

Recommendations in this Farmers' Bulletin are based on more than 40 years of research at the U. S. Northern Great Plains Field Station, Mandan, N. Dak. In addition to conducting research on tree and shrub species for the northern Great Plains, this Agricultural Research Service station conducts soil and water management studies, tests grain varieties under dryland and irrigated conditions, develops forage crops suitable to the region, and develops and tests new and standard varieties of fruits and vegetables.

The photograph on the cover is by courtesy of the North Dakota State Soil Conservation Committee.

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Shelterbelts for the NORTHERN GREAT PLAINS

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Shelterbelts, or windbreaks, are trees and shrubs planted to act as barriers against strong winds and drifting snows. They are grown in the generally treeless northern Great Plains to protect crops, livestock, farm buildings, and homes.

The northern Great Plains includes the western halves of North and South Dakota, the Plains portion of Montana lying east of the foothills of the Continental Divide, and the northern third

of Wyoming. The region has low average rainfall, frequent droughts, and extremes of heat and cold. Winds dry out and blow away exposed topsoils. They sweep snow into ravines and coulees where the resultant moisture becomes a flood hazard and does not benefit crops. They damage crops at critical stages of germination and later growth. Success of crops may depend upon whether or not they have shelterbelt protection.

BENEFITS OF SHELTERBELTS

Shelterbelts slow down speed of the wind, absorb some of the force, and divert the wind upward. The effect of diverting the wind upward is to create an island of relatively calm air near the ground on the downwind or leeward side of the shelterbelt.

Shelterbelts offer these specific benefits to the Plains farmer or rancher:

1. They improve growing conditions for his orchard and garden and for his field crops.

By slowing down wind speed, shelterbelts reduce the possibility of firing, wind breakage, and blowdown. By creating relatively calm air close to the ground, they prevent quick evaporation

of potential soil moisture and aid in reducing loss of topsoil from wind erosion. Reducing evaporation helps in the germination of crops. Reducing soil blowing prevents the destruction of newly germinated seedlings.

2. They improve his living and working conditions.

Belts protect his home and farm buildings from hot or cold winds. The home is cooler in summer and less expensive to heat in winter. Trees and shrubs make his farmstead more attractive and add to its value. They also prevent snowdrifts from blocking roads and accumulating against buildings.

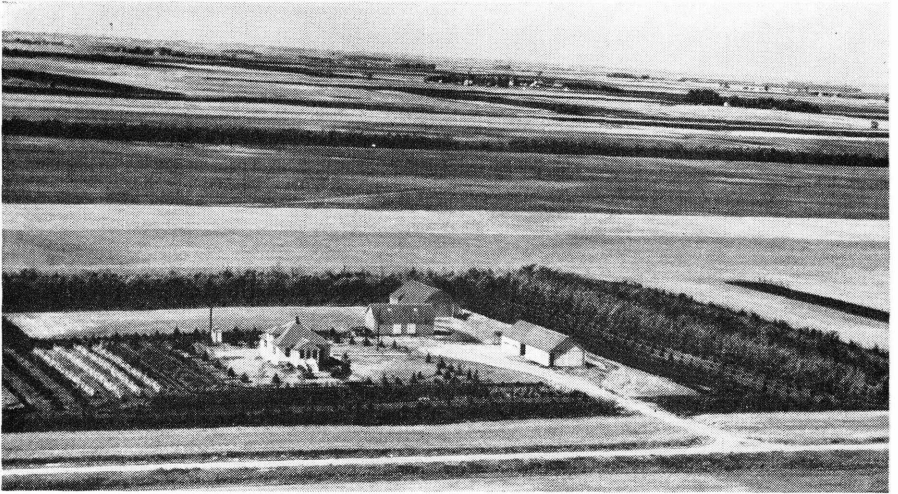
3. They provide winter protection to livestock and feeding grounds.

Belts protect feeding areas from

¹ U. S. Northern Great Plains Field Station, Mandan, N. Dak.

drifting snow. Feed is distributed more readily from feed stacks. Studies have shown that cattle wintered on the same rations gain more in a normal winter in tree-protected feeding

grounds than in unprotected areas. Also, cattle wintered in tree-protected areas lose less weight during severe blizzards than those wintered in exposed locations.



A 750-55

This farm home and the other buildings are well protected against wind and drifting snow. (Courtesy of North Dakota State Soil Conservation Committee.)



A windbreak on the north keeps strong wind and drifting snow out of this feedlot. (Courtesy of U. S. Soil Conservation Service.)



SHELTERBELT 1585

A well-planned windbreak holds snow in the trees, prevents it from drifting around farm buildings.

GROWING SHELTERBELTS

Climatic conditions of the northern Great Plains do not favor tree growth. However, research has shown that shelterbelts can be grown successfully in this region. The studies were distributed over the entire region, which covers more than 200,000 square miles.

