New Mexico
Department of
Energy, Minerals and
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Guidelines for Windbreaks in New Mexico

Prepared by NM Forestry Division

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INTRODUCTION

A world without trees would be a barrren world. Great dust storms would roll across the countryside, blowing away precious topsoil, choking people, plants and animals. Parched fields could no longer grow enough food to feed the world's population. Hillsides would erode away, choking streams and rivers with silt.

Without trees, we would have little protection from summer heat and cold winter wind. Air conditioners would run 24 hours a day in the summer, and furnaces would work overtime in the winter. People would stay indoors, unable to enjoy life outdoors and have little incentive to venture out.

A World With Trees

Trees are such a commonplace part of our environment that it's easy to overlook their vital roles in making our communities and rural areas more livable, pleasant places.

The roots grip and hold the topsoil. Leafy tree canopies cool the hot summer sun, conserve moisture, slow the wind, keep the air clean, and help quiet loud traffic noises. And trees create a welcome home for birds and wildlife.

A leafy, tree-filled landscape has a beauty that is practical as well. Planted trees provide protection from the sun and wind, hold the soil and improve its permeability—as well as providing a living beauty that changes with the seasons.

From: *Conservation Trees*
John E. Rosenow
National Arbor Day Foundation

WHAT IS A WINDBREAK?

A windbreak is a planting usually of both trees and shrubs that is designed to reduce or eliminate undesirable effects of strong winds. They are especially effective in reducing soil blowing and plant and soil water losses.

A windbreak diverts the wind in the same manner that a dam diverts water. Any combination of trees which provides dense foilage for protection both at the groundline and 40 to 50 feet up will serve as a windbreak.

To grow successfully in windbreaks, trees and shrubs must meet two major requirements. First, they must be a species that is best adapted to the climate and soil of the area. Second, they must be able to grow in close association with other tree species and have growth characteristics that will produce the desired density for a given type of barrier.

FIG. 1 A windbreak's effectiveness depends upon its height, density and location with respect to area needing protection. A mature windbreak provides many benefits around the farmstead and makes a very attractive setting for the farmstead and for the farm buildings.

BENEFITS OF WINDBREAKS

The values of an effective windbreak are many. Such a windbreak, containing the right tree species in the proper location, will provide protection from hot, dry winds of summer, and relief from winter wind and snow.

Other Benefits From Windbreaks

Increase crop yields
Keeps crops from blowing out
Protects crops from hot, dry winds
Increases value of land
Reduces the potential of livestock death during severe winds and blizzards
Helps beautify farm and ranch
Provides food and shelter for wildlife
Traps snow in winter to increase soil moisture
Lowers the evaporating of soil moisture in the summer
Prevents wind erosion of top soil on both crop and range lands
Reduces energy consumption; air conditioning in summer, heat in winter

FACTORS TO CONSIDER FOR A SUCCESSFUL WINDBREAK

Despite natural situations that make windbreak establishment difficult; there are many controllable factors that can improve success.

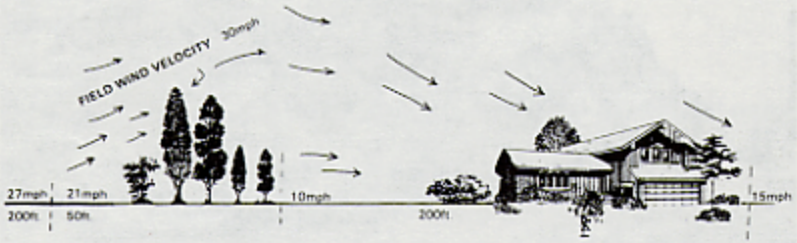


FIG. 2 A dense windbreak that is properly designed and correctly located will effectively reduce wind velocity and control snow drifting.

Here are some factors that are important in the establishment of a windbreak. There will be additional discussion about some of the factors later in the publication.

A favorable climate
A suitable soil
To be planted according to a sound plan
To be carefully handled and planted
To be kept free of weeds
To have adequate moisture
To have protection from livestock, rodents and other damaging agents

PLANNING YOUR WINDBREAK

Windbreaks are permanent, long-term investments in soil and water conservation. Only careful planning can prevent costly mistakes in location, species selection, tree arrangement, and spacing. Windbreaks will give some protection early in their life, but will not reach full effectiveness until maturity. In windbreaks composed entirely of deciduous trees, you can expect a gradual decline and loss of effectiveness after 30 or 40 years. Windbreaks containing conifers, however, will remain effective for 40 to 50 years or more.

Windbreaks are planted to reduce air movement in the vicinity of the windbreak. However, well-planned windbreaks serve other functions as well.

Beauty and recreation possibilities should also be considered when planning a windbreak. Properly designed windbreaks can provide sheltered areas for outdoor recreational activities. Shrubs and trees with colorful flowers, foliage or edible fruit should be included to enhance this natural use.

Windbreaks should be planned to provide maximum wildlife potential. Select tree and shrub species that have food or cover value for wildlife. Generally, shrubs have greater wildlife benefits than trees.

TYPES OF WINDBREAKS

Decide first on the purpose of windbreak protection for each field or other unit of land. This is essential in the beginning because different purposes may require that windbreaks be located, and spaced in different ways. The intended purpose will also require differences in windbreak structure which will govern selection of tree and shrub species and their arrangement and spacing.

Field Windbreaks

On a campaign trip in 1932, Franklin Roosevelt's train was detained in the intense July heat on the bleak, treeless plain near Butte, Montana. During the wait, Roosevelt hit upon the idea for a massive tree planting project on the Great Plains to halt the ruinous effects of the ever-present winds.

His election, and the continuing Dustbowl and unemployment during the Depression, gave Roosevelt the opportunity to test his idea on a huge scale. Foresters were organized; seed collected; and men were put to work as some 222 million shelterbelt trees were planted between 1935 and 1942. Thousands of miles of shelterbelts were planted and made to grow—on the Great Plains.

The field windbreaks planted during and since the Dustbowl have found to be especially effective in reducing wind erosion.

Field windbreaks can provide protection to soils, young seedlings, fruits, vegetables and help prevent shattering and blow down of grain. They can also be used to supplement farmstead and feedlot windbreaks by trapping snow in the fields. Field windbreaks are also valuable for wildlife which use them for nesting sites, travel lanes and cover.

FIG. 3 A field windbreak takes some land out of production; but in areas of severe winds, this loss is more than offset due to crop gains, especially on light soils that are more subject to wind erosion.

