NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WINDBREAK/SHELTERBELT ESTABLISHMENT

(Ft.)

CODE 380

DEFINITION

Windbreaks or shelterbelts are single or multiple rows of trees or shrubs in linear configurations.

PURPOSE

- Reduce soil erosion from wind.
- Protect plants from wind related damage.
- Alter the microenvironment for enhancing plant growth.
- Manage snow deposition.
- Provide shelter for structures, animals, and people.
- Enhance wildlife habitat.
- Provide noise screens.
- Provide visual screens.
- Improve air quality by reducing and intercepting air borne particulate matter, chemicals and odors.
- Delineate property and field boundaries.
- Improve irrigation efficiency.
- Increase carbon storage in biomass and soils.
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

Apply this practice on any areas where linear plantings of woody plants are desired and suited for controlling wind, noise, and visual resources.

CRITERIA

General Criteria Applicable to All Purposes

Specific design criteria for Windbreak/Shelterbelt are contained in Appendix 1 of this standard.

The location, layout and density of the planting will accomplish the purpose and function intended within a 20-year period.

Refer to Tree/Shrub Site Preparation Standard 490, for preparing site conditions for plant establishment.

Species must be adapted for the planned practice purpose(s) and to the soils, climate and site conditions.

Refer to Tables 1 and 2 in Section IV of the FOTG – Tools – Tree/Shrub establishment guide for KY. Other species may also be suitable for use in windbreak/shelterbelt establishment. Consult the Division of Forestry personnel, the NRCS staff forester or biologist to determine suitability.

Plant Guide and Plant Information Sheets for individual species found in the USDA Plants Database can be utilized to supplement the material in this standard. http://plants.usda.gov

No plants on the Federal or state noxious weeds list shall be planted.

Spacing between individual plants shall be based on the needed growing space for plant type and species, the accommodation of maintenance equipment, and the desired characteristics of the stem(s), branches and canopy as required for a specific purpose.

The windbreak will be oriented as close to perpendicular to the troublesome wind as possible.

The length of the windbreak will be sufficient to protect the site including consideration for the “end effect” and changes in wind direction.

Avoid planting trees or shrubs where they will interfere with structures, agricultural operations and above or below ground utilities.

Moisture conservation or supplemental watering shall be provided for plant establishment and growth where natural precipitation is too low for the selected species.

Refer to Tree/Shrub Establishment Standard 612 for further guidance on planting trees and shrubs.

The maximum design height (H) for the windbreak or shelterbelt shall be the expected height of the tallest row of trees or shrubs at age 20 for the given site. Heights may be based on any of the following:

- Performance of the individual species in nearby areas on similar sites under similar conditions
- Documented heights in the USDA Plants Database for a particular species and use
- "20-year" and "mature" heights for some common tree and shrub species may be found in the USDA Plants Database
- http://plants.usda.gov
- or Tree/Shrub Lists for KY located in the FOTG, Section IV - Tools.

The distance that protection extends from the windbreak's leeward side is proportional to its height. The most effective zone of protection extends to a distance 2 to 5 times its height, while significant protection extends to 10 times its height.

Site preparation shall be sufficient for establishment and growth of selected species, not contribute to erosion, and be appropriate for the site. Refer to (490) Tree/Shrub Site Preparation.

Refer to the publication "Windbreak Establishment"(University of Nebraska Extension EC-1764) located in the FOTG, Section IV - Tools for additional information.

Plantings are to be located across prevailing wind direction and on hilly terrain, along the contour when possible.

Only viable, high quality and adapted planting stock or seed will be used.

Multiple species, within rows, may be used if heights and growth forms are similar.

The planting shall be done at a time and manner to insure survival and growth of selected species. Refer to (612)Tree and Shrub Establishment.

The method of planting shall include hand or machine planting techniques and be suited to achieving proper depths and placement of the planting stock roots – See Tree and Shrub Establishment – 612.