The requirements for success are:

1. Planning in complete detail ahead of planting.
2. Selecting the right trees and shrubs.
3. Planting them in the right way.
4. Maintaining them.

Planning

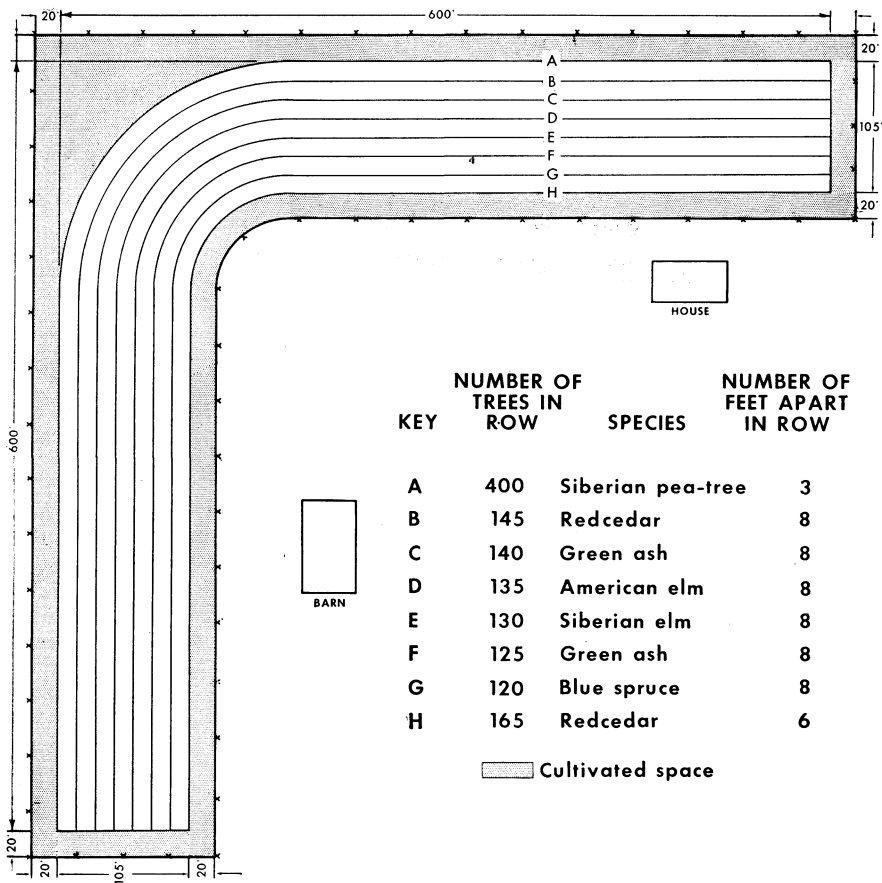
The growing of shelterbelts is a long-range improvement program under which you take a certain amount of land permanently out of cash-crop production. The average per-acre cost of trees and labor is about \$50. Shelterbelt benefits will more than pay for this initial cost by the third year of growth. For example, the control of snowdrifts eliminates the use of labor and machinery to clear snow-blocked feedlots, yards, and roads. The benefits will increase with tree growth.

Get advice on a program that best meets your needs. Get it from the local technician for your soil conservation district; from your county agent, State or extension forester, or agricultural college; or from the U. S. Northern Great Plains Field Station.² Put down on paper a detailed planting plan showing the size and shape of the site, the spacing distances that you will use in setting out trees, and the number, kinds, and arrangement of species. Here are guides to use in developing your planting plan:

Place your shelterbelt correctly in relation to prevailing winds and what it must protect.

To shield farm buildings against winds from the north and northwest, use an L-shape planting on those sides. Place the inside or leeward row a minimum of 50 feet and a maximum of 100 feet from the nearest building used during the winter months. The

² Address: U. S. Northern Great Plains Field Station, U. S. Department of Agriculture, Mandan, N. Dak.



BN 3810

Plan for an 8-row windbreak to protect farm home and buildings. A similar plan, showing all essential information, should be prepared for each planting.

greater the number of rows, the closer the leeward row may be brought to the building.

Plan belts on three sides of orchards and gardens.

South and west belts are needed for protection against heat. A north belt shields against strong winds that may blow fruit off trees or erode topsoil. Leave the east side open to avoid frost damage caused by air stagnation.

Allow at least 50 feet between belts and orchard or garden. Trees any closer to crops will compete for soil moisture and reduce yields.

Provide protection without unnecessary use of land.

Maximum height of the trees, their growth density, and their height arrangement in the rows determine the effectiveness of a windbreak. The taller the trees, the farther the protection extends. A properly designed Plains shelterbelt gives some reduction in wind velocity for a distance of 40H (40 times the maximum height of the trees). A large field requires a windbreak system—a main belt on the windward sides and a number of supplemental belts.

