F-1054

PROTECTING FIELDS WITH WINDBREAKS

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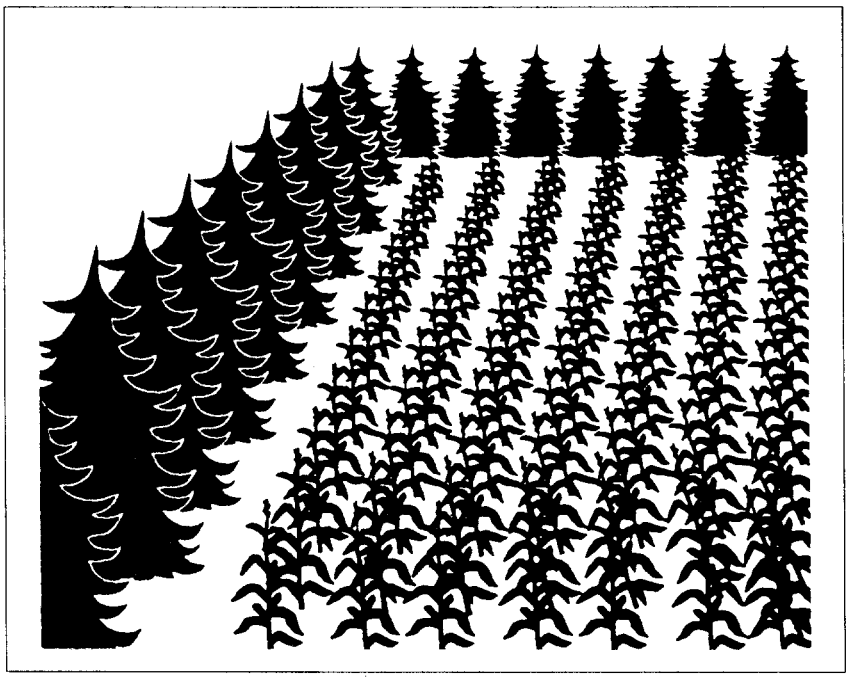

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Field windbreaks complement the farm operation by protecting crops and soil from wind damage. Winds move up and over the windbreak producing an area of protection extending out on the leeward side. The maximum area of protection extends from 15 to 20 times the height of the windbreak. The area of protection occurs in the shape of a bell.

This area of protection can be extended when supplemented with another windbreak planting perpendicular to the original planting (see Figures 1a, b, and c).

The wind protection provided by windbreaks provides several benefits in cropland production.

1) **Soils are protected** from wind exposure and erosion. Soil is the single most valuable natural resource to agriculture. When wind protection is provided, evapo-transpiration is reduced, soil moisture is retained longer and soils tend to blow less.

2) **Crop protection** is provided from winds that physically injure standing crops, including lodging of the stem and sand blasting the crop. Sand blasting can wound the crop and allow disease pests to infect. Evaporation is reduced from exposed soil, allowing more moisture for crop uptake. Many crops have a very low tolerance level to wind and wind blown soil. These crops include beans, soybeans, sugarbeets, potatoes, muskmelons, and alfalfa.

3) **Crop production** is increased in the protected zone. A unique area of protection or a microclimate is created. The various changes in crop yield and microenvironment are presented in Figure 2. Soil moisture (b), daytime air (c) and soil temperature (d) and relative humidity (e) are higher near the windbreak and tapper off at a distance of 8 to 10 times the height of the windbreak. Night air temperature (g), and evaporation (h), are lower ducts decreased windspeeds (f) are lower near the windbreak. These factors contribute to the increase of crop

