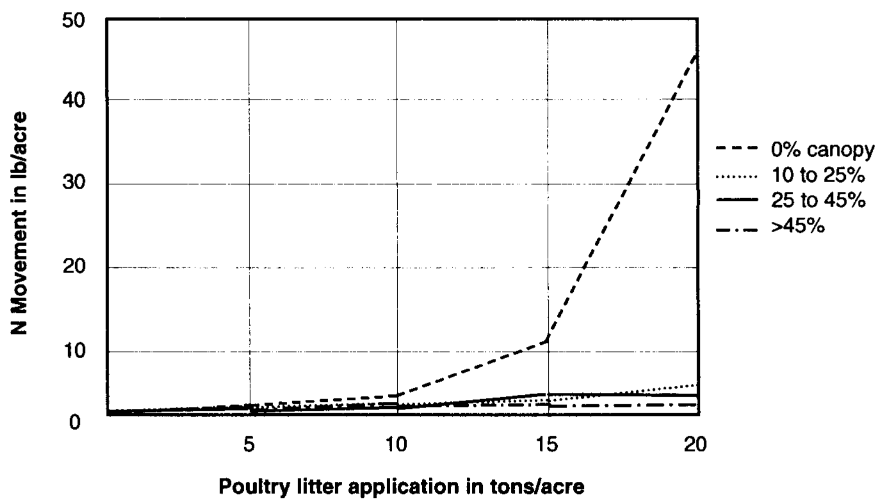
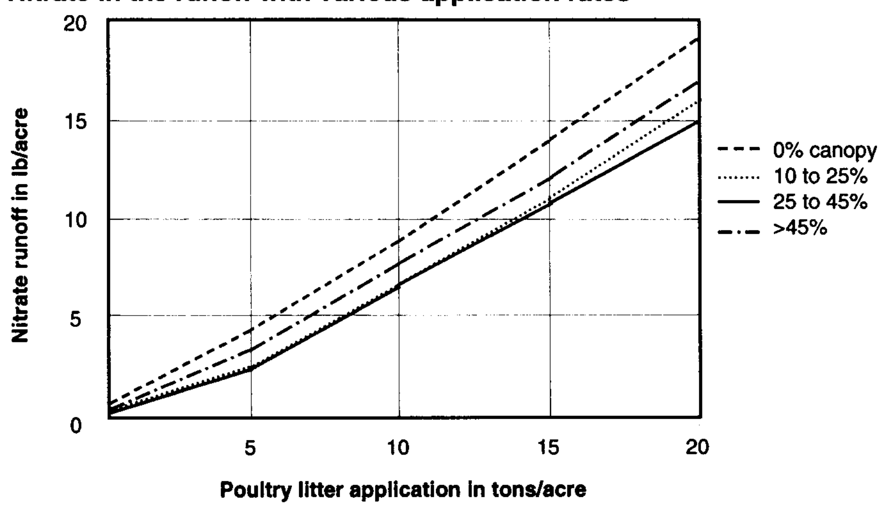


Table 2

Nitrate in the runoff with various application rates



(Silvopastoral from page 3)

lowed by a broadcast fertilizer application of nitrogen, phosphorus, and potassium at rates recommended for normal field conditions.

Perennial forage crops, which are well adapted for a timber pasture forage system, can be established at planting rates recommended for open fields. In most cases, understory burning and fertilizer application provide adequate seedbed preparation, which minimizes soil erosion potential. Less adaptive forage crops may require more intense establishment procedures. Forage utilization should be delayed for at least one growing season to permit stand establishment.

When planting conifers in pastures or on abandoned crop land, consideration should be given to planting rates, spacing between seedlings, insect protection, and herbaceous vegetation control during the first two growing seasons. Tree planting rates should range between 300 and 450 trees/acre with trees spaced 6 feet apart in rows 16 or 24 feet apart. These planting rates and spacing combinations will yield growing stock for thinning between ages 10 and 15 and will provide easy access for farm and logging equipment, thus minimizing tree and forage crop damage. Prior to and after thinning, lower limb pruning should be performed to maintain adequate light for forage production and to stimulate growth of knot-free lumber. Since herbaceous weeds and insects can limit early plantation growth and development, appropriate control measures should be applied during the first and second growing seasons. If control measures are properly applied, forage management and utilization will be possible during the second or third growing season.