Plan a larger number of rows for farmstead, feedlot, and main field belts than for garden, orchard, and supplemental field belts. More than eight rows is not generally recommended because the trees in wider belts compete with one another for soil moisture. Use a minimum number of rows unless your site is very much exposed. Recommendations are as follows:

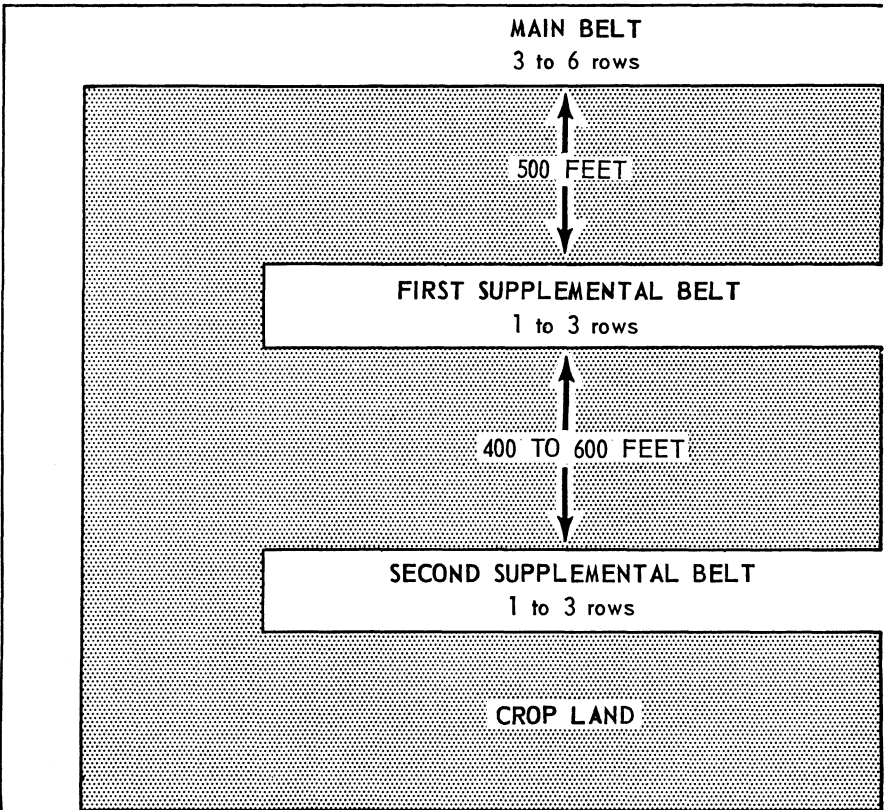
Purpose:	Number of rows
Farmstead	7 or 8
Feedlot	5 to 8
Field, normal (main belt)	3 to 5
Field, wind eroded (main belt) ..	4 to 6
Garden or orchard	1 to 3
Supplemental belts	1 to 3

Allow these spacings:

	Feet
Between belts:	
Main belt and first supplemental ..	500
Other supplementals	400 to 600
Between rows:	
2-row belts	10
Other belts	12 to 15
Between trees and shrubs:	
Trees in leeward row	6
Trees in interior rows	6 to 8
Shrubs	3

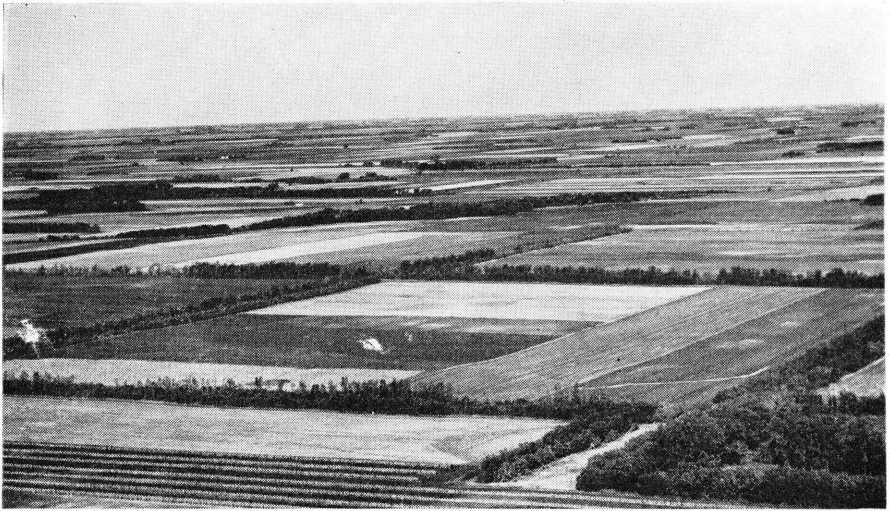
Plan adequate protection against wind erosion.