In addition to reducing wind erosion, field shelterbelts can significantly increase the yield of crops sheltered by the trees. Research at the Nebraska Institute of Agriculture shows that using 10% of the land for field shelterbelts substantially increases crop yield overall, more than compensating for the land put into trees. When comparing open 40-acre plots to similar plots protected by trees (4 acres of trees, 36 rows of crops), the 36 acres protected by trees produced 23% more soybeans than the 40 unprotected acres, and 18% more wheat. Because fewer crop acres are planted, less energy is consumed in planting, tilling and harvesting.

These specific figures apply only to unirrigated fields in eastern Nebraska; but crop-yielding increases can be anticipated wherever there are dry conditions or strong winds during the growing seasons.

Perhaps the greatest benefit in most areas comes during the growing season. By reducing hot winds; moisture loss and stress is decreased in growing crops. There is less evaporation and transpiration through the plant. Available moisture is used by the plant much more effeciently.

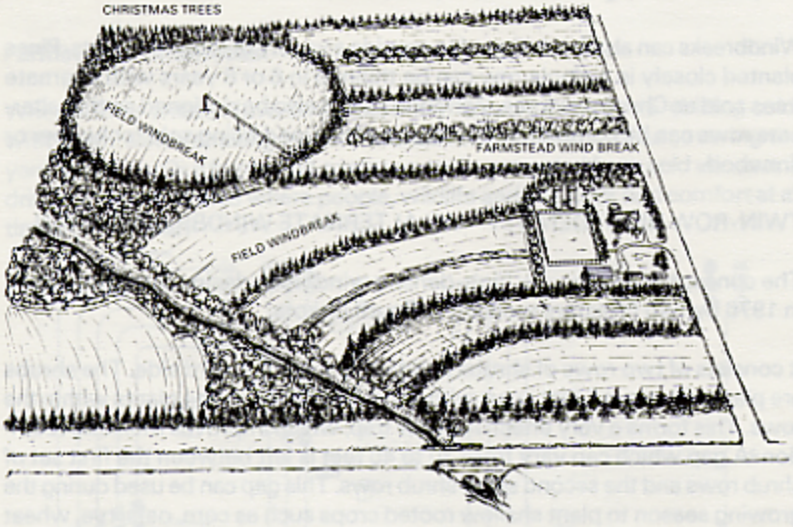


FIG. 4

Since they are permanent farm improvements, field windbreaks should be carefully planned. Field boundaries, power lines, roads, and irrigation systems should be established permanently because they are important in determining the location of your windbreak.

The amount of land occupied by windbreaks should be less than five percent of the total field area. Yield reduction due to windbreak land requirements may be minimized by careful species selection and windbreak design and maintenance. Species which sprawl or spread should be avoided, while upright, narrow trees give the most protection relative to the area of land occupied.

Windbreaks planted during the 30's were often 10 or more rows wide. These were the first large-scale planting in the dry areas of the Great Plains, and foresters thought it would be necessary to create forest-like conditions for the trees to survive.

However, by carefully selecting tree species, and proper site preparation; trees can be established in narrow windbreaks in all but the driest of areas. Drip irrigation systems can give the trees the moisture they need to start.

Today, most field windbreaks are one or two rows.

In areas where summer protection of growing crops is a priority, there needs to be wind protection close to the ground. Low-growing shrubs or cedars do this job; while height comes from pines or deciduous trees.

Windbreaks can also be designed to provide a variety of forest products. Pines planted closely in a single row can be thinned in 6 or 8 years with alternate trees sold as Christmas trees. Windbreaks can also be designed so that alternate rows can be completely harvested with wood being sold for lumber or firewood.

TWIN-ROW HIGH-DENSITY—AN ALTERNATE WINDBREAK DESIGN

The concept of a twin-row high-density windbreak design was formulated in 1976 by two foresters working in South Dakota.

It consists of two rows of shrubs planted on the windward side. The shrubs are planted in rows 6 feet apart with 4 to 5 feet between the plants within the rows. This forms a very effective snow trap, which improves moisture retention. A gap which can vary from 30 to 40 feet is left between the first set of shrub rows and the second set of shrub rows. This gap can be used during the growing season to plant shallow rooted crops such as corn, oats, rye, wheat or vegetables. Perennial crops such as alfalfa should not be used because their deep root systems compete with the newly planted trees for moisture. The second set of double rows should be a set of trees either mid-sized or tall. The tree rows are planted 6 feet apart and the trees within the rows also about 6 feet apart. This is followed by another 30-40 foot gap, followed by a third set of double row trees. This set should be tall tree species at a spacing the same as in the second set. A fourth set of ornamental evergreens or shrubs can be added if needed.

FIG. 5 A bird's-eye view (top) and a ground level view of this windbreak design shows a 6-foot space between rows and 25 to 50 feet between each set of rows. Row 1 could be juniper trees, Row 2 pine trees, and Row 3 shrubs or broadleaf trees. This windbreak design will take about the same amount of land as a traditional, four-row, normally spaced windbreak.

The twin-density windbreak provides several benefits. If a landowner plants three of the double-tree rows, the land used will be about the same as that used for a traditional, four-row normally spaced windbreak. The twin-row windbreak will grow denser sooner, providing a barrier against the wind more rapidly; snow will accumulate between the rows rather than on the trees, which will prevent broken trees; and as already stated, spacing between the rows is wide enough to farm.

Farmstead Windbreaks

When winter winds blow, an isolated farmstead can be bone-chilling cold, with north winds shaking its very foundations and snowdrifts covering the yard and drive. Or a farmstead can be an oasis; protected from cold winds and drifting snow—a place where people, wildlife and livestock find comfort at all times of the year.

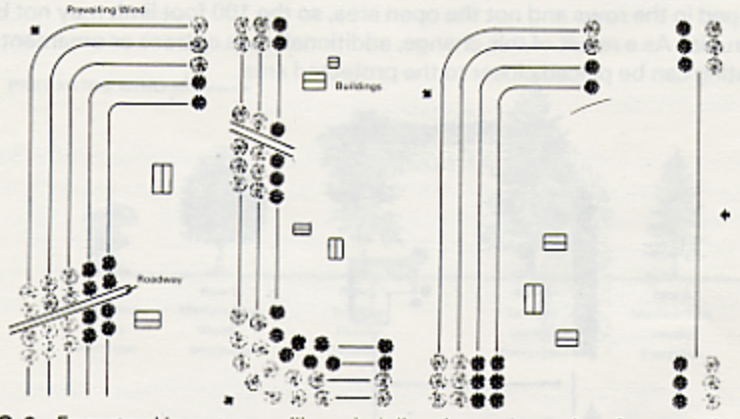


FIG. 6 Farmstead layout, prevailing wind direction and severity of snow drifting in your area are important factors to consider in windbreak planning. No set windbreak pattern can be prescribed. The sketches in this figure illustrate how windbreaks can be designed in different situations.