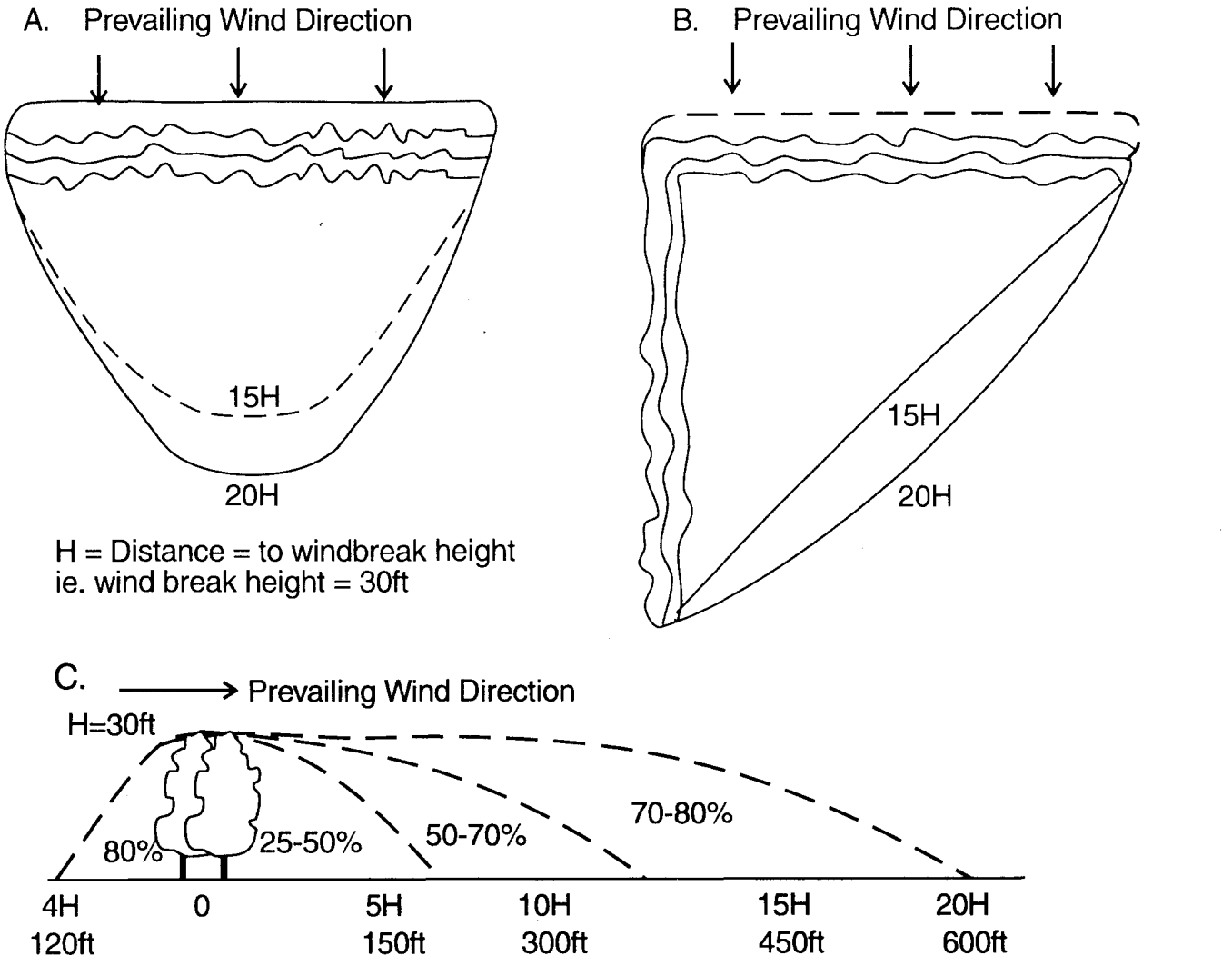


Figure 1. The zone of wind protection provided by A) a two row windbreak on one side of the field and B) two two row windbreaks on two sides of the field. C) A cross section view of wind protection where percentages of open field velocity are indicated by distance from the windbreak.

Table 1. Relative responsiveness of various crops to shelter[1].

Crop	No. of Field Years	Weighted mean yield increase (%)
Spring wheat	190	8
Winter wheat	131	23
Barley	30	25
Oats	48	6
Rye	39	19
Millet	18	44
Corn	209	12
Alfalfa	3	99
Hay (mixed grasses and legumes)	14	20

[1]Based on 50 studies compiled by John Kort, Agriculture Canada, Saskatchewan, Canada

Research locations were in U.S.A. (North Dakota, South Dakota, Nebraska, Kansas, Wyoming, Wisconsin), U.S.S.R., Denmark, Canada (Manitoba, Saskatchewan), Germany, Argentina, Japan, Italy, India, Netherlands, Pakistan, New Zealand, Nigeria, Poland, 1932-1985.

yield (a) in this protected zone except for the area next to the windbreak. About 1 to 2 times the windbreak height distance from the windbreak edge, crop yields are reduced due to competition with tree roots. Yields level off at about 12 to 15 times the windbreak height to average yield, but some wind protection continues out to 40 times height. Single row belts will have a smaller protection zone. Total crop production is higher in a protected field than one not protected.