Winds of 15 miles an hour damage soils wherever they can sweep across fields. Provide a windbreak system. Don't have interruptions in belts.



BN 3808

The purpose of the windbreak system shown in this plan is to protect a quarter section of crop-land. A main belt on the north and west sides (illustrated) gives winter protection. A main belt on the south and west gives protection from heat. Plant supplemental belts in an east-west direction; space them from the north main belt or from the south main belt.



This well-designed system of field windbreaks in eastern North Dakota gives good protection to field crops. (Courtesy of North Dakota State Soil Conservation Committee.)

Winds build up velocity as they go through extensive openings. Reduce soil blowing at the ends of a belt by gradually tapering off with shrubs to the ground and by sodding.

Choose a planting site where the belt will give effective protection.

In doing this, you have little opportunity to select the most favorable site for tree growth. Sites that are level or that slope gently to the north or east are preferable. Coarse-textured soils, such as sandy loams, will give best results under dryland conditions. Finer textured soils, such as clay loam and clays, will grow trees successfully if supplemental water is used.

Expect poor results when you plant trees in soils underlain by hardpan, in alkali spots, or on sites that have been heavily manured or in corrals for many years.

Prepare land to store the maximum amount of moisture by freeing it completely of live sod or noxious weeds.

Fit your method of preparation to the condition of the land. Summer fallow your tree site a year ahead of planting on most croplands. Practice

clean cultivation for 2 years on established grasslands. Put cover crops on light sandy soils that are subject to blowing. Follow good water conservation practices, such as terracing, diking, or building of water diversion structures, on drier lands.

Build a fence around the site to keep out livestock.

Their browsing of lower branches destroys the lower belt cover. Rubbing against trunks injures trees. Trampling packs the soil, preventing it from readily absorbing moisture.

Arrange species so that, when they reach full growth, the tops will form a roof-shaped outline.

The slope on the windward side of the "roof" should be longer than on the leeward side.

Indicate the desired arrangement on your planting plan, as follows:

- In the outside row on the windward and leeward sides of farmstead and feedlot belts: Trees or shrubs that will form a dense growth close to the ground. (This arrangement is not important for field, supplemental, garden, or orchard belts.)

- Between these rows and the center: Taller-growing species arranged according to the height they will reach—a gradual progression upward as the center rows are approached.

- In the center rows or in the rows on the leeward side of the center rows: Tallest-growing trees.

Table 1 lists recommended tree and shrub species by outside, intermediate, and center row location in shelterbelts. It also gives planting results on dry-land and supplemental water sites.

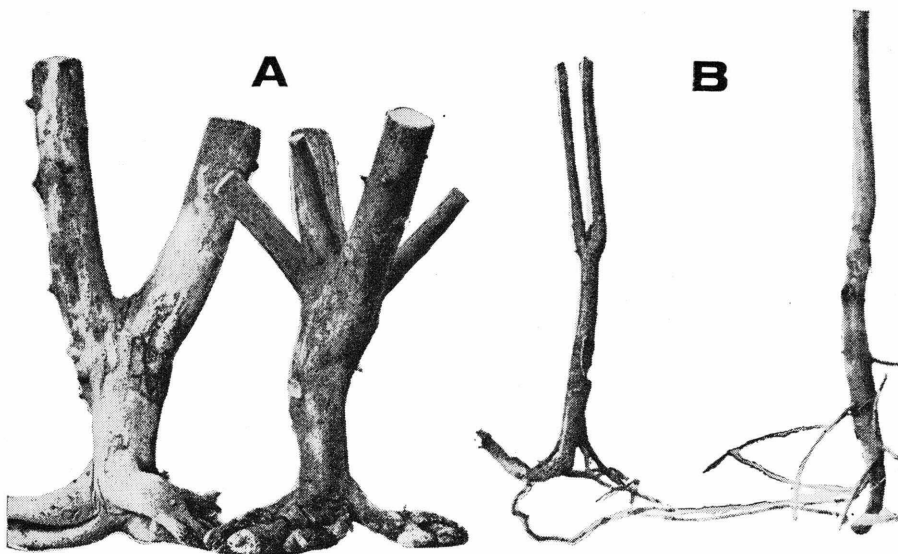
Selection

You can buy trees from commercial nurseries, grow them from seed, or transplant them from nearby woodlands. For best results on the Plains, use nursery trees. Choose those grown from seed that is collected locally or those grown from seed produced in other localities by trees or shrubs that are known to be hardy.

Year-round leafage is important in the effectiveness of a windbreak. Choose a combination of deciduous (leaf-shedding) species and evergreen coniferous species. Select seedlings of deciduous species that measure $\frac{1}{4}$ to $\frac{3}{8}$ inch in diameter just above the swelling of the root collar. Generally, they will be 18 to 36 inches tall. Also, select seedlings that have good root systems.