Plantings will be protected from livestock, grazing, and fire. In most instances other exclusionary measures will be necessary to protect plantings from wildlife browse during the establishment period. Refer to (472) Access Control, (612) Tree/Shrub Establishment, (394) Firebreak and (382) Fence.

Avoid locations that will create hazards to safety and health such as road ditches, junctions, and utility rights-of-way.

Roadways should not be located along the rows of the windbreak; they should be at an angle or in curves to reduce wind tunneling.

Refer to (595) Integrated Pest Management if pesticide recommendations or mitigative strategies are needed on a particular site.

Comply with applicable federal, state and local laws and regulations during the installation, operation, and maintenance of this practice.

Additional Criteria to Reduce Wind Erosion and Protect Growing Plants

The interval between windbreaks shall be determined using current, approved, wind erosion technology. Interval widths shall not exceed that permitted by the soil loss tolerance (T), or other planned soil loss objective. Calculations shall account for the effects of other practices in the conservation management system.

For wind erosion control, temporary measures will be installed to supplement the windbreak until it is fully functional.

Sites, fields, and plants are protected within an area 10 times the design height (H) on the leeward side and two times the design height (H) on the windward side of the windbreak.

Select species that are taller than the crops being protected.

Additional Criteria to Manage Snow Deposition

The windbreak will be oriented as close to perpendicular to the snow-bearing wind as possible.

For snow distribution across a field, the windbreak density (during expected snow-producing months) shall not be less than 25 percent or greater than 50 percent. The interval between barriers will not exceed 20H.

For snow accumulation, the minimum barrier density, during expected snow-producing months, will be 50 percent.

The length of the windbreak will extend beyond the area being protected to allow for end drifts.

Windbreaks will be located so that snow deposition will not pose a health or safety problem, management constraints, or obstruct human, livestock or vehicular traffic.

Where water erosion and/or runoff from melting snow is a hazard, it shall be controlled by supporting practices.

The windward row will be at least 100 feet from the area to be protected.

Refer to "Windbreaks for Snow Management" (University of Nebraska Extension EC-1770) located in the FOTG, Section IV - Tools for additional information.

Additional Criteria to Provide Shelter for Structures, Livestock and People

For wind protection, the minimum barrier density will be 65 percent during the months of most troublesome wind.

The area to be protected will fall within a leeward distance of 10H.

Drainage of snowmelt from the windbreak shall not flow across the livestock area.

Drainage of livestock waste from the livestock area shall not flow into the windbreak.

Refer to “Windbreaks for Livestock Operations” (University of Nebraska Extension EC-1766) for additional information.

Additional Criteria for Noise Screens

Noise screens shall be at least 65 percent dense during all times of the year, as tall as, and as close to the noise source as practicable.

The length of the noise screen shall be twice as long as the distance from the noise source to the receiver.

For high-speed traffic noise, the barrier shall not be less than 65 feet wide. The edge of the planting should be 100-150 feet from the center of the nearest traffic lane. The tallest tree row should be capable of attaining a mature height of at least 45 feet.

For moderate speed traffic noise, the barrier width shall not be less than 20 feet wide. The edge of the planting should be 50-80 feet from the center of the nearest traffic lane. The tallest tree row should be capable of attaining a mature height of at least 30 feet.

Species selected will be tolerant to noxious emissions, sand, and gravel depositions or salt spray from traffic areas.

Additional Criteria for Visual Screens

Visual screens shall be located as close to the observer as possible with a density, height and width to sufficiently block the view between the area of concern and the sensitive area.

Use plants that will add color, texture, and diversity to the site.

Additional Criteria Improve Air Quality by Reducing and Intercepting Airborne Particulate Matter, Chemicals and Odors

The windbreak interval shall be less than or equal to 10h depending on site conditions and related supporting conservation practices.

Windbreak density on the windward side of the problem source, (i.e. particulate, chemical or odor) shall be greater than 50% to reduce the airflow into the source area.

Windbreak density on the leeward side of the problem source, and windward of the area to be protected, shall be greater than 65%.

Select and maintain tree and shrub species with foliar and structural characteristics to optimize interception, adsorption and absorption of airborne chemicals or odors.