Windbreaks should be designed for protection from prevailing winds. Crops that have a high moisture requirement may need protection from hot, dry winds during the growing season. These sensitive crops, such as soybeans, produce higher yields with southern protection during the growing season (Figure 4).

4) **Snow collection** is important in designing your field windbreak. It is desirable to provide adequate crop protection during the growing season yet remain open enough to allow winter snows to spread evenly across the field. Spreading of collected snow will allow closer cultivation to the windbreak planting in the spring.

5) Field windbreaks are excellent **wildlife habitat** cover and travel lanes to and from sources of water, feeding areas, and activity. Game and song birds make nests and feed on tree seeds and fruits. Many of these birds feed on insects that are potential crop pests.

Windbreak Design

There are two main designs used in field windbreaks — single row or multirow designs (two to three rows). The single row takes less land out of production and allows more snow movement out over the field. The multirow (two to three rows) windbreak allows the use of several tree or shrub species. This design gives more diversity in case loss to a pest invasion similar to Dutch elm disease. Multirow windbreaks are denser than the single row and provide more wind protection to crops.

Center Pivot Irrigation Systems

Field windbreaks decrease water evaporation from irrigation systems by decreasing exposure to drying winds. This ensures more water delivery to the crop. Evaporation from the crop is decreased within the area of wind protection. Taller trees in single or twin row designs are used outside of the pivot system. Shrub rows can be used as needed under the pivot arms. The corners are opportunities for wildlife planting or other harvestable crops. (Christmas trees, fence posts, fruit trees and shrubs.)

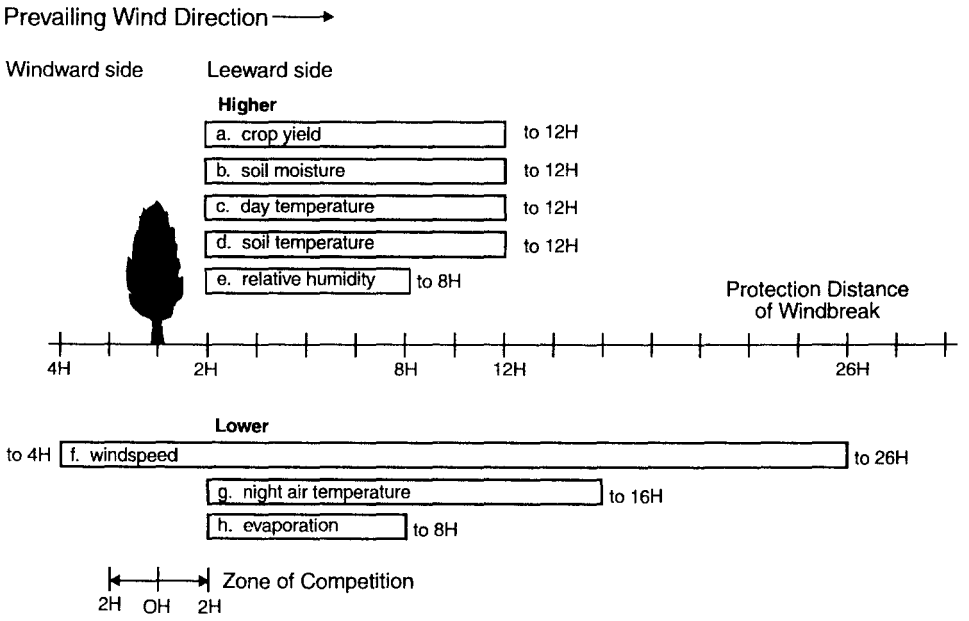


Figure 2. The generalized response of crop yield and microenvironment factors due to windspeed reduction on windward and leeward side of field windbreaks.