Your stock of coniferous species may be transplants or potted stock. Choose trees that are 6 to 12 inches high and 3 to 5 years old.

Be sure to have enough stock to enable you to select the most suitable diameter sizes and to discard undersized and injured trees. Get about 20 percent more trees than you will need in following your planting plan. Put the surplus in temporary nursery rows as replacements for losses.



SHELTERBELT 1558

These 10-year-old tree roots got no deeper in the soil than they were when planted; they did not penetrate the hardpan layer. A, Northwest poplar roots planted in northern South Dakota. B, Green ash roots planted in northern North Dakota.

TABLE 1.—Species of trees and shrubs rated as to suitability for planting in shelterbelts on the northern Great Plains

Species	Suitability ratings			
	Dryland sites			Supplemental water sites
	Light soil	Medium soil	Heavy soil	
PLANTINGS IN OUTSIDE ROWS				
Deciduous species:				
Buffaloberry, silver ¹	Fair	Good	Good	Good
Crab, Siberian	Good	Good	Fair	Good
Currant, golden	Good	Good	Good	Good
Honeysuckle, Tatarian	Good	Good	Fair	Good
Lilac, common ²	Good	Good	Fair	Good
Lilac, Persian ²	Good	Good	Fair	Good
Maple, Amur	Poor	Poor	Not suited	Good
Pea-tree, Siberian ³	Good	Good	Good	Good
Plum, American	Fair	Fair	Not suited	Good
Russian-olive	Good	Good	Fair	Good
Serviceberry	Good	Good	Fair	Good
Sumac, skunkbush	Fair	Good	Good	Good
Coniferous species:				
Redcedar ¹	Good	Good	Good	Good
Rocky Mountain juniper ¹	Good	Good	Good	Good
Spruce, Black Hills	Fair	Fair	Not suited	Good
Spruce, blue	Fair	Fair	Poor	Good
PLANTINGS IN INTERMEDIATE ROWS				
Deciduous species:				
Ash, green ⁴	Good	Good	Fair	Good
Boxelder	Fair	Fair	Not suited	Good
Hackberry	Fair	Fair	Not suited	Good
Maple, silver	Fair	Poor	Not suited	Good
Oak, bur	Good	Good	Fair	Good
Russian-olive	Good	Good	Fair	Good
Willow, laurel	Not suited	Not suited	Not suited	Good
Willow, white	Not suited	Not suited	Not suited	Good
Coniferous species:				
Pine, limber	Good	Good	Fair	Good
Pine, ponderosa	Good	Good	Good	Good
Pine, Scotch	Fair	Fair	Not suited	Good
Spruce, Black Hills	Fair	Fair	Not suited	Good
Spruce, blue	Fair	Fair	Poor	Good

See footnotes at end of table.

TABLE 1.—Species of trees and shrubs rated as to suitability for planting in shelterbelts on the northern Great Plains—Continued

Species	Suitability ratings			
	Dryland sites			Supplemental water sites
	Light soil	Medium soil	Heavy soil	
PLANTINGS IN CENTER ROWS				
Deciduous species:				
Elm, American	Good	Fair	Poor	Good
Elm, Siberian ³	Good	Good	Good	Good
Elm, Dropmore ³	Good	Good	Good	Good
Maple, silver	Fair	Poor	Not suited	Good
Plains cottonwood	Not suited	Not suited	Not suited	Good
Willow, laurel	Not suited	Not suited	Not suited	Good
Willow, white	Not suited	Not suited	Not suited	Good

¹ See section on control of diseases.

² This species has suckering habits.

³ Do not plant on wet sites.

⁴ See section on control of insect pests.

Planting

Care Before Planting.—Because they are packed in bundles, nursery trees keep a week to 10 days. Unpack them in a cool, protected place as soon as possible. If you will be ready to plant within a week, wet down the packing material, repack it around the roots, and keep the trees in a cool cellar or barn.

If you will not start planting for a week or more, heel in your trees in a cool, shaded location. To heel in, dig a trench 9 to 12 inches wide, with one straight and one sloping side, and about 1 foot deep. Open bundles and spread out trees evenly with the roots resting on the bottom of the trench and the tops pointing up the sloping side. Cover the roots with loose moist soil and water well. Fill in the trench with soil and pack firmly.