Additional Criteria for Increasing Carbon Storage in Biomass and Soils

Maximize width and length of the windbreak to fit the site.

For optimal carbon sequestration, select plants that have higher rates of sequestration in biomass and soils.

Plant and manage the appropriate plant spacing for the site that will maximize above and below ground biomass production

Minimize soil disturbance during establishment and maintenance of the windbreak/shelterbelt.

Select plants that are adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

Use fast growing species in a mix with long-lived species.

Maintain optimal water and nutrient needs for the planting.

Additional Criteria for Enhancing Wildlife Habitat

Plant species selection shall benefit targeted wildlife species including pollinators.

Design dimensions of the planting shall be adequate for targeted wildlife species.

Add rows to a planting to increase wildlife benefits. A minimum of three rows is required wqhen the primary purpose is wildlife habitat or linkage of habitat through corridors.

Use plants of different sizes, growth forms, food bearing and densities to increase plant diversity.

The windbreak layout should include a partial east-west orientation, if possible

During winter months, direct sunlight is available on southern rows throughout the day. The opportunity to "sun" in a protected southern exposure decreases food needs for wildlife.

For pollinators, a woody pollinator mix shall contain a minimum of three species in each of the three blooming periods (very early, early and mid). Note: Late season species may be included if available in lieu of very early season species.

Trees and shrubs should be planted at a close spacing to aid in pollinator access but also allow for maximum crown development and bloom.

Planting materials may be seedlings, containerized or balled and burlapped.

Additional Criteria for Improving Irrigation Efficiency

For sprinkler irrigation systems, the windbreak shall be taller than the spray height.

The windbreak shall not interfere with the operation of the irrigation system.

Additional Criteria to Reduce Energy Use

Orient the windbreak as close to perpendicular to the troublesome wind as possible

Use proper plant density to meet energy reduction needs.

Use plants with a potential height growth that will be taller than the structure or facility being protected.

CONSIDERATIONS

Consider enhancing aesthetics by using evergreen species or species with features such as showy

flowers, brilliant fall foliage, or persistent colorful fruits.

When designing and locating a windbreak or shelterbelt, consider the impact upon the landowner's or public's view of the landscape.

Selection of plants for use in windbreaks should favor species or varieties tolerant to herbicides used in the area.

Plants that may be alternate hosts to undesirable pests should be avoided. Cedar – apple rust is an example.

All plantings should complement natural features.

Tree or shrub rows should be oriented on or near the contour where water erosion is a concern. Where water erosion and/or runoff from melting snow is a hazard, it should be controlled by supporting practices.

Wildlife and pollinator needs should be considered when selecting or siting tree or shrub species. Species diversity, including use of native species, should be considered.

Species diversity, including use of native species, should be considered to avoid loss of function due to species-specific pests.

Consider the invasive potential when selecting plant species.

Windbreaks for odor and chemical control increase in effectiveness as the amount of foliage available for intercept increases. Multiple-row, wide plantings offer greater interception potential than do smaller plantings.

When using trees and shrubs for greenhouse gas reductions, prediction of carbon sequestration rates should be made using current, approved carbon sequestration modeling technology.

A shelterbelt can be used as a travel corridor to connect existing patches of wildlife habitat.

In cropping systems select windbreak and shelterbelt species that minimize adverse affects to crop growth (e.g. shade, allelopathy, competing root systems or root sprouts).

Windbreaks/shelterbelts are appropriate places to establish pollinator habitats. Desirable species should be selected that encourage use by pollinators and bloom throughout as much of the season as possible. Since trees and shrubs typically are available prior to the bloom period of most herbaceous plants, they are often the most visited of plants by bees early in the season. Conversely, woody species stop blooming earlier in the growing season and the floral resources are not available throughout the growing season. Therefore, it is not advisable to depend solely upon woody species to provide pollinator resources. For this reason, it is acceptable when installing exclusively woody species enhancements to utilize bloom periods of very early, early and mid-season.