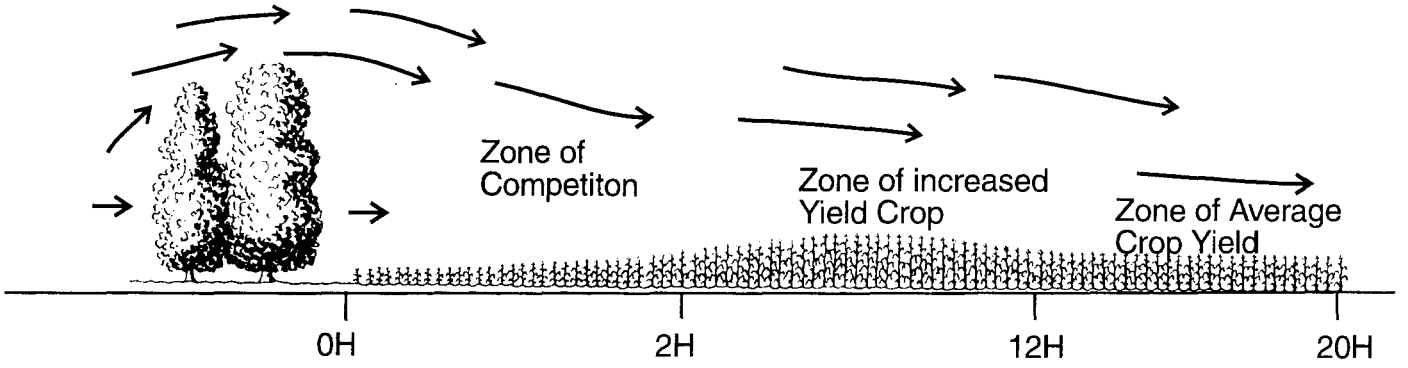


Figure 3. Often crop yields are lowest next to a tree windbreak. A common mistake is to observe only this area — the greatest gains are out a few more rods.