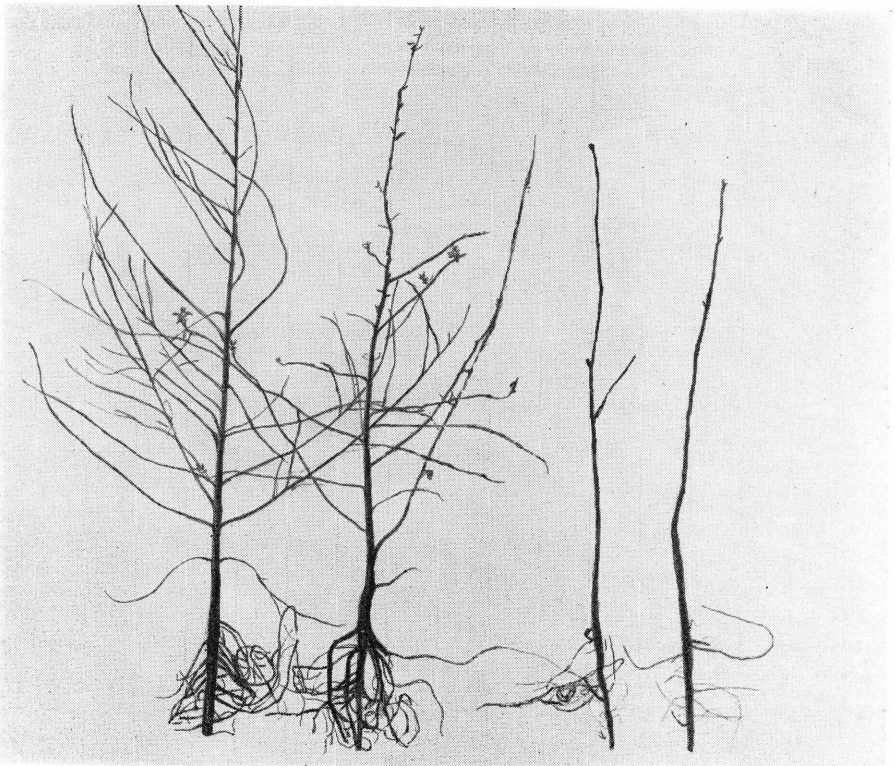
Time To Plant.—Plant in the spring after frost is out of the ground and before trees begin to send out leaves.

Do not plant in the fall. Fall-planted trees in heavy soils may be heaved out of the ground during the winter. If you receive nursery trees in the fall, heel them in until spring.

How To Plant.—Consult your planting plan before setting out trees. Most shelterbelt trees are now planted by machine. Set stakes to establish the first row and set the marker for correct distances between rows. If you plant by hand, use stakes and stretch lines between them to be sure of having straight, correctly spaced rows.

Observe these basic rules whether you plant by hand or machine:

1. Keep roots moist at all times. Carry trees in a large pail of water



SHELTERBELT 1732

These seedlings have good root systems. Left to right: Siberian elm, Russian olive, American elm, and green ash.

or on a tray covered with wet burlap and shingletow or moss.

2. Make a hole or trench wide and deep enough to permit roots to spread naturally without crowding or curling.

3. Set the tree a little deeper than it stood in the nursery.

4. Pack soil firmly around the roots.

Use a long-handled, straight-shanked shovel for planting by hand. Make a hole for stock that has bushy roots. Make a slit or trench for stock that has very few lateral roots. Insert the shovel in the ground and work it back and forth.

Your soil conservation district will rent a mechanical tree planter to you, and will send experienced men to operate it. The complete job of opening

the trench, planting the trees, closing the trench, and packing the soil is performed in one operation.

Maintenance

Replanting.—Replant the second year to replace all trees and shrubs that have died. Count the dead trees in each row before freezing temperatures kill the leaves on living trees. A good time to make the count is the last week in August or the first week in September.

Don't delay replanting. Trees set out a few years after the first planting cannot compete successfully with older trees for moisture.

Cultivation.—Under dryland conditions, maintain 20 feet of clean-cul-

tivated space on all sides of the belt. If the land is irrigated, keep down weeds and grass to prevent fire.

Practice clean cultivation between rows as long as you can work with equipment or until tree crowns shade out weeds and grass. Use a duckfoot cultivator or spring-tooth harrow. Use a single section of the harrow when rows become too narrow for the full equipment.

Practice clean cultivation between trees in the row. A special side attachment for any make of farm tractor is now available for less than \$100. This equipment may also be rented from your soil conservation district.

If you plant in sandy soils subject to blowing, put garden crops or corn between rows, or put grain in the centers between trees. Allow at least 3 feet between crops and trees. A mulch of hay, straw, or manure may also be used in the control of water or wind erosion. Do not mulch as a substitute for clean cultivation.

Chemicals for spraying or dusting may be used to control certain weeds in shelterbelt plantings. Be sure that spray preparations, such as 2,4-D, do not get on trees or shrubs.

