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BASIC WINDBREAK DESIGN CRITERIA FOR FARM AND RANCH HEADQUARTERS AREAS AND LARGE RESIDENTIAL LOTS

Attached is Midwest National Technical Center Technical Note 190-LI-6, "Basic Windbreak Design Criteria for Farm and Ranch Headquarters Areas and Large Residential Lots."

The note contains excellent information and criteria that can be used to develop planting plans for windbreaks around homesteads. For most of California, the minimum number of rows will be one row as stated on page 7. Figure 12 on page 12 does not generally apply to California.

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NOTE

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BASIC WINDBREAK DESIGN CRITERIA FOR FARM AND RANCH HEADQUARTERS AREAS AND LARGE RESIDENTIAL LOTS

INTRODUCTION

A well designed, well maintained windbreak will be appreciated for its usefulness and beauty. Plantings made without thought to basic design principles, soils, and species selection often function and grow poorly. Poorly designed windbreaks may not protect key areas; they may deposit drifted snow on buildings, lanes, roads, feeding areas and other areas causing damage, expensive removal operations, blocked access roads or soil wetness problems. They can also be difficult to maintain.

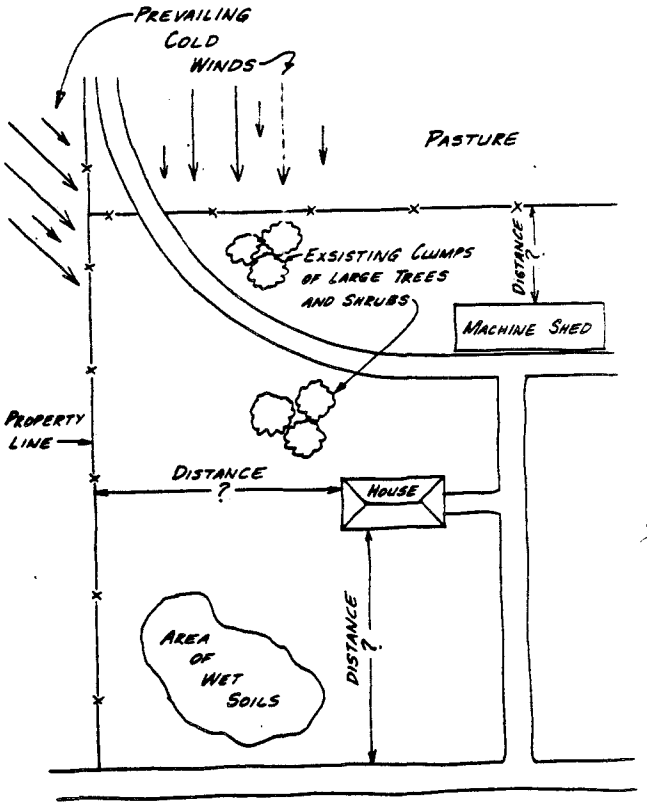
TERMINOLOGY

Windbreaks are frequently designated primary or secondary. Primary windbreaks are located on the sides where the greatest need for wind protection exists. For example, if the prevailing winds come from the north and west, the windbreak plantings on these sides are primary windbreaks. Any windbreak plantings on the south and east sides would be secondary windbreak plantings.

LOCATION

A preliminary review of any potential windbreak site is a must before any steps are taken to design a farm or ranch headquarters or residential windbreak. During the review, a sketch should be drawn of the area. All primary objects or areas in need of protection, existing windbreaks, other groves or clumps of trees and/or shrubs, soil problems, utilities, direction of prevailing or most troublesome winds, property lines and roads or access lanes should be noted. Figure 1 illustrates the type of information that is desirable in the sketch.

Figure 1



The sketch illustrated in figure 1 will be an important aid in the proper layout of a windbreak planting.

There are several general planning guidelines which must also be taken into account in the layout of a windbreak. The most important guidelines are:

1. Position the windbreak perpendicular or as nearly perpendicular to the most troublesome winds as possible.

2. For wind protection only, position the row containing the tallest growing tree species approximately 2-5 H from all primary areas or objects in need of protection. (H is the tree height.) See figure 2. Where the objects to be protected are located uphill from the windbreak, the row may need to be located closer to provide adequate wind protection. All areas in need of wind protection should be located within 10 H of the tallest tree row. Since H will change until the tallest tree row reaches maturity or becomes ineffective, it is suggested that the estimated height of the tallest tree species at 20 years of age be used for planning purposes.

When a primary area in need of protection is located more than 10 H leeward of a primary windbreak, supplementary windbreaks of one to three rows should be made at 8 to 10 H intervals leeward of the primary windbreak.

3. For wind and snow protection, there are different guidelines for windbreaks. It is still desirable to locate primary areas or objects in need of protection 2-5 H from the tallest tree row. However, in some areas, this could result in the burying of primary areas under deep drifts. To minimize problems associated with deep drifts, it is important to properly position the most windward row.

Figure 2

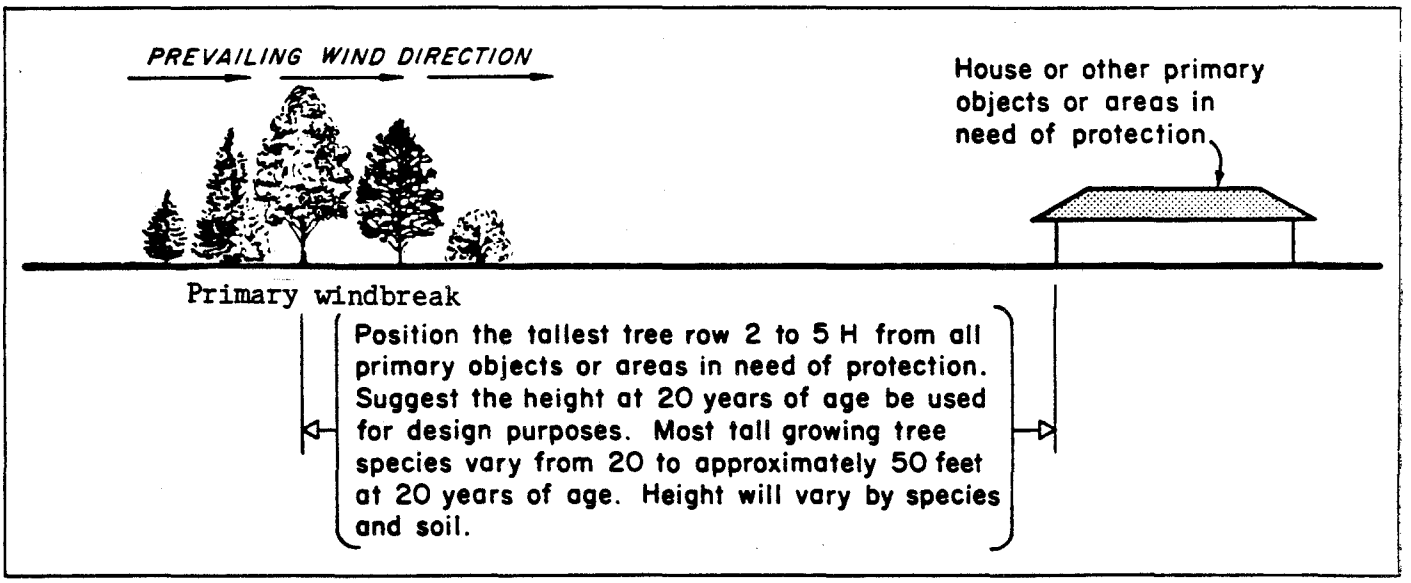


Figure 2. Cross section of windbreak for farm-ranch headquarters or large residential lots--Wind Protection Only

The windward row of a windbreak designed to provide protection from wind and drifting snow should be located 100 to 200 feet from primary areas or objects in need of protection. The distance will vary from region to region and should be based on the average length of snow drifts adjacent to typical windbreaks after severe storms. See figure 3. In the northern Great Plains where blowing snow can come from wide, open fields, the distance recommended is approximately 200 feet to the windward row of primary windbreaks. In most other areas, 100 to 150 feet is adequate.