The benefits from farmstead windbreaks have been recognized for the past 150 years in North America and even longer in Europe. The most commonly cited benefits of farmstead windbreaks include the following:

Improves living conditions from reduced energy consumption.
Improves outside working conditions by reducing wind velocity.
Beautifies the farmstead by adding color and form to the landscape.
Prevents snowdrifts from accumulating around buildings and roads.
Reduces wind damage to property.
Improves farmstead orchards and gardens through better pollination, less windfall, less bruising and higher yields.
Provides products such as fruit, nuts, and firewood.

Provides winter cover, nesting cover and food for wildlife.
Reduces noise levels from roads and other areas
Filters out blowing soil and dust from adjoining fields.
Screens out unsightly views.

All these benefits improve the quality of life for a farm, ranch or other rural family. Each windbreak may not provide all of these benefits, but it will provide many of them.

In planning the farmstead windbreak, the first factor to consider is location. Place your windbreak at a right angle to the prevailing winds as nearly as possible. The windbreak at a right angle to the wind is more effective than one at an oblique angle with wind currents.

It is usually recommended that the windbreak be located no closer than 100 feet from driveways and buildings. However, recent Soil Conservation Service studies have shown that most of the snow captured by a windbreak is trapped in the rows and not the open area, so the 100 foot limit may not be as crucial. As a result of this change, additional rows of trees or ornamental planting can be placed closer to the protected area.

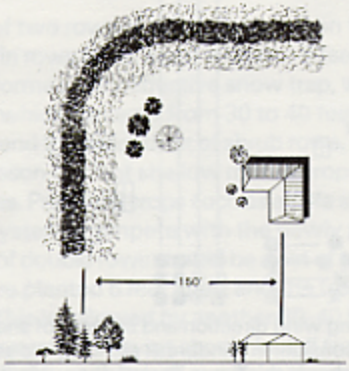


FIG. 7 With this windbreak design, the 100-foot limit in the distance a windbreak can be planted from the area to be protected has been eliminated. Additional rows of trees can be placed closer to the protected area.

Extend your windbreak at each end 50 feet beyond the boundaries of the farmstead. This will prevent winds from whipping around the windbreak into the areas you want protected. Where farm driveways and main-travelled roads join, avoid creating hazardous blind corners by planting no closer than 20 feet from the main road.

In laying out the site where the trees are to be planted, it is best to curve the windbreak rather than make square corners. A curved windbreak is easier to cultivate, and is more aesthetically pleasing.

The number of rows in a farmstead windbreak will depend upon the space available, species to be planted and the objective of the landowner. A five row planting makes a very desirable farmstead windbreak. The best results are usually obtained by using a different kind of tree or shrub in each row. A windbreak of mixed species also gives some protection against insect and disease damaging the entire planting. Figure 8 shows the types of trees ordinarily used in windbreaks and where they are placed in five-row planting.

Where space is limited, it is better to plant only two or three rows of evergreens rather than crowd a large number of rows and mixed species close together. A well developed single row can be more satisfactory than three rows with inadequate growing space. In a single-row windbreak, never mix species such as a fast growing deciduous tree with a slow growing evergreen.

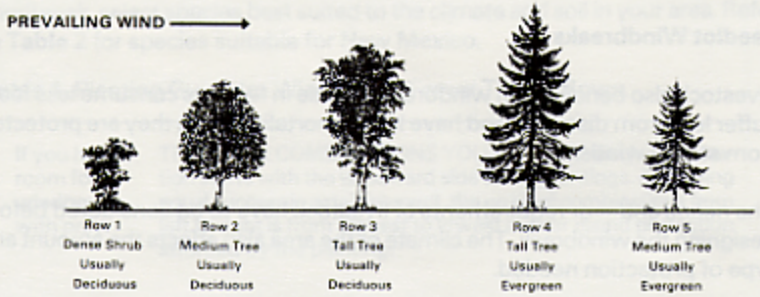


FIG. 8 The types of trees ordinarily used in windbreaks and the row positions they usually are given in a five-row planting.

Since air infiltration is proportional to the force of wind on a building, windbreaks reduce heat loss by decreasing wind velocity. A solid row of dense shrubs planted around the base of a structure tends to create a "dead air space" and thus improves the insulation value of the foundation or basement. This is particularly helpful if the foundation is not insulated.

Also a dense tree area has a substantial cooling effect. On a hot summer day, there is up to a 10 degree difference in temperature between an open field and a grove of trees. This is more than shade effect. The leaves of one mature tree can evaporate over 200 gallons of water per day, producing evaporative cooling.

Energy savings up to 20 percent can be realized by using windbreaks around heated buildings. This is because they reduce wind velocity, which increases air infiltration into the building. Cold air will infiltrate all parts of a structure, but is most pronounced around doors and windows.

Feedlot Windbreaks

Livestock also benefit from windbreaks. Cattle in feedlots consume less feed, suffer less from diseases, and have lower mortality when they are protected from strong winds.

The needs and—or requirements of livestock have to be considered before designing the windbreak. The climate of the area also affects the amount and type of protection needed.

Usually feedlot windbreaks can be designed in the same manner as farmstead windbreaks. Use evergreens in at least one row if winter protection is desired.

Windbreaks for Wildlife

Any of the three types of windbreaks discussed here can be managed for wildlife. Windbreaks provide benefits to wildlife in several ways including protection from wind and adverse weather, escape or refuge cover, food and foraging sites, reproductive habitat and travel corridors.

For enhancement of wildlife benefits, windbreaks should be designed to provide the needs of wildlife most desired and be of sufficient size and complexity to provide wildlife needs throughout the year, including winter food and weather protection appropriate for local climactic conditions. Greater number and kinds of wildlife are usually associated with increased windbreak size and length of perimeter, diversity of vegetation and vegetation complexity.

A basic five-row windbreak design that incorporates wildlife benefits consists of two rows of evergreens (preferably red cedar and a second species of "choice") on the north and west side to provide winter wind and snow protection. The middle row should be one or more species of deciduous, tall trees, such as hackberry, black locust, or green ash to provide vertical habitat, nesting cover and added wind protection. The last two rows should be shrubs with high wildlife values. The taller shrubs (or short trees), such as Russian olive, hawthorn, honeysuckle, are recommended for the fourth row, and small shrubs, such as plum, crabapple or sumac to offer the greatest food availability and food production potential are recommended for the fifth row.