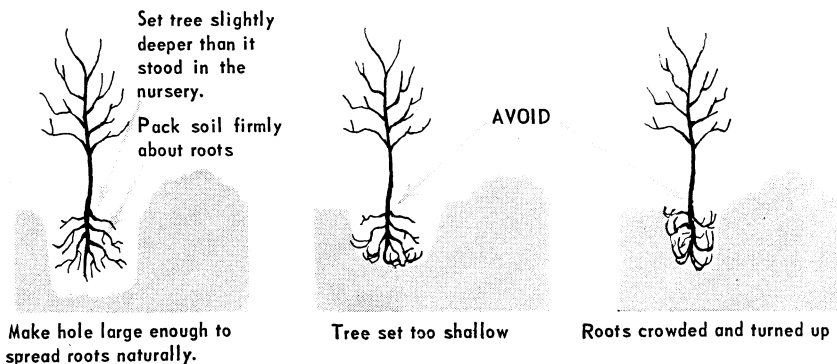
Pruning.—Limit pruning of trees to corrective measures at the beginning of the second year of growth or the year

after an injury occurs. At time of planting, cut back tops of hedge-type species, such as Siberian pea-tree in outside rows, to encourage branching close to the ground. Don't allow development of more than one main trunk for interior-row trees, such as ash, elm, hackberry, and poplar. If a double leader appears on an evergreen tree, remove the weaker of the two branches.

Restrict pruning of side branches to those growing less than 1 foot above the ground. Cut off branches close to the trunk so that no stubs are left to decay. Use a sharp knife or pruning shears. Paint large wounds with a dressing, such as asphalt paint that is obtainable from most paint stores. Thin with mineral oil in cold weather or whenever the mixture does not adhere readily to the wound.

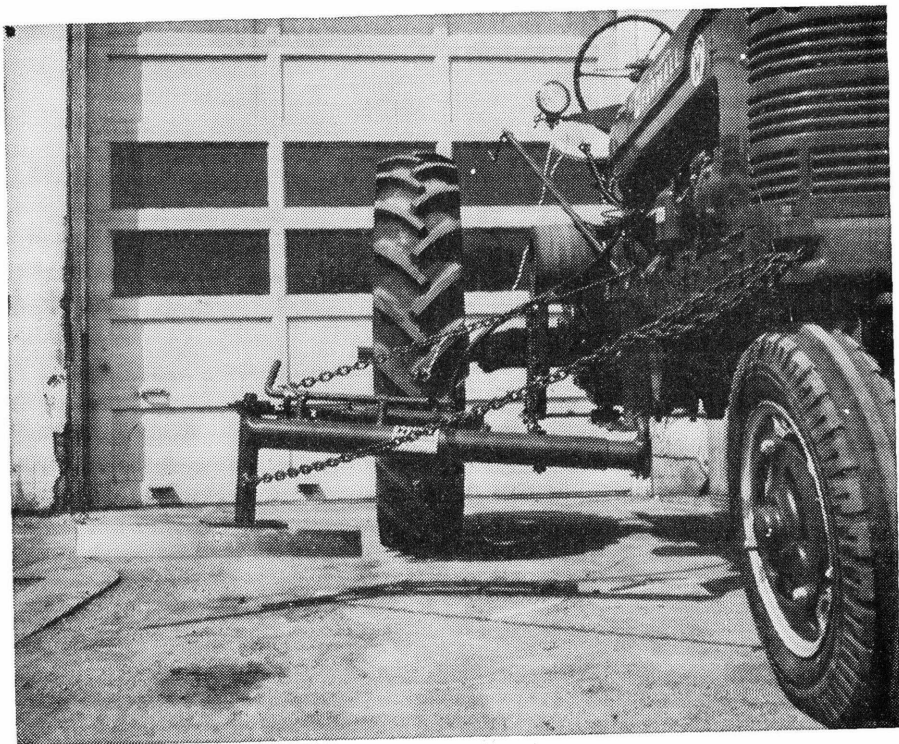
Control of Disease.—Two species listed in table 1—Redcedar and Rocky Mountain juniper—are alternate hosts of fungi that cause cedar apple rust and hawthorn rust. Do not plant these species in commercial apple-growing areas.

The common barberry (*Berberis vulgaris*) is often found in or near shelterbelts. It is the alternate host of stem rust of wheat. This shrub is not recommended for shelterbelt or ornamental use. Destroy native and cultivated shrubs of this species.



Correct and incorrect practices in planting trees.

BN 3800



This in-the-row cultivator, which can be attached to any make of tractor, will remove nearly all the weeds between trees in the row. (Courtesy of Orville Hill, Ree Heights, S. Dak.)

Several species are damaged by canker fungi, heart rot, and wetwood. Cankers weaken the stems of poplars and willows so much that they may break during storms. Poplar canker, caused by the fungus *Septoria musiva*, will attack vigorous trees. Normally, cankers caused by weak parasites do serious damage only to weak trees. Remove trees when cankers have caused extensive dieback of the tops.