Silvopastoral land use management systems are capable of producing marketable products while maintaining long-term land productivity. They encourage enterprise diversification by combining agricultural commodities having compatible management requirements. Since management costs are distributed among commodities, the potential exists to lower production costs and to enhance marketing flexibility for each commodity in the management system. These integrated production systems can achieve profitable utilization of marginally productive agricultural land.

(Livestock from page 2)

air temperatures below 35 degrees F. The amount of decline is dependent on animal health, coat condition, and feed intake. Under windy conditions further declines in production or increased feed requirements can be expected, due to lower windchill temperatures.

A windbreak significantly reduces windchill effects to livestock. Research indicates that merely by providing adequate wind protection, the direct effects of cold can be cut by more than half. A properly designed livestock windbreak can reduce wind velocity as much as 70 percent, with resulting reductions in windchill effects.

There are two major types of windbreak designs generally used for a livestock confinement area; the traditional multi-row design and a newer twin-row, high-density design. Which design you choose depends on the area available for planting, the area to be protected, and what the windbreak is supposed to accomplish.

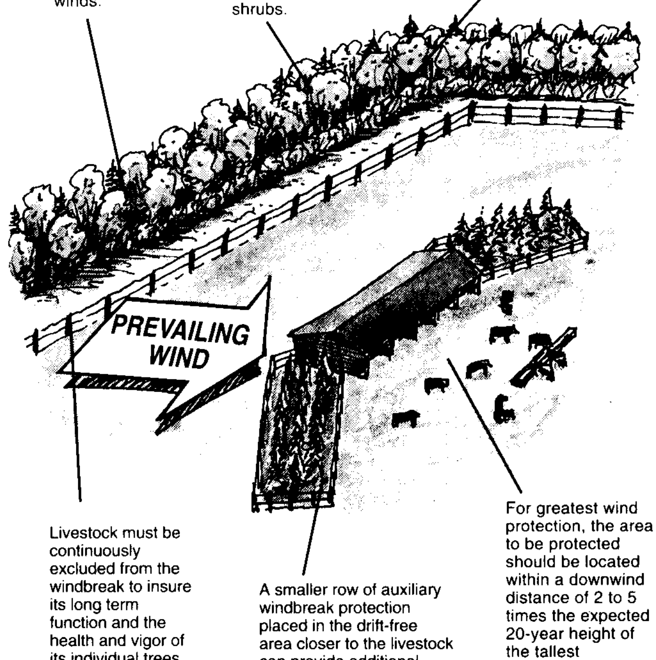
Developing a livestock windbreak for maximum protection requires that animal enclosures be located in the well-protected downwind zone, while at the same time avoiding snowdrift and drainage problems. They should be located perpendicular to the prevailing winter winds. For example, in the Upper Midwest and Northern Great Plains, windbreaks should be located on the north and west. In some situations, an additional windbreak on the south side will provide protection from snow storms in late winter and early spring. Be careful that windbreaks located on the south side do not block summer breezes, increasing heat stress. In southern locations, windbreaks on the south should be avoided.

Proper drainage for melting snow must be provided in order to reduce the level of mud in feedlot areas. Likewise, runoff from the feedlot should be directed away from the trees since the high nitrate levels of the runoff will damage the windbreak.

The length, height, and density of a windbreak determine the area that is protected. In general, the protection provided by a moderately dense windbreak (60 to 80 percent density) will extend downwind a distance of 15H, where H equals the height of the windbreak.

A windbreak designed to protect livestock must take into account a number of different factors and should be designed to meet the specific needs of the site, the farm operation, and the landowner's preferences. The complexity increases when additional benefits or objectives are involved. For additional guidance in designing livestock windbreaks refer to your local NRCS field office technical guide or the Center's Agroforestry Note - 2 "Outdoor Living Barn: A Specialized Windbreak."

Adapted from "Conservation Trees For Your Farm, Family, & Future," National Arbor Day Foundation and "Windbreaks for Livestock Operations," University of Nebraska Cooperative Extension



Maximum protection from a livestock windbreak requires animal enclosures be located in the well-protected downwind zone, while at the same time avoiding snowdrift and drainage problems.