For single-row windbreaks, use high wildlife value deciduous trees.

SELECTION OF TREE AND SHRUB SPECIES

A major consideration in windbreak planning is the selection of the kinds of trees and shrubs to be planted. When you choose shrubs and trees for your windbreak, select species best suited to the climate and soil in your area. Refer to **Table 2** for species suitable for New Mexico.

Table 1. Planting Guide for Windbreaks Fewer Than 5 Rows.

If you have room for a windbreak with only:	THESE ARE COMBINATIONS YOU MAY USE. Each combination starts with the windward side of the plantings. Assuming equal success in establishment, the order of combinations from left to right is from highest to lowest in year round protection afforded by the planting.			
4 rows	Dense shrub Med. evergreen Tall evergreen Med. evergreen	Dense shrub Med. deciduous Tall evergreen Med. evergreen	Dense shrub Med. deciduous Tall deciduous Med. evergreen	Dense shrub Med. deciduous Tall deciduous Med. deciduous
3 rows	Dense shrub Tall evergreen Med. evergreen	Dense shrub Tall deciduous Med. evergreen	Dense shrub Med. deciduous Med. evergreen	Dense shrub Med. deciduous Tall deciduous
2 rows	Med. evergreen Tall evergreen	Dense shrub Tall evergreen	Dense shrub Tall deciduous	Dense shrub Med. deciduous
1 row	Med. evergreen	Tall evergreen	Med. deciduous	Tall deciduous

Table 2. Recommended Windbreak Species

				
Dense Shrub	Medium Size deciduous	Tall deciduous	Tall evergreen	Medium-size evergreen
*Lilac Quailbush Caragana *Skunkbush Sumac	Russian Apricot *Russian Olive *Native Plum Russian Mulberry Golden Willow *Hackberry	*Green Ash Narrow-leaf Cottonwood Chinese Elm Honey Locust *Lombary Poplar	*Ponderosa Pine *Scotch Pine *Douglas-Fir	*Blue Spruce *Austrian Pine Rocky Mountain Red Cedar *Arizona Cypress *Afghanistan Pine

*Available from New Mexico Division of Forestry

Shrubs

A windbreak needs to be dense near the ground. For this purpose a bushy deciduous or evergreen shrub should alway be used for the windward row of a multi-row planting. In many areas, shurb rows are necessary to give protection needed to establish the evergreens in a windbreak.

Deciduous Trees

Deciduous trees are usually faster growing than evergreens, so they provide earlier protection. They are usually used for the middle rows in windbreaks. The height added by deciduous trees extends the protection zone of the windbreak. In some areas, certain deciduous trees are the only ones that can be grown satisfactorily. In such areas, windbreaks are made up of deciduous trees in combination with a dense shrub.

Evergreens

Evergreens give year-round protection, and should be included in windbreaks whenever possible. The standard practice is to plant evergreens in one or two rows facing the wind. If evergreens do well in a certain area, they may be used for the entire windbreak.

SELECT FOR DESIRABLE CHARACTERISTICS

The ability of a windbreak to provide protection depends on the characteristics of the trees and shrubs that constitute the windbreak.

The species selected should have the ability to grow in close association with each other; they should have compact crowns, dense foliage, strong stems and branches to withstand the wind, a well distributed root system, with capability to retain lower branches and foliage as the tree grows, and a uniform rate or height growth.

Height

The maximum height that windbreaks can achieve will determine the distance between wind barriers and the size of the area protected. As a rule, the distance between parallel windbreaks on level fields should not exceed 20 times the average height that your tallest trees can attain in 20 years. A closer interval of 10 to 15 times the height will increase protection. On sloping land the strips should follow the field contours or terraces, and be spaced at 10 to 15 times the maximum height of your tallest tree.

Choose species that will grow tallest on your particular soil types.

Density

Most conifers suited for use in windbreaks have dense, compact crowns that retain foliage throughout the year. Broadleaf trees and shrubs lose foliage in the fall and cause the windbreak to have less density during the winter.

The crowns of the tallest trees will determine the density of the upper level of a windbreak. Foliage density at the middle of the windbreak can be provided by fast growing broadleaf trees for the first 15 years.

When the trees are young, lower level density is provided by all of the species. After 20 to 30 years, most conifers and broadleaf species will lose their lower foilage. At this point, shrubbery species may be planted to provide foilage density near the ground.

Information on size, growth habit and adaptability of tree species used for windbreaks in New Mexico is listed in **Table 3**. (For additional information on species refer to **Appendix 3**).

SPACING AND ARRANGEMENT OF TREES AND SHRUBS

Since windbreaks are planted to reduce the force of the wind, the total effect of all trees composing the barrier is the most important factor. However, the individual tree must have enough space to grow well, in order to contribute its share to the wind-reduction effect. Often, there must be a compromise between: 1) the space required for the maximum growth of the individual tree; and 2) the density required to make an effective windbreak.

Give your trees room to grow, even if it means using fewer rows in your windbreak. Adequate growing space tends to keep your trees thrifty. It gives assurance that your windbreak will have better appearance and a longer useful life.

Table 4 shows recommended spacing which will give your trees room to develop good crowns before strong competition sets in. These spacings are also within the optimum range for highest windbreak effeciency.

Growth characteristics of individual species vary considerably from one area to the next. Measurements show that shrubs such as skunkbush sumac will do well at a variety of within-the-row spacing, but 4-6 feet is often times best. Deciduous trees will do well at 10-14 feet within-the-row spacing. Evergreens also have some variability.

Spacing between trees within-the-rows also changes between single and multiple-row windbreaks. Research has shown that ponderosa pine can be planted as close together as 4 feet, and then thinned to 8 feet after 10 years. Ponderosa pine and Eastern red cedar can be planted alternately in pairs at 6 feet and thinned to alternate 12 foot intervals after 10 years. Recommendations for Scotch pine are at 6 feet and then thin to 12 feet after 15 years. Eastern red cedar may be planted at 4 feet and left unthinned or thinned to 8 foot intervals at age 10, or planted at 6 feet, and left unthinned.