Heart rots infect some species, including silver buffaloberry, and cause breakage of trunks and limbs. Fungi that cause heart rot often enter through wounds. Avoid unnecessary wounding. Keep your trees and shrubs in vigorous condition.

Wetwood of poplar is caused by bacteria that infect the wood and produce toxins. The toxins cause dieback of the tops and may kill the trees. No control measure for wetwood is known.

Leaf spot diseases caused by various fungi damage some species. The damage is seldom extensive enough to require control measures.

Control of Animal Pests.—Rabbits are the major animal pests of shelterbelts on the northern Great Plains. They cause serious damage by eating shoots, branches, leaves, and buds and by gnawing and peeling off bark. Control them by organized hunting and by painting or spraying trees with chemical preparations that will keep rabbits away.

In planning rabbit hunts, be sure to comply with State game laws and regulations. For information on repellents, see Leaflet 396, *Protecting Trees and Shrubs From Rabbit Damage*. Get a copy from your county extension agent, or write to the U. S. Department of Agriculture, Washington, 25, D. C.

Pocket gophers eat through tree roots and may uproot and kill trees. Control them by placing traps in open runways or by using poisoned baits.

Field mice girdle or strip the bark off trees under the snow line during the winter. They build nests in thistles and other weeds that accumulate near trees in late fall. Prevent field mice damage by clean cultivation.

Control of Insects.—Three types of insects damage shelterbelt trees:

1. Leaf-eating insects. These include blister beetles, leaf beetles, and caterpillars, such as cankerworms.

2. Insects that feed by sucking juices. Aphids or plant lice attach themselves to growing shoots or the leaves. Scale insects attach themselves to the bark.

3. Insects that tunnel in trunks or branches (borers).

Make your trees less subject to insect attack by maintaining them in vigorous growing condition. If control measures become necessary, get the advice of your county extension agent or the U. S. Northern Great Plains Field Station.

ADDITIONAL INFORMATION

For further information on shelterbelts, write or see your county extension agent or the local technician for your soil conservation district.

Advice on species of trees and shrubs and local control measures for diseases, animal pests, and insect pests may be obtained from the following:

In North Dakota—U. S. Northern Great Plains Field Station at Mandan;

State or extension forester or agricultural college at Fargo.

In South Dakota—extension forester or agricultural college at Brookings.

In Montana—extension forester or agricultural college at Bozeman.

In Wyoming—extension forester or agricultural college at Laramie or Cheyenne Horticultural Field Station.

Common and Scientific Names of Species Included in Table 1

Common name	Scientific name
Ash, green-----	<i>Fraxinus pennsylvanica</i> var <i>lanceolata</i> (Borkh.) Sarg.
Boxelder-----	<i>Acer negundo</i> L.
Buffaloberry, silver-----	<i>Shepherdia argentea</i> Nutt.
Crab, Siberian-----	<i>Malus baccata</i> (L.) Moench
Currant, golden-----	<i>Ribes odoratum</i> Wendl.
Elm, American-----	<i>Ulmus americana</i> L.
Elm, Dropmore-----	<i>Ulmus pumila</i> L. var. Dropmore
Elm, Siberian-----	<i>Ulmus pumila</i> L.
Hackberry-----	<i>Celtis occidentalis</i> L.
Honeysuckle, Tatarian-----	<i>Lonicera tatarica</i> L.
Lilac, common-----	<i>Syringa vulgaris</i> L.
Lilac, Persian-----	<i>Syringa persica</i> L.
Maple, Amur-----	<i>Acer ginnala</i> Maxim.
Maple, silver-----	<i>Acer saccharinum</i> L.
Oak, bur-----	<i>Quercus macrocarpa</i> Michx.
Pea-tree, Siberian-----	<i>Caragana arborescens</i> Lam.
Pine, limber-----	<i>Pinus flexilis</i> James
Pine, ponderosa-----	<i>Pinus ponderosa</i> Laws
Pine, Scotch-----	<i>Pinus sylvestris</i> L.
Plains cottonwood-----	<i>Populus sargentii</i> Dode
Plum, American-----	<i>Prunus americana</i> Marsh.
Redcedar-----	<i>Juniperus virginiana</i> L.
Rocky Mountain juniper-----	<i>Juniperus scopulorum</i> Sarg.
Russian-olive-----	<i>Elaeagnus angustifolia</i> L.
Serviceberry-----	<i>Amelanchier alnifolia</i> Nutt.
Spruce, Black Hills-----	<i>Picea glauca</i> var. <i>densata</i> Bailey
Spruce, blue-----	<i>Picea pungens</i> Engelm.
Sumac, skunkbush-----	<i>Rhus trilobata</i> Nutt.
Willow, laurel-----	<i>Salix pentandra</i> L.
Willow, white-----	<i>Salix alba</i> L.