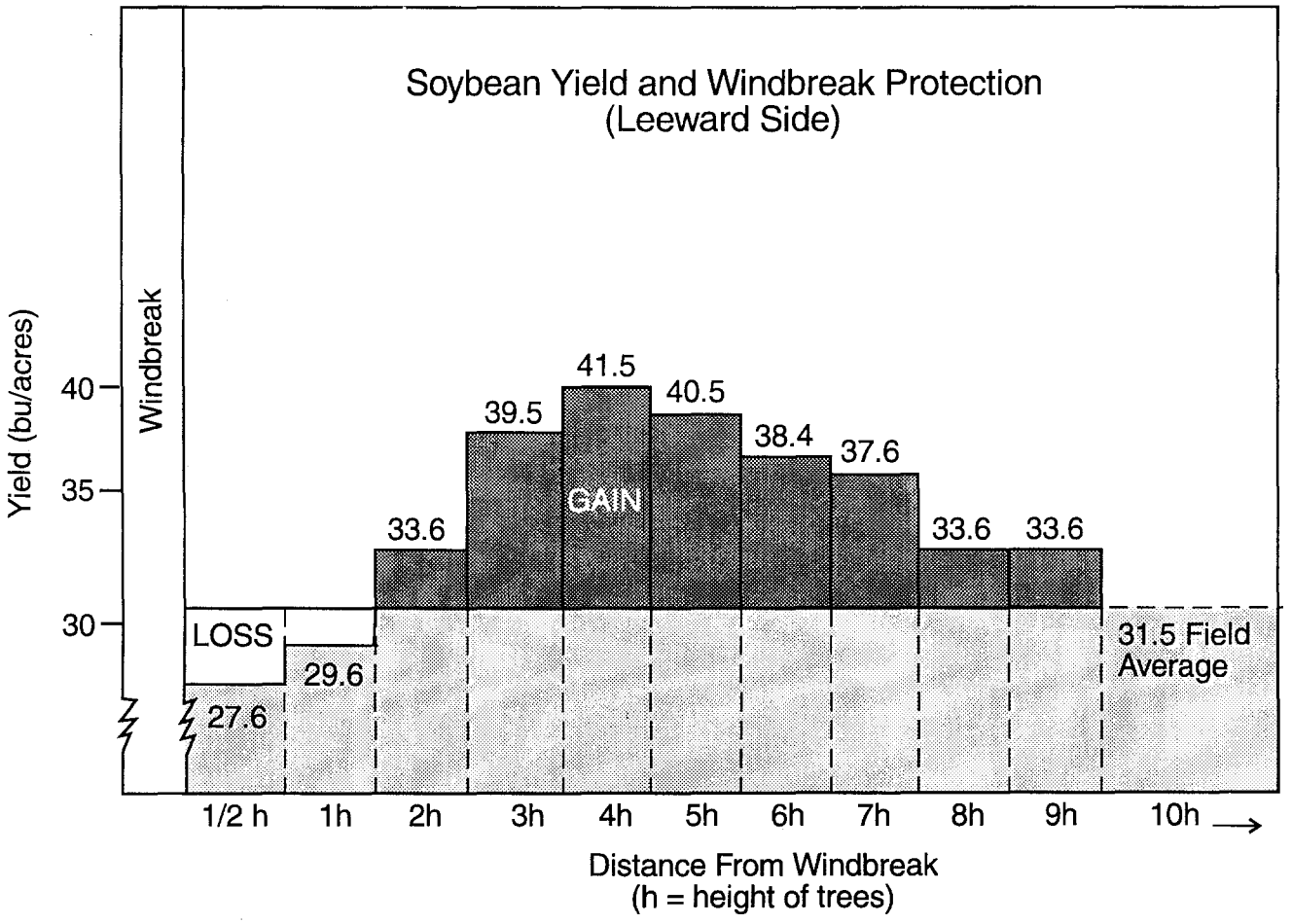


Figure 4. Average soybean yields in relation to windbreak protection at Ridgetown, Ontario, Canada (Baldwin and Johnston, Ridgetown University 1984).

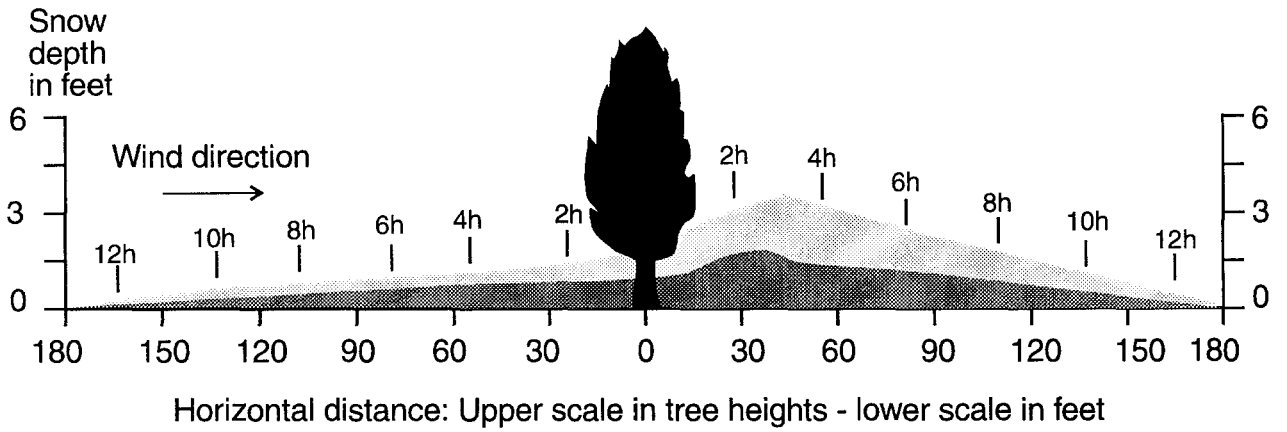


Figure 5. Snow Collection and spread of a single row windbreak planting of green ash. Light shaded area represents a spacing between trees of 5 to 6 feet and dark shaded area represents spacing between trees of 9-14 feet.