4. The number of legs in a windbreak planting will depend upon the number of directions from which troublesome or problem winds occur. Windbreaks with one leg can be effective for controlling troublesome winds and/or drifting snow coming from one direction.

Figure 4 illustrates the effect that a one leg windbreak will have on north winds. For most windbreak plantings, all primary objects and areas in need of protection should be within the shaded area. It is important to note that farmstead, ranch, feedlot, and residential windbreaks with one leg are not effective against problem winds from more than one direction.

If troublesome winds or blowing snow are a problem from more than one direction, two or more legs will be needed to provide adequate protection. Figure 5 illustrates the area protected by two primary windbreaks; one is planted on the north and the other on the west side of objects and areas in need of protection. Again, all primary objects or areas in need of protection should be within the shaded zone and no more than 10 H leeward.

Figure 3

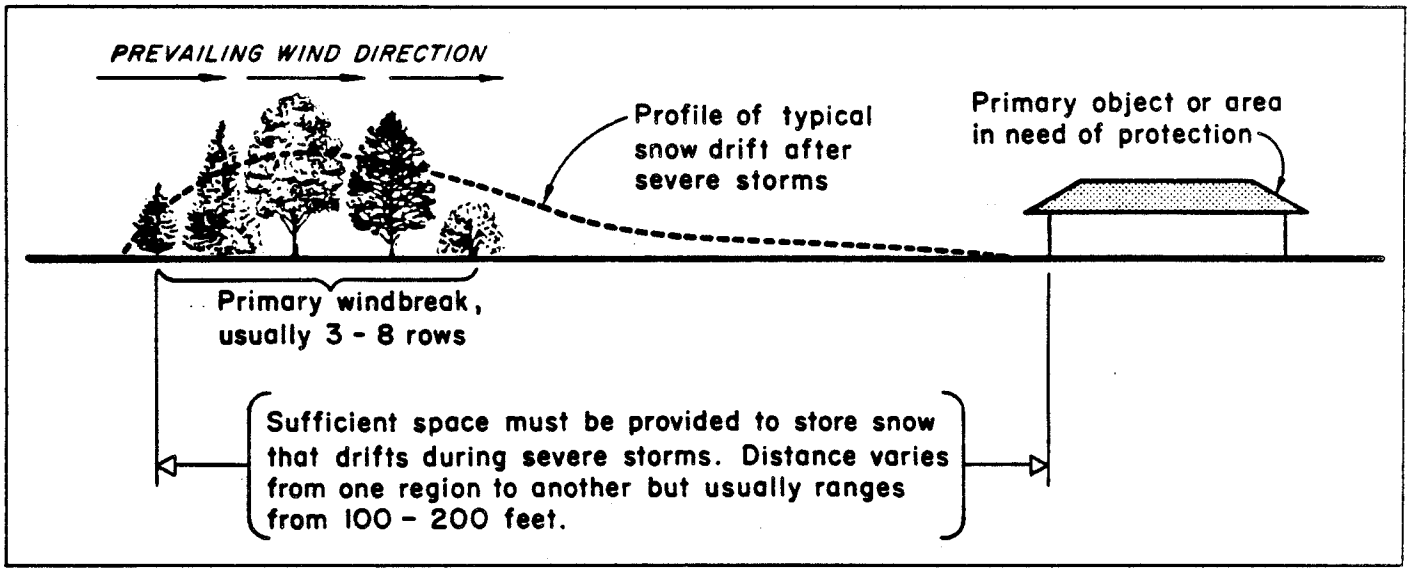
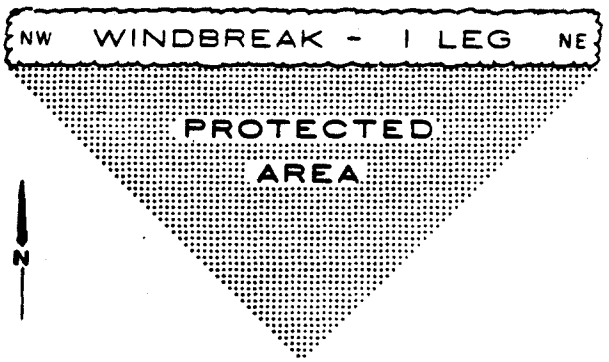
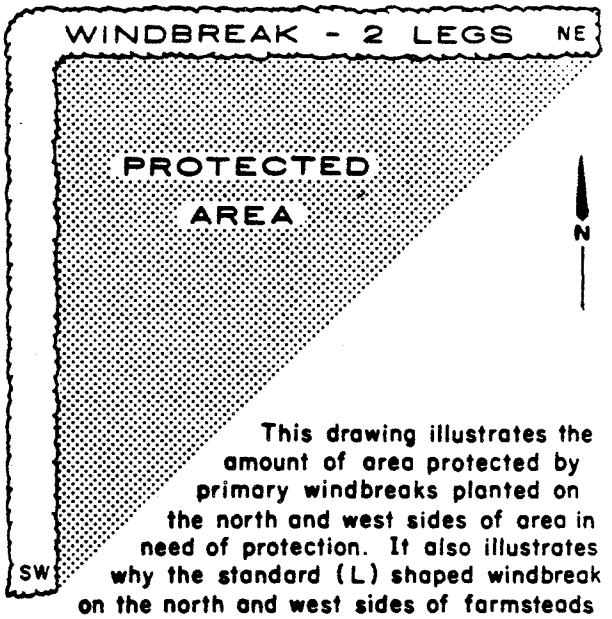


Figure 3. Cross section of windbreak for farm-ranch headquarters or large residential lots--Wind and Snow Protection Only



This drawing illustrates the amount of area protected by a primary windbreak planted on the north side of an area in need of protection. The area to be protected would be vulnerable to winds from all directions except from the north.

Figure 4. Area Protected by One Primary Windbreak



This drawing illustrates the amount of area protected by primary windbreaks planted on the north and west sides of area in need of protection. It also illustrates why the standard (L) shaped windbreak on the north and west sides of farmsteads and feedlots is necessary.

Figure 5. Area Protected by Two Primary Windbreaks

Using this approach, one can readily see that two primary windbreaks, one on the west side and one on the north side, would be needed to adequately protect the site shown in the sketch in figure 1.

Although in most areas, primary windbreaks are desirable on the north and/or west, there are some areas where there is a need for primary windbreaks on the south and east.

5. Access lanes or roads which cut through a windbreak designed only for wind protection should be at an angle to prevailing or troublesome winds. See figure 6. Access lanes or roads which are parallel to the prevailing wind direction will cause the winds to funnel through gaps.

Lanes or roads located at an angle to prevailing or troublesome winds will not allow wind to funnel into areas in need of protection.

Access lanes or roads which must be used during winter months in areas subject to severe snow blowing, should not cut through a windbreak. Lanes and roads located in such a manner are prone to deep snowdrifts. It can also be difficult to remove snow from such lanes or roads. It is recommended that access roads be located at the ends of windbreaks in areas beyond where snowdrifts form. The lanes or roads should be a minimum of 100 to 500 feet from the ends of the windbreaks to minimize snowdrift problems. See figure 7.

6. The soils of the potential planting site must be known. If there is more than one soil type, there may be a need to plant different tree and shrub species on each soil or to plant around areas of problem soils.