Consider utilizing tree species that are not attractive to bees when the purpose is to minimize pesticide drift.

A windbreak should contain as many of the species in each of the three blooming periods (very early, early and mid) as feasible without compromising the intended purpose. Trees and shrubs should be planted at a close spacing to aid in pollinator access but also allow for maximum crown development and bloom.

The needs of farming equipment will be considered when designing a windbreak/shelterbelt system.

Selection of plants for use in windbreaks should favor species or varieties tolerant to pesticides used in the area.

Consideration should be given to using a variety of species to lessen the chance of losing the entire planting to insects or disease, and to provide a more effective deflector of winds.

A moderately dense windbreak is more effective in reducing winds over a greater distance than a windbreak of higher density. The height and penetrability of the windbreak are more important in reducing wind velocity than the width of the windbreak.

The direction of the prevailing wind may change from season to season. Consider how to design a windbreak that will work all year.

Where site conditions allow, attempts should be made to curve windbreak rows to avoid angular appearance. Establishing an irregular edge can also reduce the linear appearance of windbreaks.

PLANS AND SPECIFICATIONS

Specifications for applying this practice shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

Substrate material and site preparation necessary for proper establishment of the selected plants shall be included in the design.

At a minimum the following will be identified in the conservation plan (as appropriate):

- Purpose of the windbreak/shelterbelt
- Length
- Width
- Field location
- Plant species
- Planting dates
- Spacing
- Planting method(s)
- Protection methods
- Operation and maintenance plan
- Replacement strategies
- Thinning / Pruning schedule

OPERATION AND MAINTENANCE

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance).

Replacement of dead trees or shrubs will be continued until the windbreak/shelterbelt is functional.

Supplemental water will be provided as needed.

Thin or prune the windbreak/shelterbelt to maintain its function.

Inspect trees and shrubs periodically and protect from adverse impacts including insects, diseases or competing vegetation. The trees or shrubs will also be protected from fire and damage from livestock and wildlife.

Periodic applications of nutrients may be needed to maintain plant vigor.

The following actions shall be carried out to insure that this practice functions as intended throughout its expected life. These actions include normal repetitive activities in the application and use of the practice (operation), and repair and upkeep of the practice (maintenance):

Replacement of dead trees or shrubs will be continued until the windbreak/shelterbelt is functional.

Supplemental water will be provided as needed.

Thin or prune the windbreak/shelterbelt to maintain its function. See Forest Stand Improvement - 666 and Tree/Shrub Pruning - 660.

Inspect trees and shrubs every 6 months and protect from adverse impacts including insects, diseases, or competing vegetation. Plantings should also be checked after storm events.

The trees or shrubs will also be protected from fire and damage from livestock and wildlife.

Periodic applications of nutrients may be needed to maintain plant vigor.

Where practical, management activities will be performed outside the primary nesting season May 15 – Aug1. An exception may be for mowing or cultivation to control vegetative competition.

Refer to “Windbreak Management” for guidance on maintaining a healthy and functional windbreak.

Additional operation and maintenance requirements may be developed on a site- specific basis to ensure performance of the practice as intended.

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Appendix 1

Criteria for Windbreak/Shelterbelt Design

Where sufficient space is available, windbreaks should contain a minimum of three rows of evergreen trees or two rows of evergreen trees and one row of evergreen or deciduous shrubs. When used the, the dense shrub row should be placed on the windward side to maximize wind and snow protection. Five to six rows are desirable to keep snowdrifts within the windbreaks.

Where drifting snow is a hazard, the windward row of plantings should be a minimum of 100 feet from the right-of-way of roads, highways, and railroads, and primary areas in need of protection unless state, county, or city regulations differ.

Where snow drifting is not a problem, the most effective planting distance from primary areas in need of protection to the inside (leeward) row should be approximately 60 feet.

Where possible, windbreaks should extend approximately 50 feet beyond areas in need of protection.