Table 3. Resistance to:

	Average Height	Cold	Alkali	Sand Action	Rodents	Borers	Leaf Eaters	Disease	Drought
Shrubs									
Caragana	12	1	2	2	2	1	3	1	1
Lilac	8	1	2	2	1	2	2	1	1
*Native Plum	15	1	2	2	1	2	1	1	1
Quailbush	5	1	1	2	I	1	1	1	1
Trees									
*Green Ash	40	1		2	2	3	2	1	2
*Narrowleaf Cottonwood	60	1	1	1	2	3	2	2	3
Chinese Elm	35	1	1	1	3	2	2	1	1
*Hackberry	35	1	2	2	3	1	2	1	2
Honey Locust	40	1	1	1	2	3	2	3	1
Russian Apricot	20	1	1	2	2	2	2	1	1
*Russian Olive	20	2	1	3	3	1	2	2	1
Russian Mulberry	20	1	2	2		2	2	1	2
Golden Willow	30	1	2	1	2		2	2	3
Evergreens									
Rocky Mtn. Red Cedar	25	1	2	2	1	1	1	1	1
*Arizona Cypress	25	3	2	2	1	1	1	1	1
*Ponderosa Pine	60	1	2	3	2	2	1	1	2
*Austrian Pine	40	1	3	3	2	2	2	1	3
*Scotch Pine	40	1	3	3	2	2	2	1	2
*Douglas-fir	60	1	3	3	2	2	2	1	3
*Colorado Blue Spruce	50	1	3	3	2	1	2	1	3

Code of Resistance: (1) Resistant, (2) Susceptable, (3) Highly Susceptable

*Available from New Mexico Division of State Forestry
Also available from the Division of Forestry: Skunkbush Sumac, Lombardy Poplar, White Fir, Afghanistan Pine.

NOTE: Species availability subject to change.

Appearance, durability and effectiveness of the windbreak will depend greatly on how the various species are arranged.

If the windbreak is to have only one shrub row, that row should be planted on the windward side. If two shrub rows are to be used, plant one on either side of the barrier. The tall fast-growing species (deciduous) should be planted on the inside rows.

See **Fig. 8** for various row planting of windbreaks.

SELECTION OF PLANTING STOCK

As with planning and design, an adequate supply of suitable plant materials is essential for successful windbreak planting. Selection of materials of adequate size, vigor and hardiness should be prime considerations

The following questions should also be answered:

1. Availability— are the shrubs called for in the planting plan available?
2. Pricing— are the trees and shrubs available at a price that is economically feasible for windbreak planting?
3. Adaptability— are the selected trees and shrubs adapted to the planting site?

Nearly all windbreak planting is started with seedling-size plants. Get seedlings grown in a nursery in your area or from an area having similar climate. Seedings may be purchased from the Energy, Minerals and Natural Resources Department, Forestry Division, 408 Galisteo Steet, Room 129, Santa Fe, New Mexico 87503. (Refer to **Appendix 1 & 2** for more information on how to obtain planting stock).

Table 4 Recommended Minimum Spacing for Windbreak Trees

Tree and shrub types	Recommended Minimum Spacings			
	Irrigated or dryland with 16" + precipitation.		Dryland plantings with 16" or less precipitation.	
	Multiple-row windbreaks	Single-row windbreaks	Multiple-row windbreaks	Single-row windbreaks
	(feet)	(feet)	(feet)	(feet)
All types (between rows)	16	—	20	—
Dense Shrub	3	2	4	3
Medium-size deciduous	9	6	10	8
Tall deciduous	20	8	20	10
Medium evergreen	9	6	10	8
Tall evergreen	12	8	12	10

PLANTING SITE PREPARATION

One of the most critical factors in survival of dryland tree and shrub planting in New Mexico is site preparation. This will accomplish three objectives: 1) loosening of the root zone for easier root penetration; 2) loosening of the surface soil for improved water infiltration and reduced evaporation; 3) reduction of competition from weeds.

Prepare the land well ahead of planting. The windbreak plots should lie fallow at least one year before planting. The planting site should be worked enough during the summer to keep the surface soil loose.

Where rainfall is adequate and in irrigated areas, deep fall plowing is most beneficial on loam or silty soils.

If planting is to be done on sandy or fine to medium textured soils, which are subject to wind erosion, plant strips of tall annual crops such as corn, sorghum, or millet. Plant one or two rows the year before you plant the trees and keep them cultivated. These strips protect the soil against blowing and catch snow during the winter, thus adding moisture for the tree seedlings.

PLANTING THE WINDBREAK

Care of Planting Stock

The quality of the planting stock and the care given to it have much to do with a successful windbreak. Special attention will improve the percentage of trees that will survive and the vigor of those that do live.

BAREROOT STOCK

The most important consideration in handling nursery stock, is to keep the seedlings cool and the roots moist at all times. The trees must be kept moist until field planted. **DO NOT LET THEM DRY!** When seedlings are received from the nursery, bundles should be opened and the trees planted. If the trees cannot be planted immediately, they should be refrigerated or stored in a cool area. Stock may be stored in refrigeration with the bundles unopened. Temperatures should not be above 38 degrees F nor below 33 degrees F. Humidity should be 90 percent. Each bundle of trees should be watered once a week. **DO NOT** store seedlings any longer than necessary. Under best refrigeration conditions, three weeks to a month should be maximum.

Another method of temporary storage for seedlings is "heeling in". This is done by digging a V-shaped trench deep enough to receive the full length of the roots. Spread the trees out along the trench and cover the roots with moist soil, then water. Dig the trench where the trees will receive at least partial shade wherever possible.

CONTAINERIZED STOCK

Two of the major causes of bareroot planting failure in the Southwest are poor physical condition of seedlings, stemming from improper refrigeration and lifting.

Containerized seedlings minimize the impact of these factors on survival. The container method permits seedlings to begin and maintain rapid root growth in a near natural condition. Seedlings are able to make better use of soil moisture and shock from transplant is reduced. Containers also protect seedlings from mishandling. If seedlings cannot be planted immediately, store in a shaded area and keep moist. Water about every two days. **NEVER** use the "heeling-in" method or store them in the refrigerator.

When to Plant

Most New Mexico tree planting is done in the spring (mid-March to mid-May). The main consideration is to plant just about the last frost and as soon as the top 18" of soil has thawed out. Fall planting may be considered only when there is no danger of frost heaving at the site.

Use of containerized stock will enable the landowner to delay planting until New Mexico's summer rains arrive. Containerized seedlings should be planted prior to mid-July in the northern half of the state to allow for sufficient root development before winter. Fall planting as late as October have been successful in the lower one-third of the New Mexico.

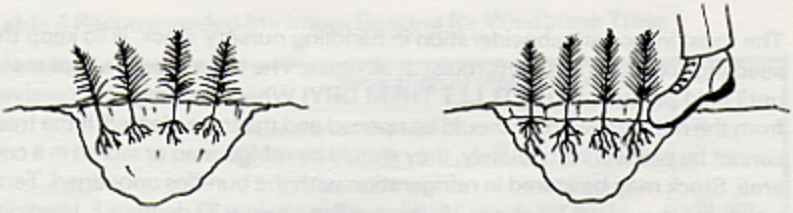


FIG. 9 Steps for heeling-in your trees. 1. Dig V-shaped trench in a moist, shady place. 2. Spread trees in trench out evenly, 3 to 4 trees thick. 3. Fill in loose soil and water well. 4. Complete filling trench with soil and press down firmly.