7. The location of property lines, subsurface drain fields, and septic fields must be known. Property lines can severely

Figure 6

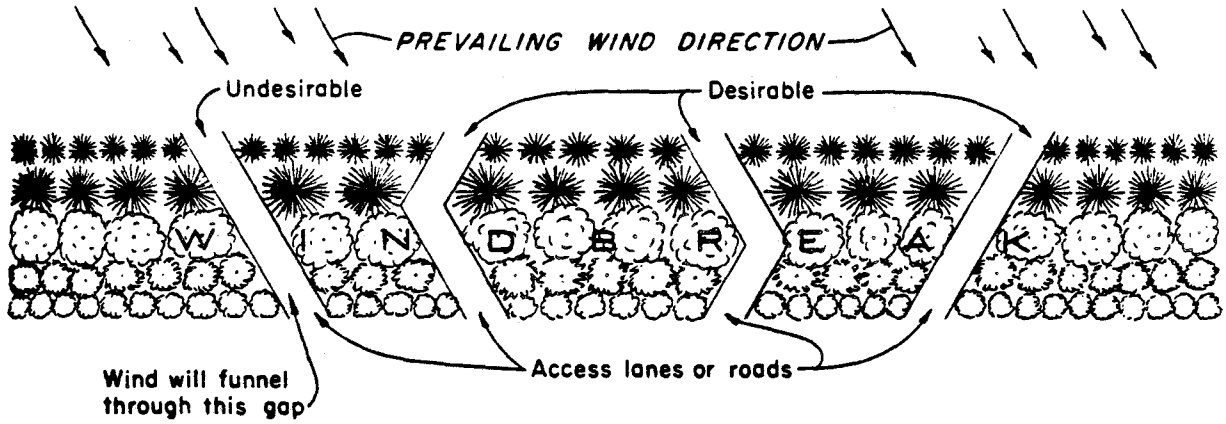


Figure 6. Access lanes and roads should be at an angle to prevailing or troublesome winds

Figure 7

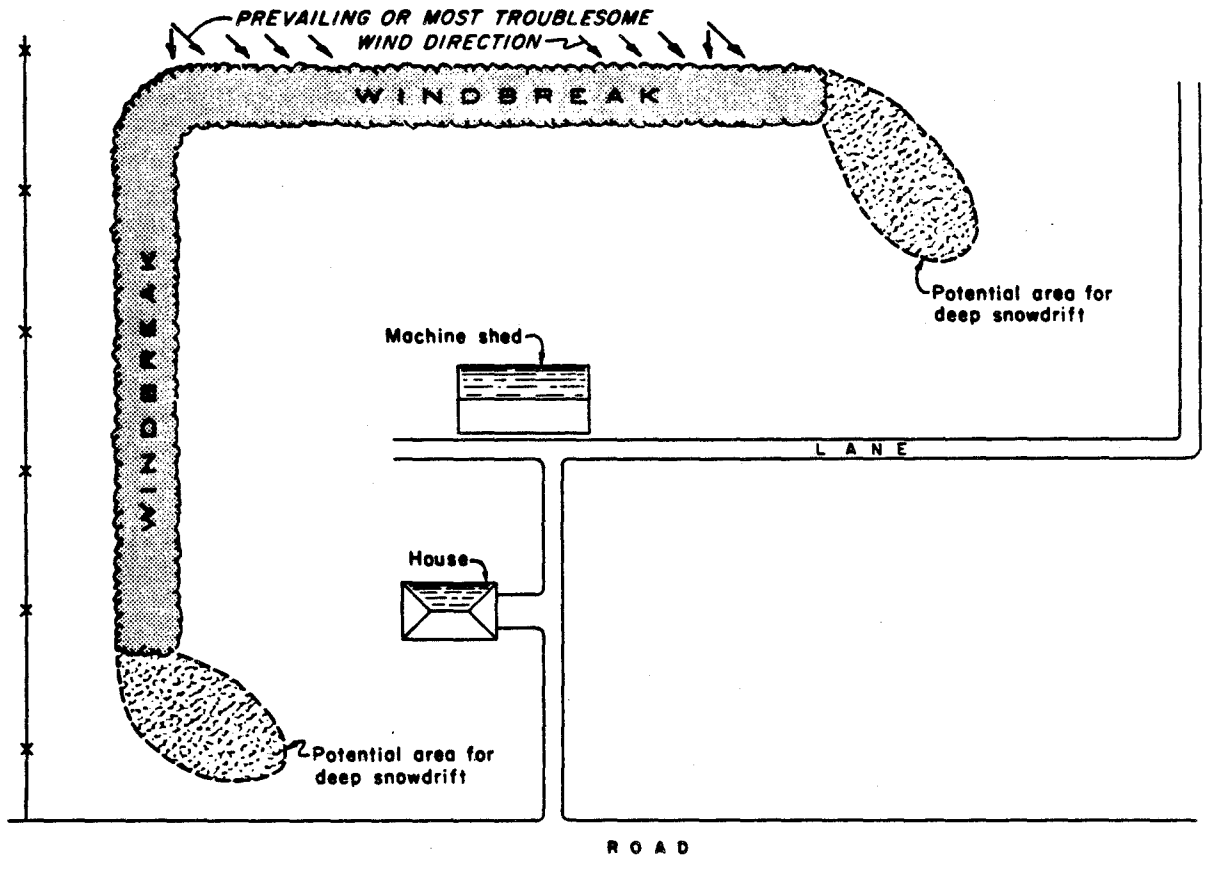


Figure 7. Locating of lanes and roads adjacent to windbreaks. Typical snowdrift pattern near end of windbreaks.

restrict the location of plantings. In some cases where severe snow drifting can be a problem and sufficient space is not available to properly locate a planting, it might be advisable not to plant all or a portion of a windbreak. Subsurface drain lines or septic fields should be relocated or avoided. Species such as the willows and poplars (includes cottonwoods) should not be planted within 100 feet of such lines or fields unless sealed conduit is used.

8. Any existing windbreaks, clumps or groves of trees or shrubs, and, in some cases, large individual trees, should be outside the boundaries of new windbreak plantings. New plantings should not be located within 50 feet of any existing trees if space is available. Where space is limited existing plantings should be incorporated into the design of new plantings or they should be removed.

Using the information from the sketch (figure 1) and the above guidelines, windbreaks can be properly located to provide protection from wind (figures 8 and 9) and wind and snow (figures 10 and 11).

The guidelines presented in figures 8, 9, 10, and 11 would not generally apply in rural or urban built up areas where lots are small (less than 1/4 acre). In these areas, the plantings on one lot can directly affect one or more adjacent lots.

Number of Rows

The recommended minimum number of rows will vary from one row in areas where only wind protection is of concern to 8-10 rows in the northern Great Plains where high winds and severe snowdrift problems are common. Instead of being concerned about the density of the species being planted, there has been a tendency to be concerned about the number of rows needed. Research and experience have shown that dense windbreaks (those that exceed 65 percent density) are needed to provide adequate protection from wind and drifting snow around buildings, feedlots, etc. Therefore, the density of the species planted should be more important than the number of rows.

A deciduous tree in full leaf has a density of 65 percent or greater. A deciduous tree without leaves has a density from 40-65 percent. These densities vary depending upon the thickness of the tree crown (number of branches and branching pattern).