Windbreak Design and Layout

1. Identify troublesome wind direction(s).
2. Identify all areas needing protection.
3. Inventory soils paying close attention to inclusions of difficult soils such as high/low pH or salts. Begin a starter list of species adapted to the site.
4. Determine if topography will cause drainage concerns either into or away from the windbreak (e.g. feedlot runoff, snowmelt, etc.)
5. Locate property lines, overhead and underground utilities and existing trees or shrubs which may be within or adjacent to the proposed windbreak.
6. Determine whether or not access roads or lanes will cause breaks in the windbreak.
7. Determine whether or not the proposed windbreak will obstruct the winter sun, picturesque views. or oncoming traffic near driveways.
8. Determine if cold air drainage will be impeded causing frost problems for home gardens or orchards.
9. Determine if access control will be necessary to protect the planting from livestock or wildlife browsing.
10. Determine whether wildlife considerations are important to the landowner.
11. Avoid choosing species that may be alternative hosts for diseases, e.g. cedar-apple rust.

Orientation, Placement and Length

1. Make a sketch (to scale) of the key items identified above.
2. Position the windbreak as close to perpendicular to the most troublesome wind direction.
3. For wind protection only, the tallest row needs to be 2-5H from the primary area needing protection. See Figure 1.
4. For wind and snow protection, the most windward row needs to be between 100 and 200 feet from the windward edge of the primary protection area. Once that critical distance is met, check to see if the area needing protection is still within the 2-5H zone. See Figure 2.
5. "One-leg" windbreaks are sufficient if the wind comes from one direction only.
6. A 'two-leg"(or more) windbreak is needed when troublesome winds deviate throughout the windy season. This type of windbreak is especially helpful for animal feeding situations. See Figure 3.

7. Extend the windbreak 100 feet past the structures. There is a potential for end drifts of snow. See Figure 4.

8. Try not to obstruct cool, summer breezes that may be desired by the landowner.

9. Locate access roads from 100 to 500 feet from the ends of the windbreak to avoid snowdrift areas. If a lane must cut through a windbreak, it should cut through the windbreak at an angle to prevailing winds to prevent funneling of wind and snow drifting. See Figure 5.

10. Avoid subsurface drain fields and septic systems. Species such as willow and poplar with aggressive root systems should not be planted within 100 feet.

11. Avoid locating rows below power or telephone lines; allow for lateral spread of the mature crown plus 10-15 feet.

12. Make sure all setbacks required for the farming operations are met.

13. Locate new rows at least 50 feet from existing windbreaks (outside of the root-sapped area of the older trees and shrubs).

Number of Rows and Arrangement

A. The objective is to reach a windbreak density > 65%.

B. Use minimum row guidelines below to achieve desired densities:

Windbreak Type

1. Farmstead - 2 rows - must be evergreen
2. Feedlot - 2 rows - must be evergreen
3. Screens
    a. High Traffic 6 rows - 3 rows must be evergreen
    b. Med to Low Traffic - 3 rows - 2 must be evergreen
4. Visual - 2 rows – 1 must be evergreen

Wildlife

1. General Wildlife/ Corridors - 3 rows – minimum
2. Pollinators- 3 rows – Utilize very early, early and/or late blooming speices

Field

2 rows of deciduous tree/shrub or evergreen

Living Snow Fence

1. Unsheltered Distance <1000 feet - 1 row of either shrub or evergreen
2. Unsheltered Distance >1000 feet - 2 rows - minimum one row of evergreen

[Note: Additional rows may be used to enhance wildlife values, meet landowner objectives, increase diversity, improve aesthetics, and increase density.]

C. Place shrubs and short trees in outer rows.

D. A single row may work in some instances, but losses from the windbreak should be considered.

E. In snowy areas, a snowtrap row of shrubs can be planted 50-100 feet to the windward side of the windbreak.

F. Under snowy conditions, place species prone to snow breakage in leeward rows.

G. Some suggested combinations and arrangements include:

For 1 row: Use a dense tall evergreen

For 2 rows: Medium evergreen, tall evergreen

For 3 rows: Dense shrub, tall evergreen, and medium evergreen

For 4 rows: Shrub, medium evergreen, tall evergreen, and medium deciduous or evergreen.