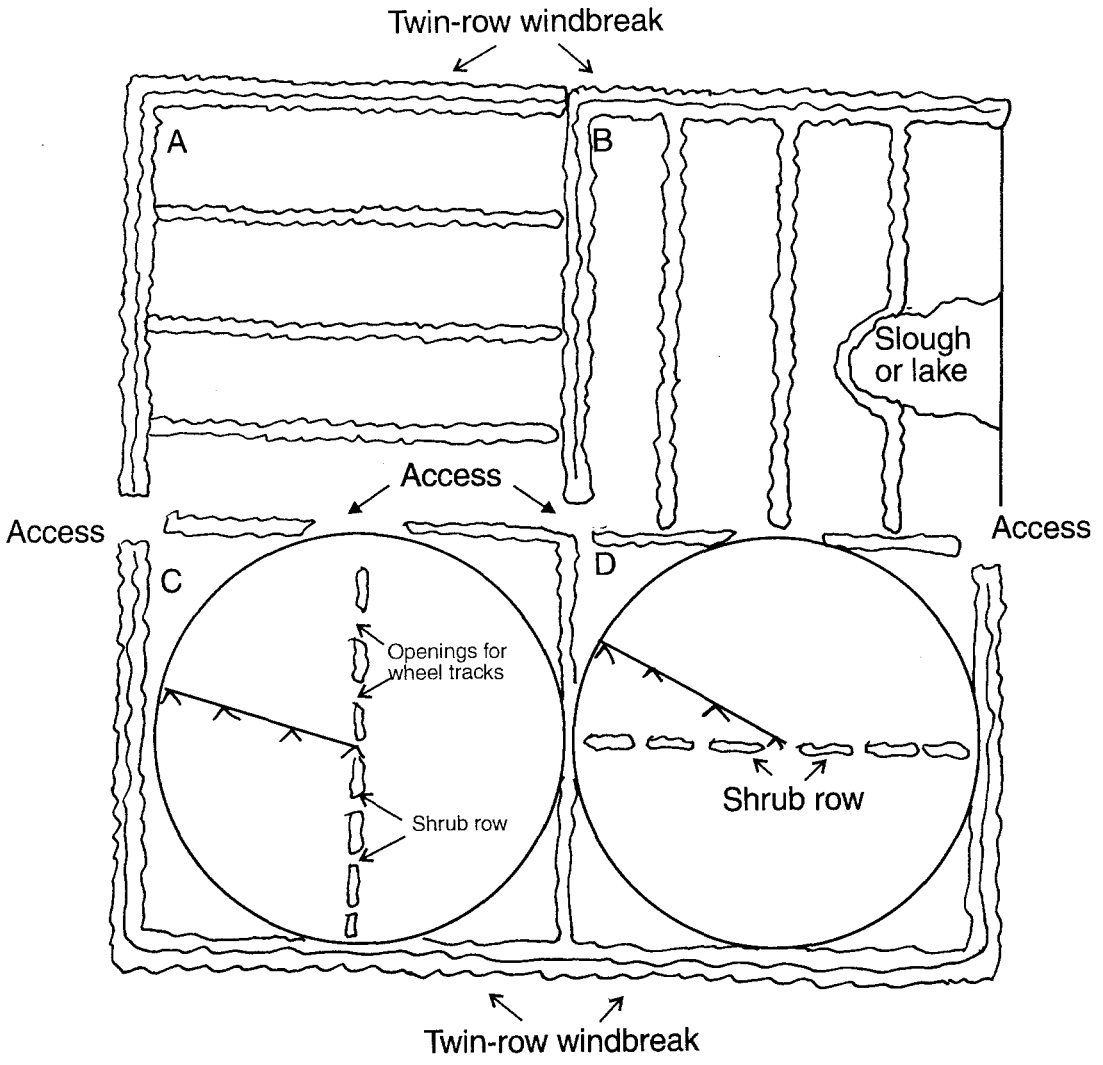


Figure 6. Potential field windbreak design patterns A and B are dryland sites and C and D are fields under center pivot irrigation. A and B have a twin row windbreak on the field margins where the fall and winter prevailing winds in combination with a series of single row belts perpendicular to most prevalent winds. B presents an option of planting around a lake or slough area. Tree planting around wetland and river systems can reduce soil and chemical runoff. C and D show a twin row windbreak on the field margins where the summer prevailing winds are present. Shrub rows can be used within the field to extend wind protection and allow spaces for the wheel tracks to pass. Access to fields should be designed downwind from protected areas.

Custom Designs

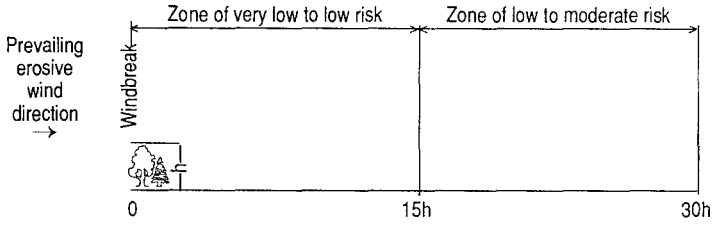
Field windbreaks can be designed to fit any size or shape of field or farming operations. Utilizing the basic single and multirow designs will provide the benefits desired for the site.