In areas where only wind protection is needed, a single row of pines, spruces or arborvitae could provide the desired density and protection. However, since trees and shrubs are living things and since living things are subject to insect and disease problems, the recommended minimum design should be two to three rows of trees. To minimize the potential impact of any future insect or disease problem, it is recommended that the rows be of different species. Combinations of evergreen species, evergreen species and deciduous trees or shrubs or deciduous trees and shrubs can all give desired densities. Where adequate space is available, it is highly recommended that thought be given to using a variety of species in

Figure 8

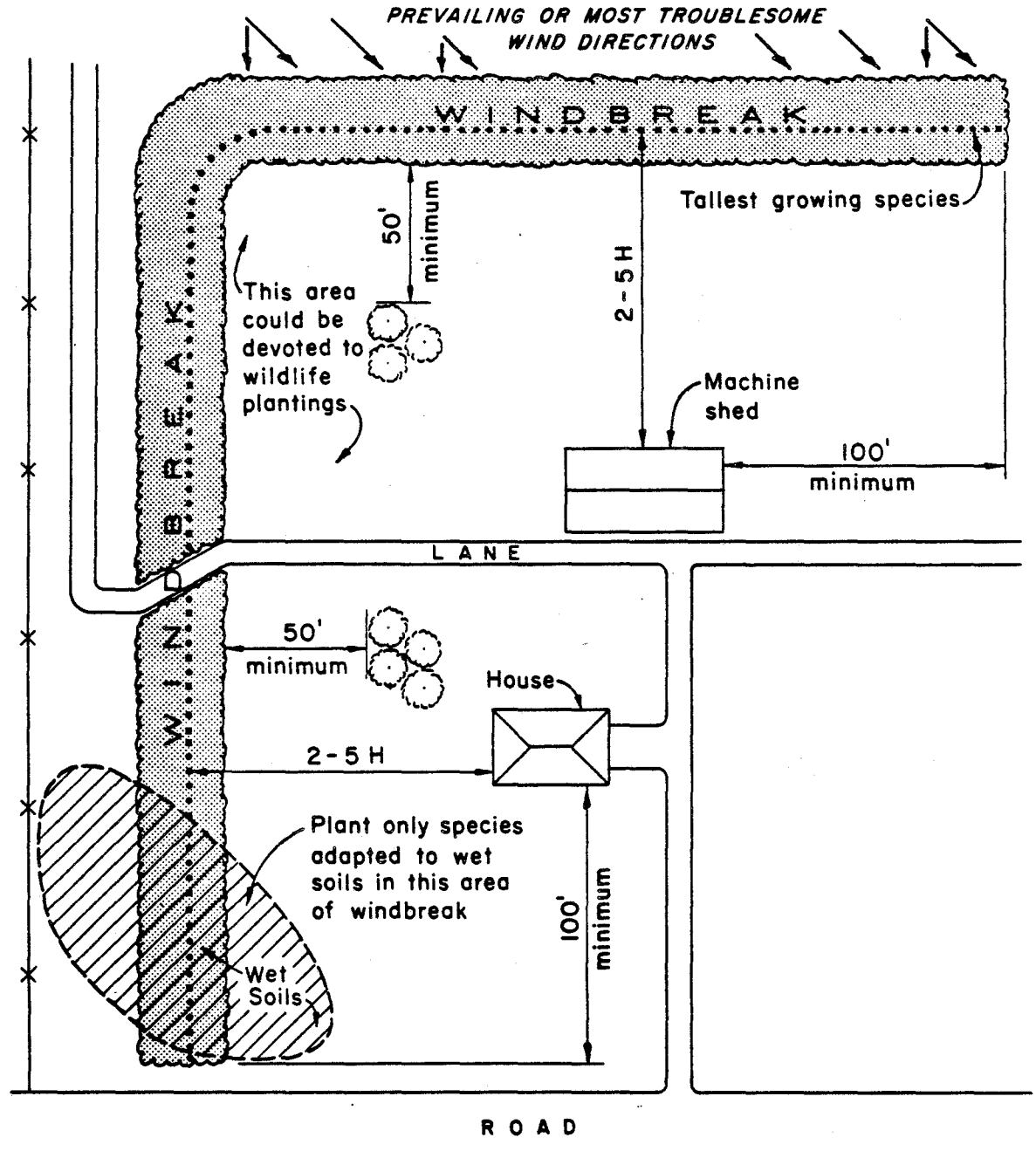


Figure 8. Design for wind protection only--wet soils suitable for planting

Figure 9

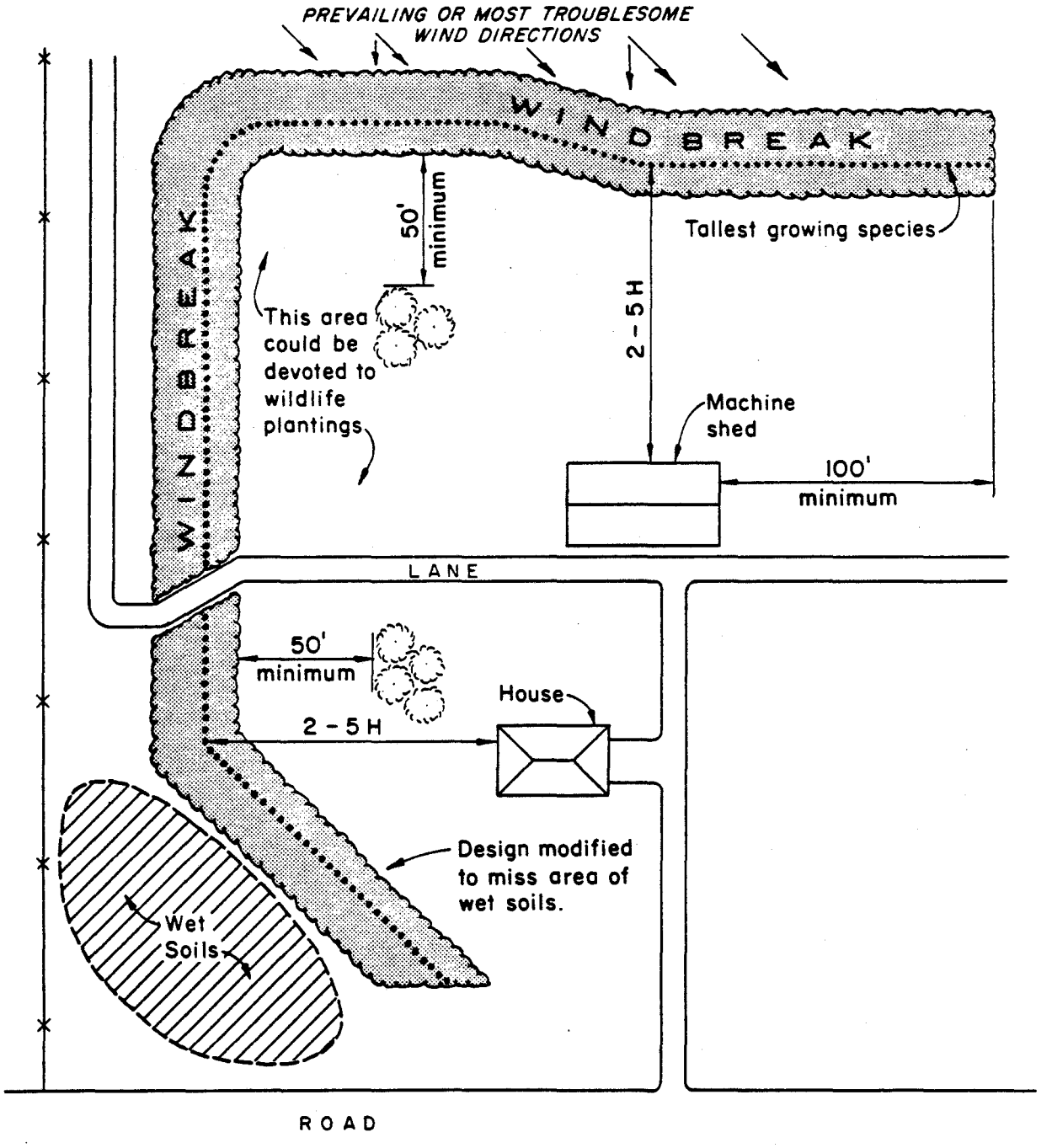


Figure 9. Design for wind protection only--wet soils unsuitable for planting

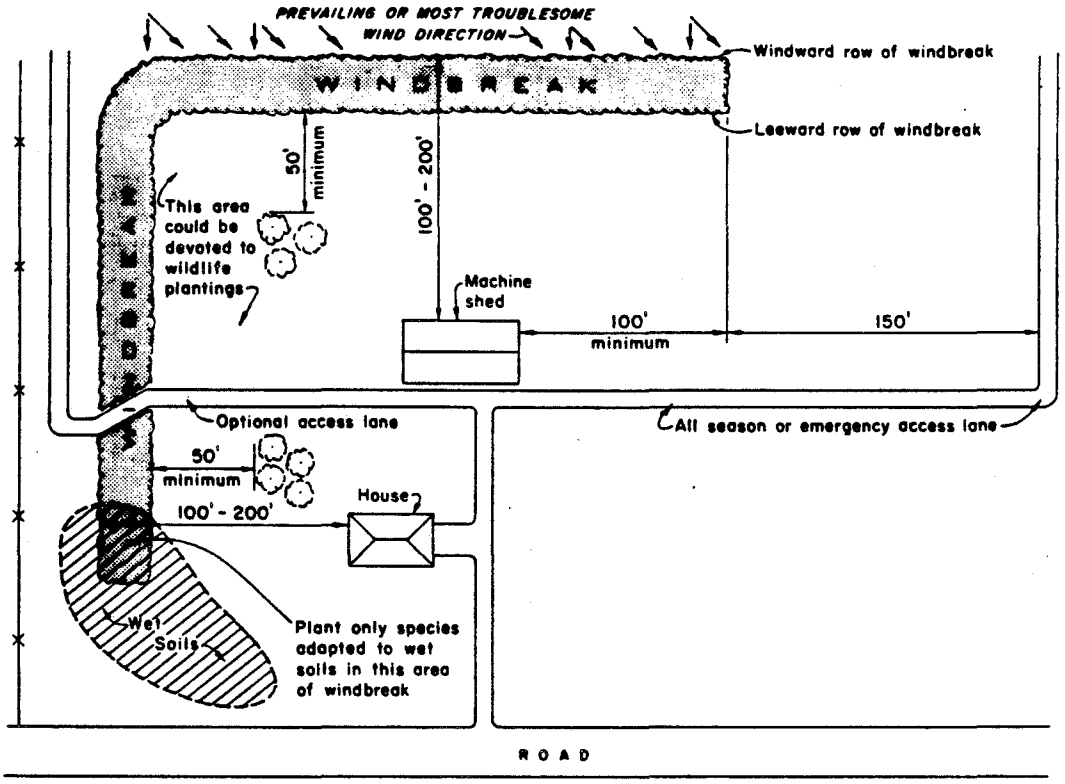


Figure 10. Design for wind and snow protection--wet soils suitable for planting

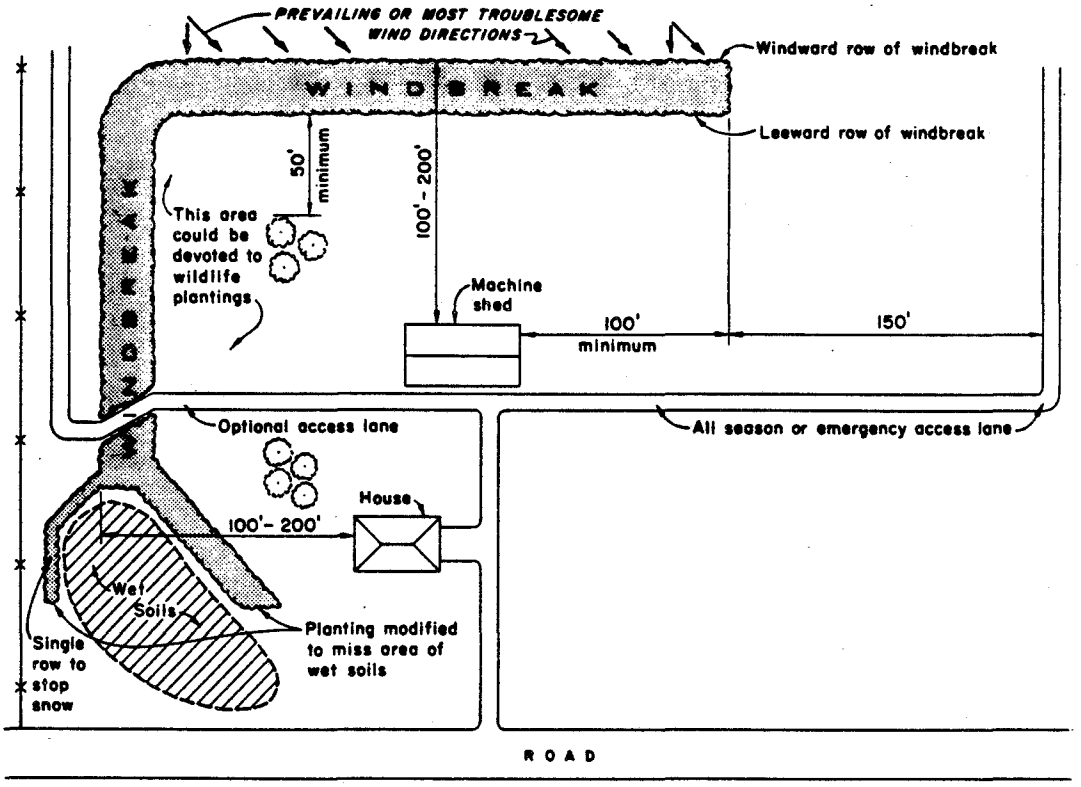


Figure 11. Design for wind and snow protection--wet soils not suitable for planting

more than the minimum number of rows. The added variety and number of rows will significantly enhance wildlife, beautification and general landscape values.

Except for the northern Great Plains states and other states subject to severe winter storms with large amounts of blowing and drifting snow, two to three rows of trees of the desired density can provide adequate protection from blowing snow. However, since most tree species take several years before they become effective against snow, it is highly recommended that an additional row or rows of dense, fast growing, closely planted shrubs or shrubby trees be added. The row of shrubs or shrubby trees can provide adequate protection from blowing snow within 3 to 4 years. This can significantly reduce snow removal costs within a short period of time. Figures 12 and 13 illustrate the minimum number of rows in a windbreak for wind protection and for wind and snow protection in states not subject to severe winter storms with large amounts of blowing snow.