Planting the Trees

1. Bareroot seedlings: The period of exposure between removing planting stock from the bundles, transplant beds, or where they are heeled-in; and placement in the hole should be as short as possible. Take only enough trees so that they can be kept moist. Carry the roots in a box, bucket or tray. This will make it possible to cover roots with wet peat moss, sawdust, sloppy mud or moist burlap. Take out one seedling at a time for planting. **Dry roots may mean dead trees.**

2. Containerized seedlings may be watered prior to extraction to facilitate separation of root plug and container. The planting hole should be dug slightly deeper than the length of the plug. Dry surface soil should be removed before the hole is prepared. Satisfactory planting tools include: power or hand auger, shovel, mattack or planting bar.

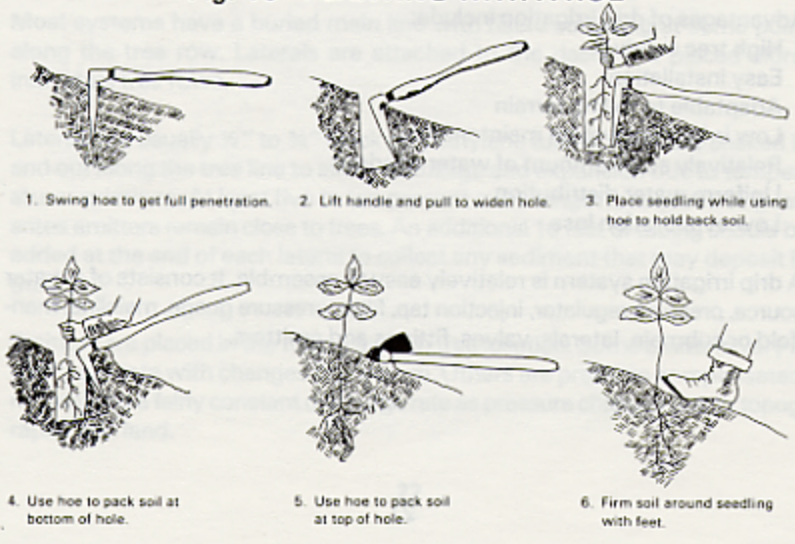
3. Place seedling in hole at the depth it grew in the nursery. This depth is indicated on stem by the ground line, which is usually about one-half to one inch below the first needles. It is better to plant a little too deep than too shallow, but never deep enough to bury any foliage.

4. **Let the roots hang naturally without turning or twisting.**

5. Hold the tree in this position with one hand, then fill in the soil, (about a third at a time), and tamp firmly with the other hand until the hole is filled. **Firm** tamping is necessary to avoid air pockets.

6. Use only moist mineral soil to fill in the hole. Do not mix soil with snow, grass, sticks, rocks etc. The roots must be in direct contact with the soil.

Fig. 10 - PLANTING WITH A HOE



1. Swing hoe to get full penetration.
2. Lift handle and pull to widen hole.
3. Place seedling while using hoe to hold back soil.
4. Use hoe to pack soil at bottom of hole.
5. Use hoe to pack soil at top of hole.
6. Firm soil around seedling with feet.

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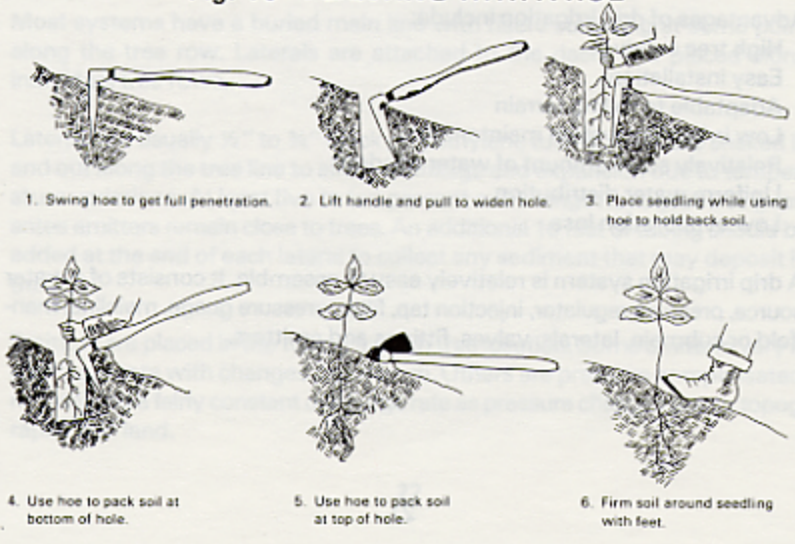

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7. After the hole is filled, tamp again with your hand or handle of the planting tool. Tamp firmly.

8. Cover the ground around the tree with a thin layer of loose soil as a mulch, or mulch with other material.

9. Water after planting to aid in packing the soil around the roots and to assure ample water for a start.

One-man power augers have become popular in recent years, and a simple unit can keep three to four people busy planting. Auger planting works best in loamy soils and can be difficult on sites with heavy clay, rocks or massive roots. Heavy litter or vegetation on the soil surface must be scalped away ahead of the auger or the soil from the planting hole is lost in surface debris.

Machine planting is practical only when soil conditions are favorable to adequate machine packing of the ground around the seedling root system. Heavy soils which are wet or sticky at planting time should be planted by one of the hand methods discussed. **Soil should be moist when seedlings are planted.**

DRIP IRRIGATION

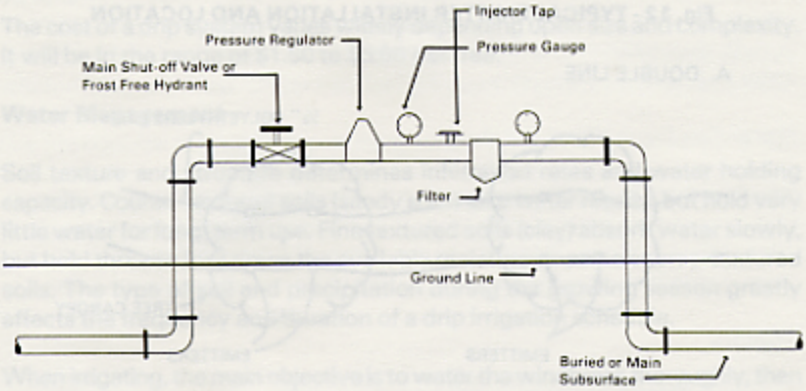
A strong commitment is required for successful windbreak planting in most of New Mexico where annual rainfall amounts range from 14 to 24 inches. Once the windbreak is planted it is essential that young trees receive adequate moisture. The best way to provide such moisture is by drip (trickle) irrigation.