For 5+ rows: Combination of shrubs, evergreen and deciduous trees that allow snow trapping, crown development, etc.

Spacing

A. Between rows: generally 12 to 20 feet. Make sure there is adequate room for maintenance and/or tillage equipment.

B. Between plant spacing in the row (Based on 20-year height)

Low shrubs (<10 feet)

Single row 3-5'

Multiple row 3-6'

Large shrubs (> 10 feet)

Single row 5-8'

Multiple row 6-8'

Small evergreen trees (<25 feet)

Single row 5-8'

Multiple row 6-8'

Deciduous columnar trees (any height)

Single row 5-8'

Multiple row 6-8'

Low deciduous trees (<25 feet)

Single row 6-10'

Multiple row 8-14'

Tall evergreen trees (>25 feet)

Single row 8-12'

Multiple row 8-16'

Tall deciduous trees (>25 feet)

Single row 8-12'

Multiple row 10-18'

C. Spacing should allow for crown closure within about 10 years without undue competition between adjacent plants in later years.

D. Stagger plantings so that the plants in one row will be planted opposite the opening of another row.

Example:

X X X X X X X X

X X X X X X X

X X X X X X X X

E. Row spacing should be at least 2 feet wider than any equipment planned for between-row maintenance.

Field Windbreak Design and Layout

A. Optimum deposition of snow to the leeward side (where applicable).

B. Unobstructed view of oncoming traffic at road intersections; no crown or root obstruction of utility lines, etc.

C. Wind funnel effects through gaps minimized

D. Farming operations not obstructed.

E. Adapted species chosen for soil conditions, herbicide resistance, etc.

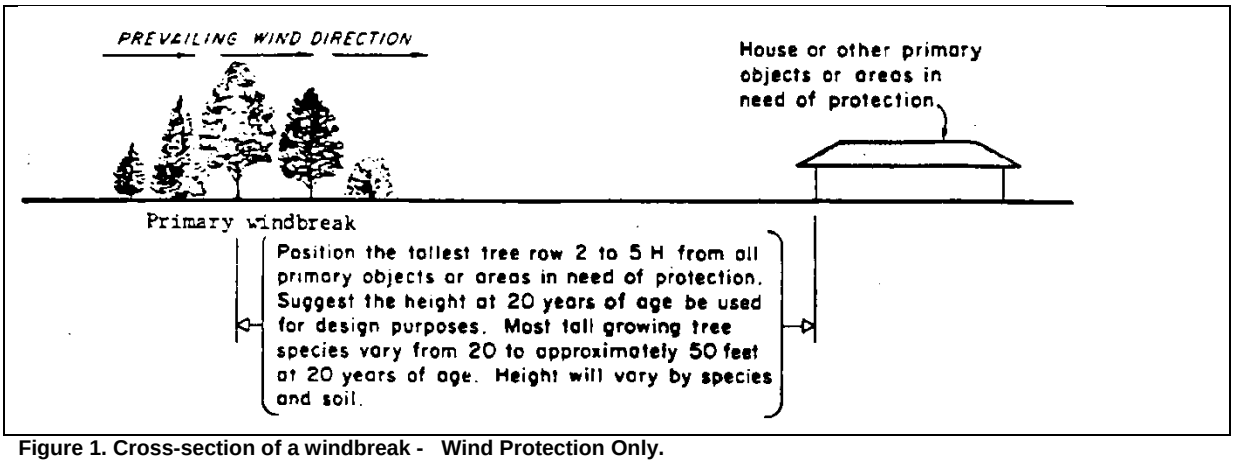

Figure 1. Cross-section of a windbreak - Wind Protection Only.