Species

The species of trees and shrubs that are planted must be adapted to the planting site. They should be relatively free of any serious insect or disease problems. Light insect injury or minor disease problems can be tolerated. The primary concern is that the trees have the desired density and the potential to provide a reasonable amount of protection from wind within 10 years. In areas subject to blowing snow the windbreak should be designed to keep snow from being a problem within the farmstead or ranch headquarters areas or around the residence within 3 to 5 years.

Soils

Soils play a very important role in the selection of species for the site. For tree and shrub species to become well established and to grow in a satisfactory manner, they must be adapted to the soils of the windbreak site. Some species of trees and shrubs are adapted to a wide range of soil conditions. Others do well only on wet or moist sites. Some can tolerate high lime conditions; others cannot. In most areas, soils information is readily available for most tree and shrub species.

When dealing with sites with more than one soil, it is best to plant species that will grow satisfactorily on all the soils. However, this is not always possible. Where soil properties are drastically different, it is best to plant only those species which are adapted to each soil. Failure to do so can result in large gaps or weak spots in windbreaks. These gaps or weak spots can have a serious effect on the way windbreaks function.

Row Arrangement

The arrangement of species in plantings should follow these general guidelines. Shrubs, short trees and slower growing trees should generally be located in the outer rows of plantings. They should not be positioned between two taller growing species. See figure 14. By placing them in the outer rows, it assures them of adequate light and allows them room to develop.