Advantages of drip irrigation include:

- High tree survival
- Easy installation
- Adaptable to rolling terrain
- Low irrigation system maintenance
- Relatively small amount of water needed
- Uniform water distribution
- Low evaporation loss

A drip irrigation system is relatively easy to assemble. It consists of a water source, pressure regulator, injection tap, filter, pressure guage, mainline, manifold or submain, laterals, valves, fittings and emitters.

FIG. 11 Typical Control Assembly



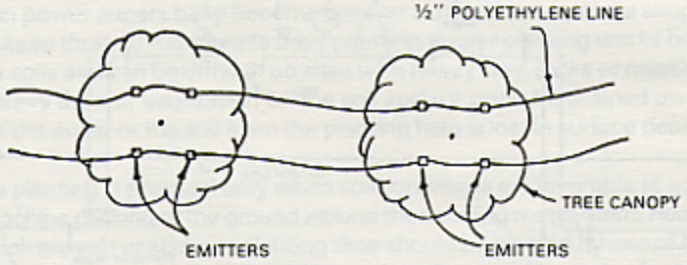
Most systems have a buried main line with risers surfacing at some point along the tree row. Laterals are attached to the risers and placed along individual tree rows.

Laterals are usually ½" to ¾" black polyethylene tubing. They are snaked in and out along the tree line to allow shrinkage and expansion due to temperature variations. At least five to ten percent extra length is required to guarantee emitters remain close to trees. An additional 10 feet of tubing should be added at the end of each lateral to collect any sediment that may deposit in the line.

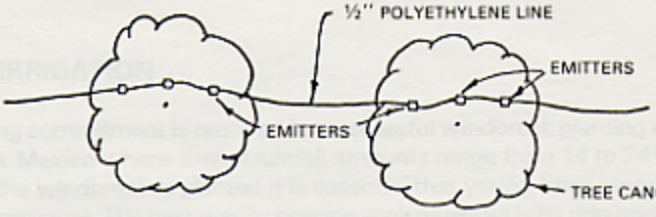
Emitters are placed in the tubing at each tree location. Some emitters vary in discharge rate with changes in pressure. Others are pressure compensated, maintaining a fairly constant discharge rate as pressure changes due to topography and land.

Fig. 12 - TYPICAL EMITTER INSTALLATION AND LOCATION

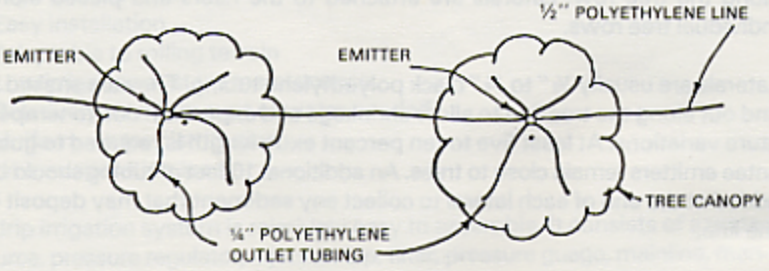
A. DOUBLE LINE



B. SINGLE LINE



C. MULTI-OUTLET EMITTER



Protection is added to the system in the form of a filer (to prevent clogging of emitters), two pressure gauges installed on each side of the filter (to insure proper operating pressure and detect filter clogging) and a pressure regulator (to maintain required pressure).

Cost

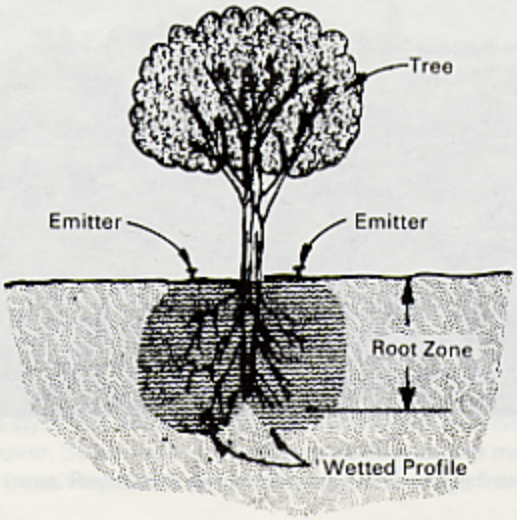
The cost of a drip system varies widely depending upon size and complexity. It will be in the range of $1.50 to $3.00 per tree.

Water Management

Soil texture and structure determines infiltration rates and water holding capacity. Course-textured soils (sandy soils) take water readily, but hold very little water for long-term use. Fine textured soils (clay) absorb water slowly, but hold three to four times the available moisture as some course-textured soils. The type of soil and precipitation during the growing season greatly affects the frequency and duration of a drip irrigation schedule.

When irrigating, the main objective is to water the windbreak thoroughly, then let the soil partially dry out. This promotes soil aeration and root growth. During the first growing season, plants require watering once or twice a week to a depth of 18-24 inches. In later years, the frequency is slowly decreased while duration is increased to encourage root growth out and away from wet soil areas.

Fig. 13 - Typical Wetted Profile below Mechanical Outlets



MANAGING ESTABLISHED WINDBREAKS

Management and renovation of tree and shrub plantings is necessary to insure a permanent stand. The effort required to establish a windbreak easily justifies a management plan designed to prolong the life of the stand.

The management system should account for trees and shrubs being planted where they do not normally grow. Such plants are in a constant state of growth stress throughout their lives; management should be designed to minimize this stress.

Protection From Wind and Sun

Newly planted evergreen trees should be protected from the wind and sun. One way to provide this protection is to place shingles or short boards all around the seedlings. This will prevent damage to the stem from wind whippage, and will also provide shading to the plant and conserve moisture.

Fencing

Livestock **MUST** be excluded from the windbreak. Grazing animals eat or trample young seedlings and older trees are damaged by browsing or breaking.

FIG. 14

Livestock can pack soil, resulting in the oxygen supply being shut-off to the tree roots and limiting the amount of water that goes into the ground. This will lead to slowed growth, weakened trees, and premature death of the windbreak.