Figures 7-10 should help in determining the type of windbreak protection required for certain crops. These figures show the area of crop protection from wind damage and windblown soil along with yield increase due to protection. A list of crops with various tolerances to wind injury and wind blown soil is provided. Your local Soil Conservation District can assist you in designing, planning, and planting your field windbreaks. For more information contact your county office of the NDSU Extension Service, USDA Soil Conservation Service, or local Soil Conservation District.

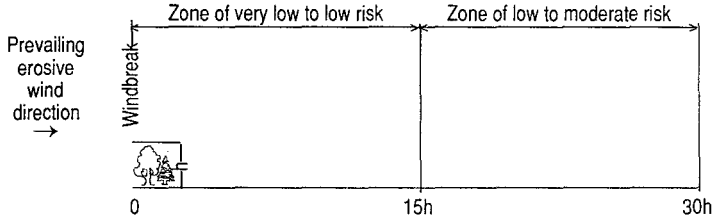
Figure 7. Risk and yield guide for tolerant crops. Tolerant crops include: barley, buckwheat, flax, millet, oats, rye and spring wheat.

(Source: USDA Soil Conservation Service)

A. Wind erosion guide



B. Wind Damage Guide



C. Yield Guide

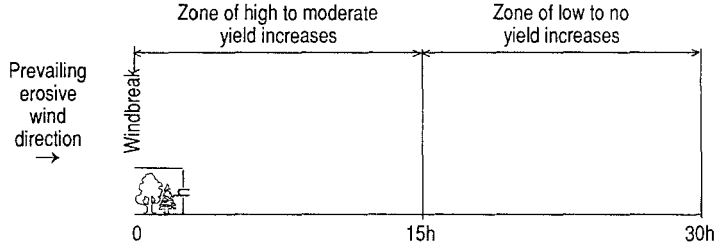
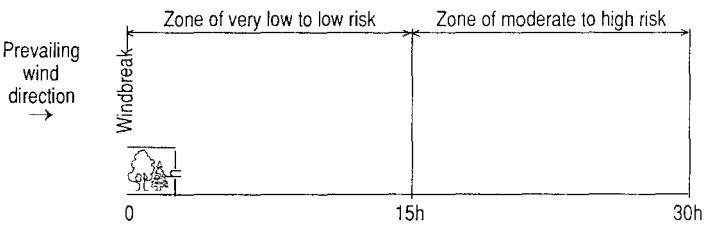


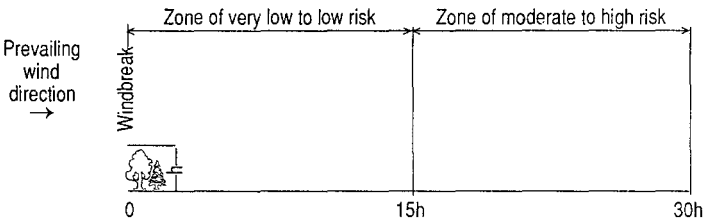
Figure 8. Risk and yield guide for moderate tolerance crops. Moderate tolerance crops include: corn, grain sorghum, sunflower and sweet corn.

(Source: USDA-Soil Conservation Service)

A. Wind erosion guide



B. Wind Damage Guide



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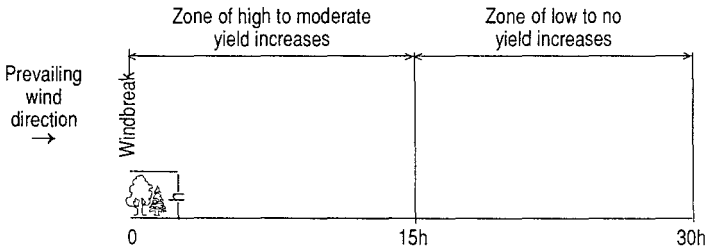
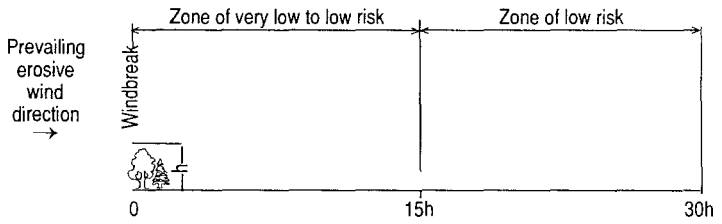


Figure 9. Risk and yield guide for low tolerance crops. Low tolerance crops include: apples, cherries, grapes, peaches, plums and pears.