Figure 12

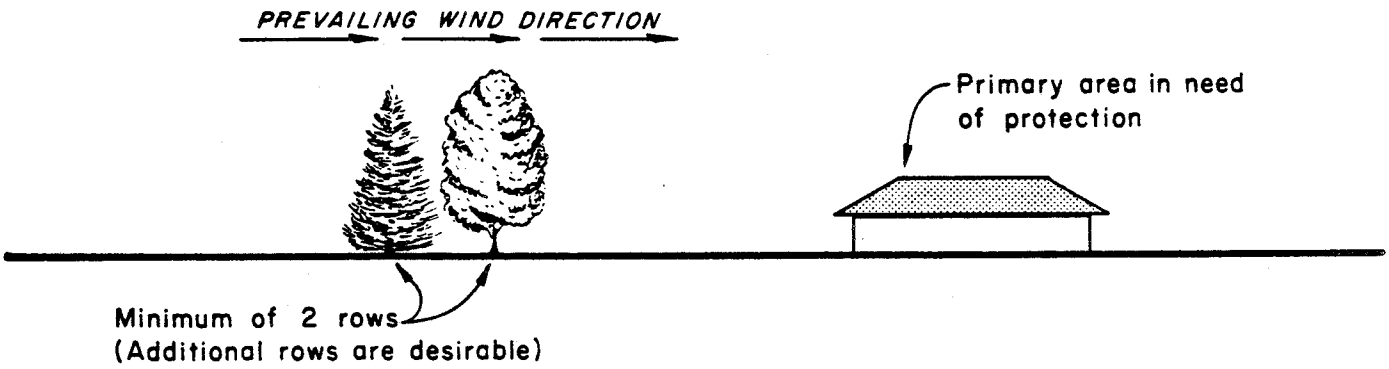


Figure 12. Minimum number of rows in a windbreak where blowing and drifting snow is not a problem

Figure 13

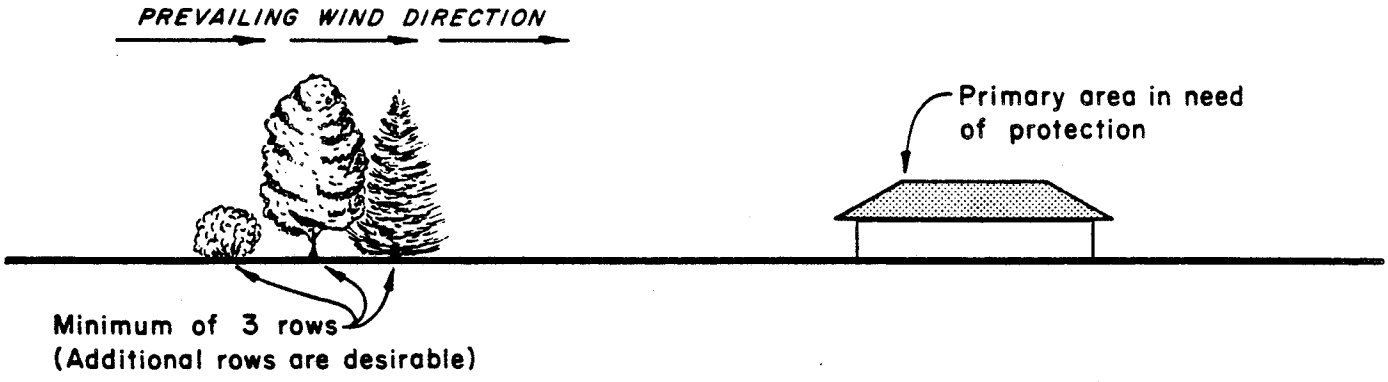
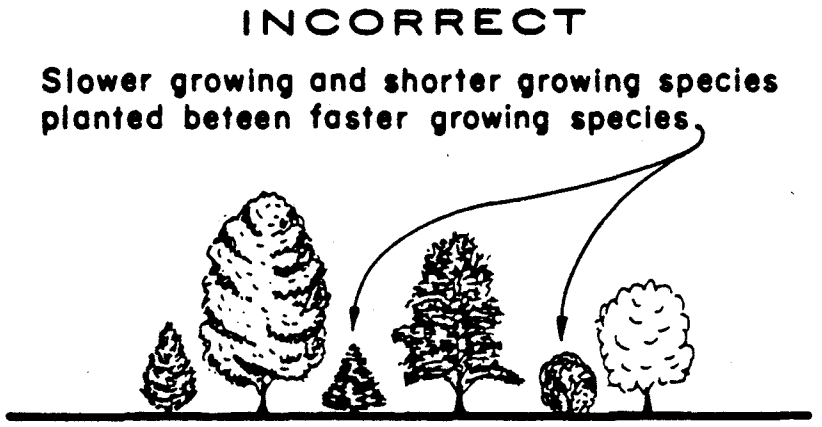


Figure 13. Minimum number of rows in a primary windbreak where severe winter storms with large amounts of blowing and drifting snow are not common

Figure 14.



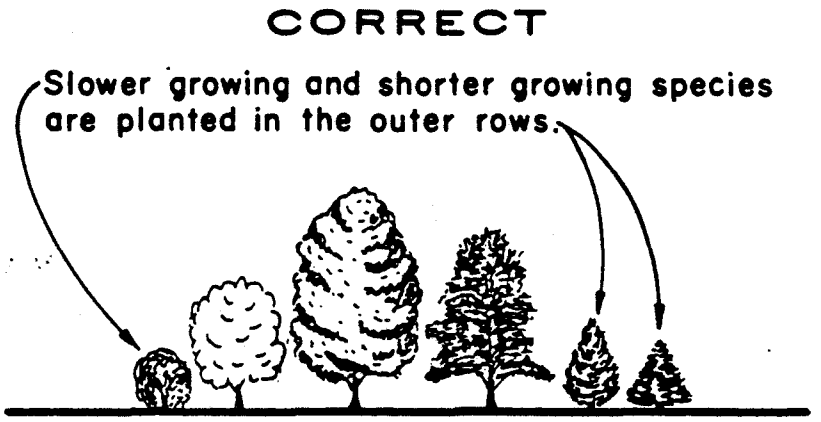


Figure 14 Placement of slower growing and shorter trees and shrubs.

Prevention of Breakage by Snow

In areas where deep snow drifts commonly occur in windbreaks, it is generally best to place those tree and shrub species most subject to breakage in the leeward rows. Although this will minimize the breakage hazard, it will not eliminate it. The best way to control snow breakage is to plant a snow trap. A snow trap can be formed by planting one or more rows of trees or shrubs windward of the primary windbreak.1/ See figure 15. The planting should be located a minimum of 50 feet windward of the most windward row of the primary windbreak. If both plantings are established at the same time, the row or rows forming the snow trap could be considered as part of the main planting. Where snow drifts are causing damage to existing plantings, temporary snow traps can be created by installing a snow fence or leaving several rows of standing corn. See figures 16 and 17.