Cultivation

The windbreak should be kept cleanly cultivated for optimum survival and growth. Cultivate your windbreak often enough to control the weeds. Do this when weeds are small, under 2 inches in height. Shallow cultivation is best.

Fire can become a dangerous possibility when weed growth covers the windbreak site. The threat is eliminated with clean cultivation.

Cultivation should be discontinued in early fall to allow tree growth to slow and wood become hardened before winter.

Pruning

Usually windbreaks need very little pruning. Pruning or trimming should be done only:

To prevent deciduous trees from developing weak crotches which may later result in split trunks.

To prevent long branches on deciduous trees from breaking off under heavy snow or windstrain and from overtopping evergreens.

To prevent the development of double or multiple leaders in the crowns of evergreens.

To promote uniformity and density in single-row supplemental planting.

Lower branches can be removed from trees in the middle rows of the windbreak to facilitate weed control. Pruning should not be higher than the shrub row on the outside of the windbreak. Lower branches of evergreens should not be pruned.

Rodent Damage Control

If you plant trees right next to a meadow, hayland, sagebrush areas or road right-of-ways, you may have to combat mice, gophers or rabbits. Although clean cultivation helps to keep out mice and gophers, it will not stop all of the damage done by them. Mice and gophers will move into clean plantings under snow cover. Screen wire or hardware cloth cylinders may be used to protect small trees. Repellants will often prevent damage from rabbits and other rodents.

Insects and Their Control

Insect damage will be less severe in strong, healthy trees. Trees weakened by drought, grazing or other causes are more liable to be seriously damaged by insect attacks. Again, weeds should be removed because they shelter insect pests.

Grasshoppers These insects damage trees by eating leaves, buds and bark. In junipers, grasshoppers kill branches or parts of branches by making a complete or partial girdle. This damage is usually not noted until after it is done, when dead spots of foliage appear throughout the tree.

Spider Mites This pest, which affects juniper and spruce, is so tiny it is difficult to see. Damage is done when this spider sucks juices from the foliage. Damage is usually first noted especially in junipers, in mid-summer when grey to yellow foliage appears throughout the tree. Close examination will reveal areas where the spiders are feeding.

Tree Borers Boring insects usually do not attack healthy trees. Trees weakened by grazing, weed competition, drought or other injury are most likely to suffer from borer attack.

Borers damage trees by working just under the bark or in the wood. Attacks may be above or under the soil surface. Watch for small holes or sawdust-like particles clinging to the bark. This is a good indication of borer infestation.

CAUTION: When obtaining firewood, or posts and poles with bark attached, be sure you do not bring borers to infect windbreak trees.

Scale Insects Scales are tiny insects that feed on the sap of trees and shrubs. Newly-hatched scale insects are known as "crawlers" and this is the only stage in the pest's life in which it moves about. After the crawler stage, the insect attaches itself to a leaf or twig and spends the balance of its life there.

Scale insects that attack windbreak trees and shrubs include oyster shell scale, common juniper scale, European elm scale, pine needle scale and mealy bugs.

Elm Leaf Beetle This insect feeds on all species of elms, skeletonizes leaves and causes them to turn brown and drop.

The adult beetle is about ¼ inch long, with a black stripe along the edge of the wings. Larvae are about ½ inch in length at maturity and are dull yellow or brownish in color with two dark stripes down the back. The head and legs of larvae are black. Two to three generations may be produced a year.

Bag Worms These are caterpillars which live in a silken, cocoon-like bag to which is attached bits of leaves from the host plant. Females are wingless and

spend their lives in the cocoon.

Aphids These insects seldom kill windbreak plants, but in severe infestations may weaken shrubs and trees so that other insect pests or diseases may successfully attack.

Aphids are soft-bodied and whitish, greenish or blackish. Their bodies are pear-shaped with relatively long legs. They are sucking insects which usually feed in colonies on the underside of foliage. Downward-curling leaves in the spring is an indicator that aphid populations are present.

Fall Webworm These leaf-eaters are approximately one inch in length at maturity. Larvae are pale yellow to greenish with a broad dusky stripe down the back and a yellow stripe along the side. They are covered with long hairs which may be whitish, yellowish or brownish. Larvae live and feed inside a dirty white web.

APPENDIX 1
SOURCES OF ADDITIONAL INFORMATION

You may obtain additional information, advice or planning assistance from any of the following offices.

NEW MEXICO DIVISION OF FORESTRY

CHAMA DISTRICT OFFICE
HC 75 Box 100
Chama, NM 85720
Phone: 505-588-7831

CIMARRON DISTRICT OFFICE
p.o. Box 5
Ute Park, NM 87749
Phone: 505-376-2204

SOCORRO DISTRICT OFFICE
HC 32 Box 2
1701 Enterprise
Socorro, NM 87801
Phone: 505-835-9359

LAS VEGAS DISTRICT OFFICE
HC 33 Box 109 #4
Las Vegas, NM 87707
Phone: 505-425-7472

CAPITAN DISTRICT OFFICE
PO Box 277
Capitan, NM 88316
Phone: 505-354-2234

BERNALILLO DISTRICT OFFICE
PO Box 458
Bernalillo, NM 87004
Phone: 505-867-2334

www.nmforestry.com

US DEPARTMENT OF AGRICULTURE NATURAL RESOURCE CONSERVATION SERVICE

NW AREA ALBUQUERQUE
6200 Jefferson NE
Albuquerque, NM 87109
Phone: 505-761-4484

SW AREA SOCORRO
406 North 6th Street
Socorro, NM 87801
Phone: 505-838-4259

EAST AREA CLOVIS
918 Parkland Drive
Clovis, NM 88101
Phone: 505-762-4769

SE AREA CARRIZOZO
409 Central Avenue
Carrizozo, NM 88301
Phone: 505-648-2941

www.nm.nrcs.usda.gov/contact/directory/area-offices.html

APPENDIX 2
SOURCES OF PLANTING

You may contact any of the six State Forestry District Offices or the Main Office in Santa Fe to obtain information about buying planting stock. The New Mexico Division of Forestry has available, many species commonly used for windbreak planting. The Division provides these species at a reasonable cost to landowners through its annual Fall and Spring Seedling Programs. To contact the Main Office write or call:

ENERGY, MINERALS AND NATURAL RESOURSES
FORESTRY DIVISION
ROOM 129
408 GALISTEO
SANTA FE, NEW MEXICO 87503
(505) 827-5830

ENERGY, MINERALS & NATURAL [
RESOURCES DEPARTMENT☐
FORESTRY DIVISION☐
1220 S. St Francis Drive☐
Santa Fe, NM 87505☐
Phone: 505-476-3325☐
(as of 1/2000)☐

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