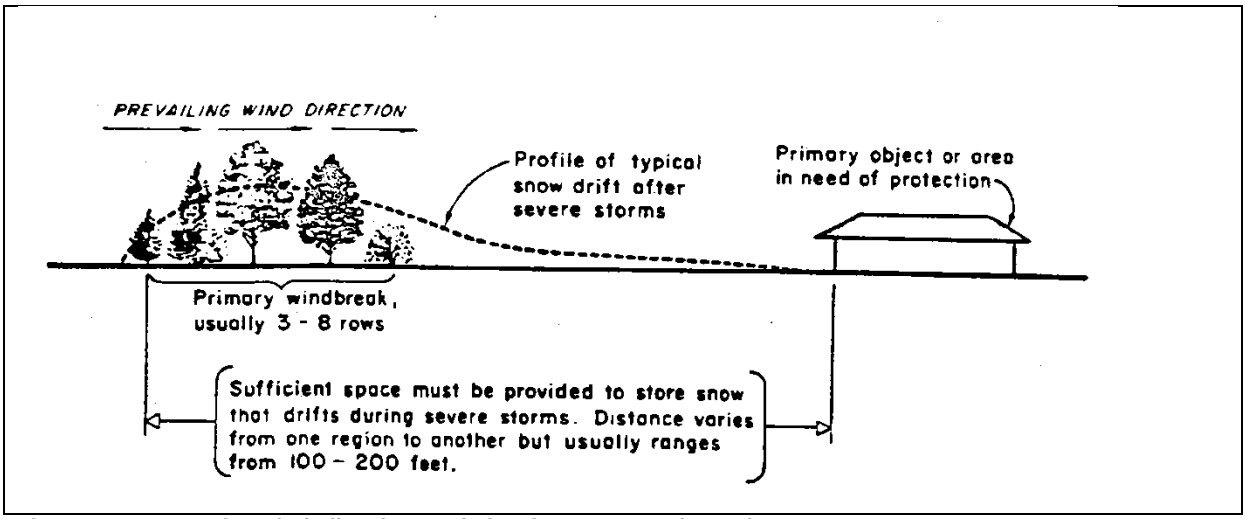

Figure 2. Cross-section of windbreak - Wind and Snow Protection Only

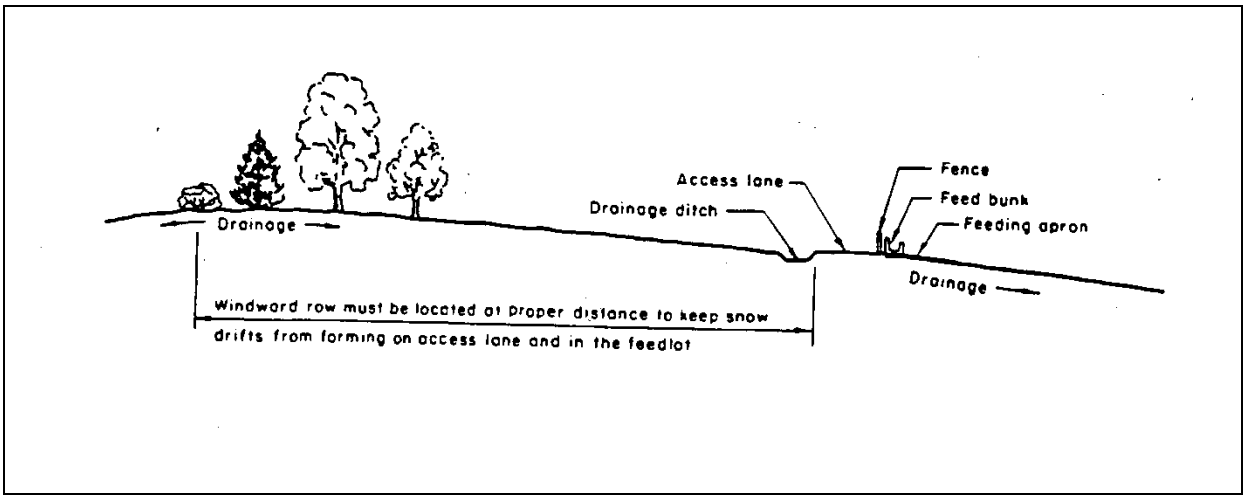

Figure 3. Area protected by windbreaks