Figure 15

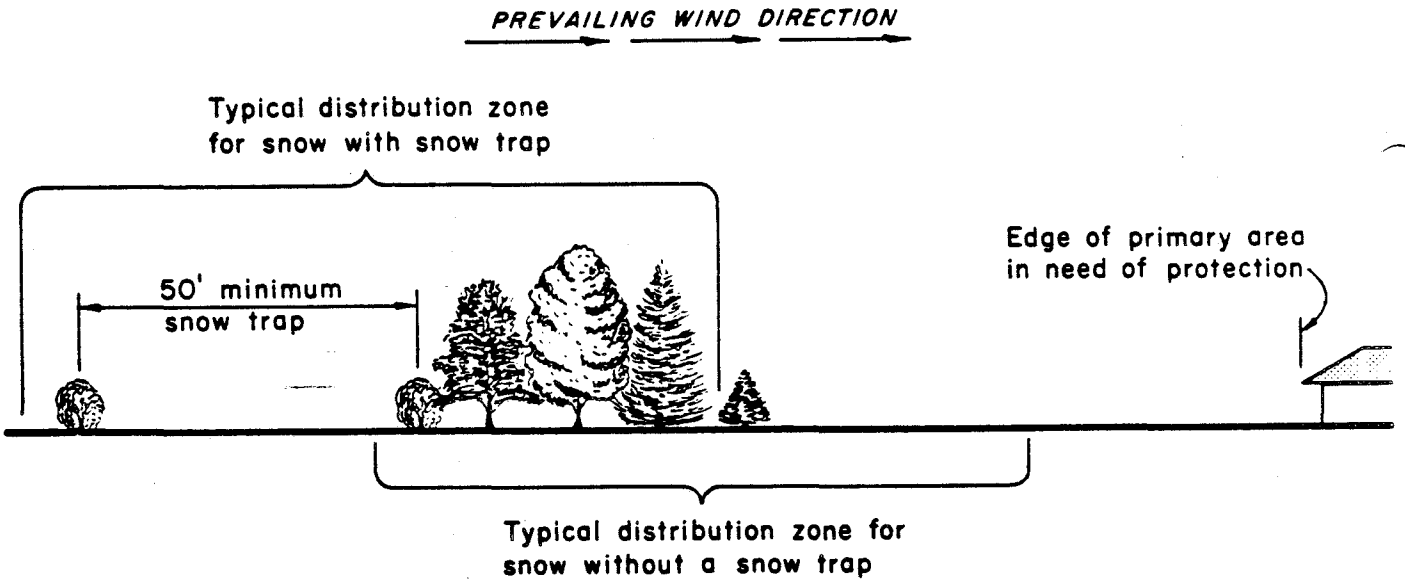


Figure 15. Snow traps significantly change the distribution of snow within and adjacent to windbreak plantings

1/ Perennial grass barriers could also be used.

Figure 16

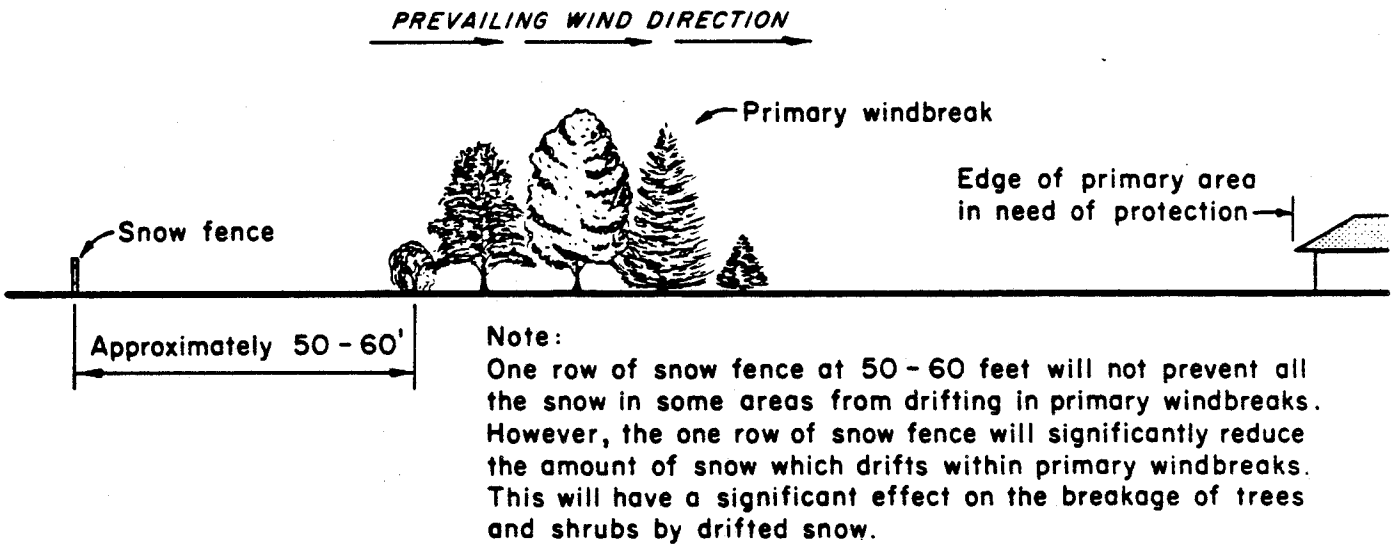


Figure 16. Using snow fence to control snow in primary windbreaks.

Figure 17

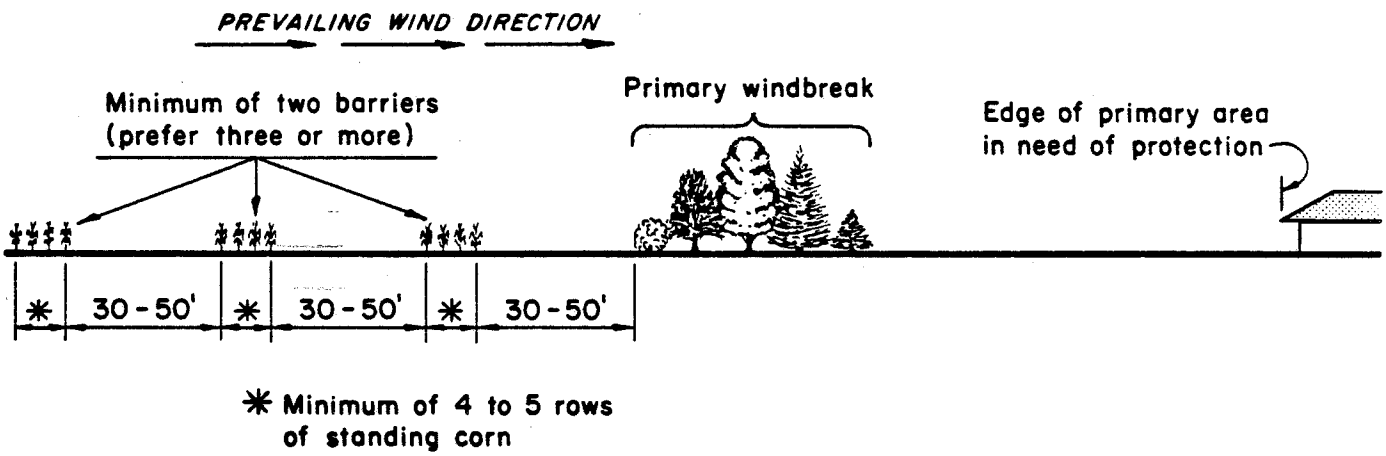


Figure 17. Using standing corn to control snow in primary windbreaks (other annual or perennial barriers can be used with appropriate adjustments in spacing interval based on effective winter height)

Spacing

The recommendations for between-the-row and within-the-row spacings are quite variable. However, to determine the spacing between-the-row, there are some general guidelines to follow. In windbreak plantings that are to be cultivated, always leave enough room for the equipment to pass freely between-the-rows. A safe rule to follow is to space rows at the width of the cultivation equipment plus four feet.

Example: If the cultivation equipment is 12 feet wide, the between-the-row spacing should be a minimum of 16 feet wide to prevent serious damage to plantings.

Figure 18

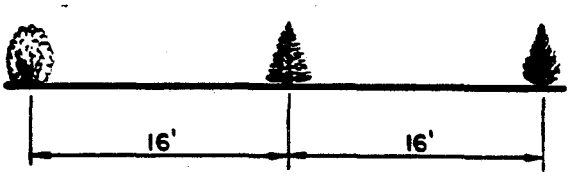


Fig. 18. Where equipment is used to cultivate planting--space rows the width of cultivation equipment plus 4 feet.

In windbreak plantings where competing vegetation is to be controlled by mowing, mulching, or herbicides, the minimum between-the-row spacing should be approximately 8 feet. Maximum spacings between-the-row have not been determined; however, the practical limits appear to be between 25 and 30 feet.