(Source: USDA-Soil Conservation Service)

A. Wind erosion guide



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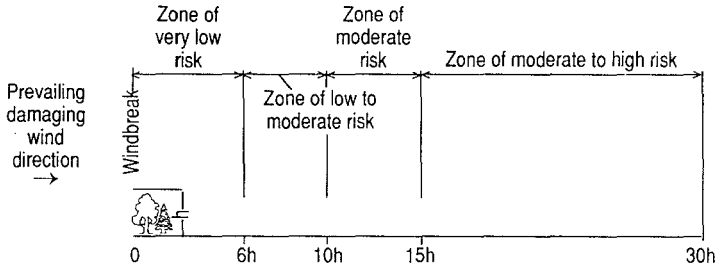


C. Yield Guide

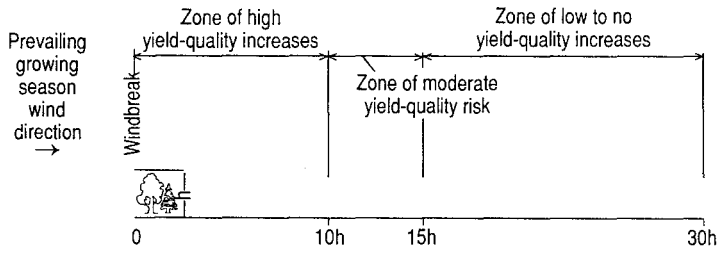
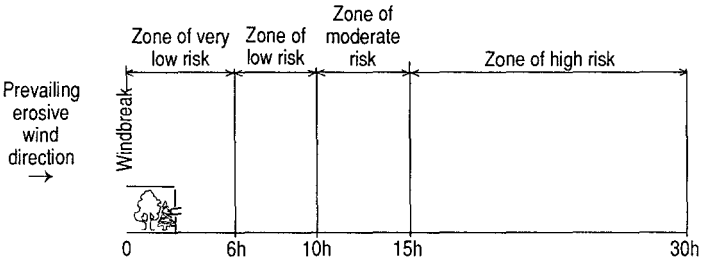


Figure 10. Risk and yield guide for low tolerance crops. Very low tolerance crops include: alfalfa, asparagus, beans, raspberries, green beans, lima beans, snap beans, table beets, sugarbeet, broccoli, cabbage, carrots, celery, cucumbers, egg plant, flowers (seed production and cut green peas, lettuce, muskmelons, onions, peppers, potatoes, soybeans, strawberries, tomatoes, watermelons and young orchards (apples, plums, sandcherries, and pears).

(Source: USDA-Soil Conservation Service)

A. Wind erosion guide



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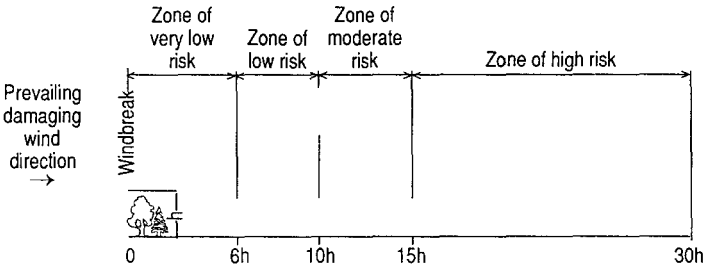
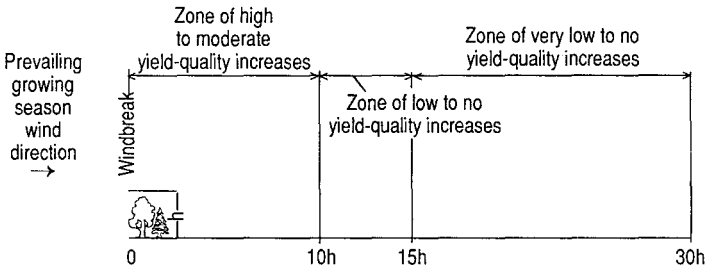


C. Yield Guide



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