A practical reason for using close (8 to 20 feet) between-the-row spacings is for weed control. Experience has shown that ground shading is an effective way to control competing vegetation. Within-the-row spacings are also quite variable. The spacings for most shrub species vary from 3 to 6 feet, deciduous tree species 6 to 15 feet and evergreens (pine, spruces, and arborvitae) 6 to 20 feet.

Serious problems can occur when entire plantings are planted at wide within-the-row and between-the-row spacings.

This is especially true of plantings which are composed solely of one species. In cases where plantings are composed entirely of spruces and pines planted at 15 feet or more within and between-the-rows, it has been found that they can be relatively ineffective for wind protection and snow control, even at 10 to 12 years of age. See figure 19. Since all windbreaks should be designed to provide significant amounts of wind protection within 10 years, one row of trees within the windbreak should be capable of forming a complete barrier and be at least 10 to 15 feet in height. On droughty sites where all tree and shrub species grow slowly, additional design modifications can be made to assure a significant amount of protection within 10 years. A complete barrier can be formed within 10 years utilizing a narrower within-the-row spacing in one row (figure 20) or by utilizing a fast growing, wide spreading, moderately dense or dense tree species. See figure 19 and figure 20.

Figure 19

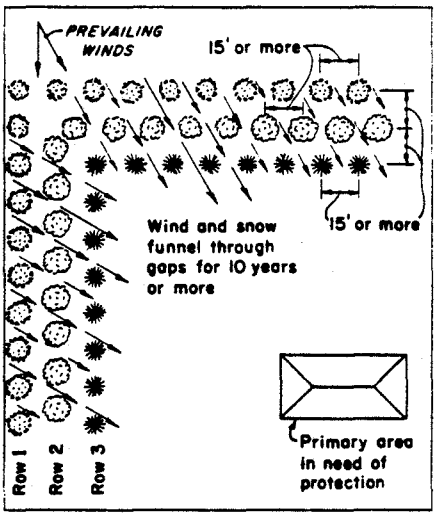


Fig. 19. Planting of spruces and pines identical within- and between-the-row spacing of approximately 15 feet or more may not effectively control wind or snow within 10 years. By modifying the row spacing in row 1 and row 2, this can be corrected. See Fig. 20.

Figure 20.

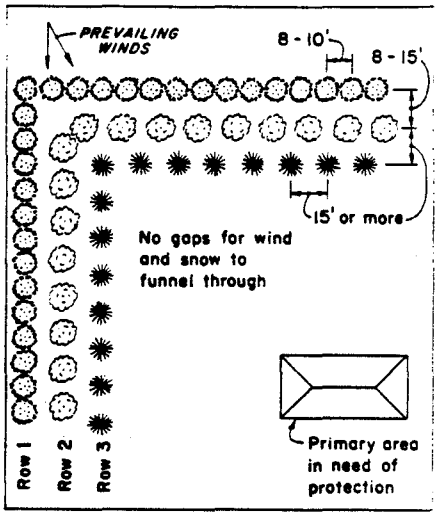


Fig. 20. Problems identified in figure 19 could be overcome by planting the seedings in row 1 or row 2 at within-the-row spacings of 8-10 feet.

Windbreaks in areas where serious snow drifting can occur should be designed to control snow within 3 to 5 years. This can be accomplished by planting one row of dense, fast or relatively fast growing shrubs or small trees in the most windward row at 3-5 feet spacings within the row.

The design criteria included in this technical note is not completely adequate for the design of windbreak plantings made for the protection of livestock in feedlots. When livestock are involved, critical attention must be given to drainage within and adjacent to the feeding area, control of snow, diversion of water and feedlot wastes and the disposal of feedlot wastes. It is planned that these problems will be addressed in more detail in a future technical note devoted to feedlot windbreaks.

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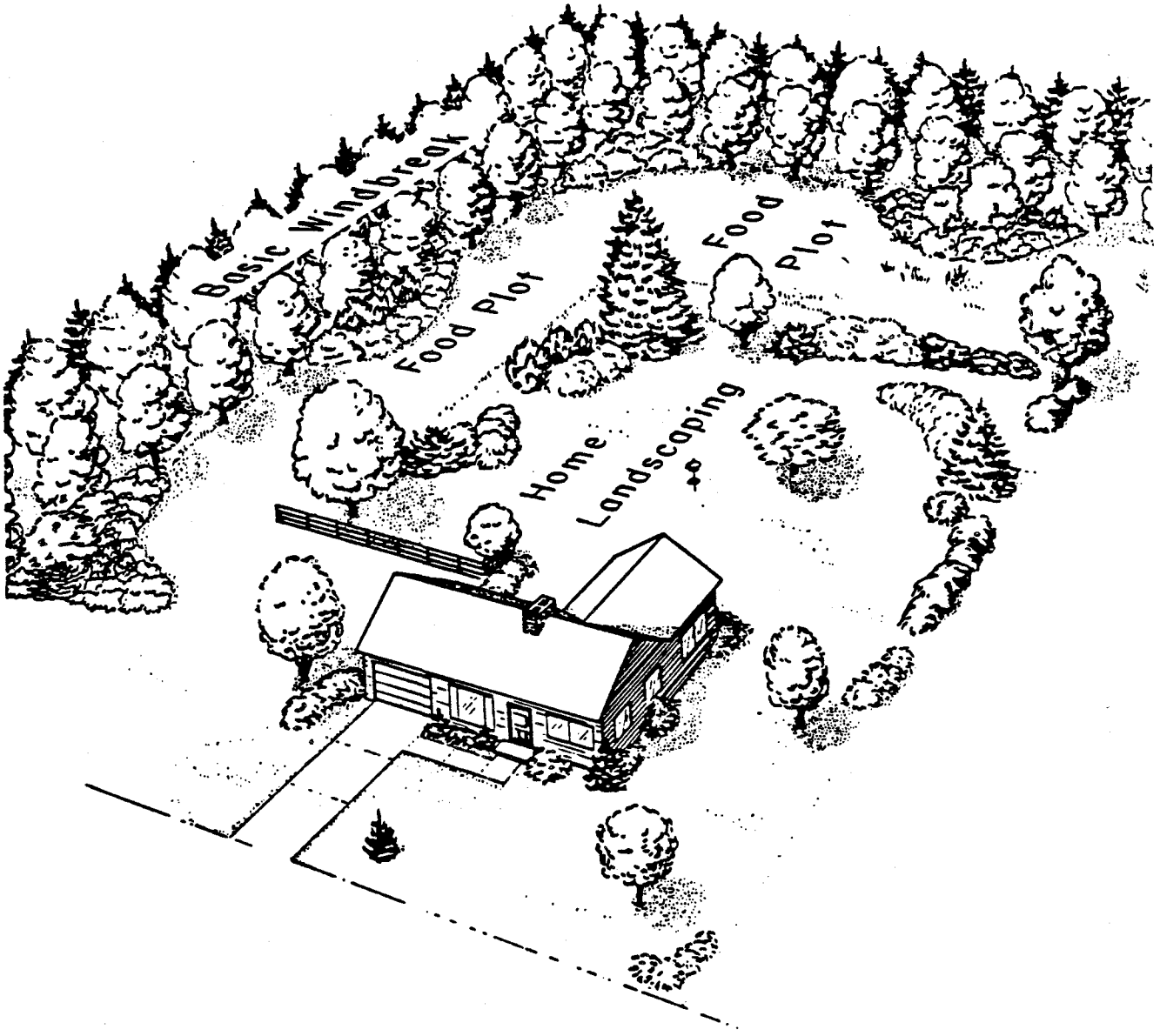

Basic components of a good farmstead, ranch headquarters or residential windbreak-wildlife planting.