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Windbreaks: How They Work

Summer storms and bitter winter winds often get people thinking about windbreaks, but did you know that a windbreak that allows some wind to pass through can provide better protection over a larger area than a completely solid one? It seems strange, but the physics behind windbreaks is surprisingly complex.

Windbreaks have numerous applications, from protecting cattle during the winter and reducing wind erosion in crop fields to sheltering gardens and even improving a home's energy efficiency. Their effectiveness depends on several factors, including height, length, continuity (the presence of gaps), shape, and solidity or density.

Windbreaks typically reduce wind speeds by a factor of 2 to 5 upwind and by as much as 30 downwind, relative to their height. However, this protection is not uniform throughout the sheltered area. When wind encounters a windbreak, air pressure increases on the upwind side as air accumulates. On the downwind side, air pressure decreases. Some wind passes through the windbreak, while the rest moves over the top or around the ends, following the pressure differences. This creates an interesting effect: a completely solid barrier, such as a metal wall, often provides less protection farther downwind than a less solid windbreak, such as several rows of trees.

A solid barrier creates a greater pressure difference between its two sides, which can produce stronger turbulence as the wind passes over and around it. Allowing some wind to pass through reduces that pressure difference and helps maintain more consistent wind protection farther downwind. This is also why snowdrifts often accumulate behind windbreaks, sometimes in places where they are not wanted. For example, a 30-foot-tall windbreak may reduce wind speeds by 60 to 150 feet upwind and by 300 to 900 feet downwind. However, the greatest and most consistent reductions generally occur much closer to the windbreak, often around three to five times its height, or approximately 90 to 150 feet downwind in this example.

The recommended density of a windbreak depends on its intended application. Windbreaks for farmsteads and cattle generally need stronger protection over a smaller area, making a density of approximately 60 to 80% desirable. Crop fields and larger gardens often benefit from less dense windbreaks, around 40 to 60%, which provide more moderate protection over a greater distance. Figure 1 demonstrates this difference. With an open wind speed of 20 mph, a windbreak with 60 to 80% density reduces wind speed to approximately 7 mph at a distance of 10 times its height. At that same distance, a completely solid fence only reduces wind speed to 14 mph. Both barriers slow the wind, but the partially porous windbreak maintains greater protection farther downwind.

Pressure differences and wind direction are also why the shape and length of a windbreak are important. Ideally, a windbreak should be at least 10 times as long as it is tall. Wind speeds

increase around the ends of a windbreak, just as they do above it. A short windbreak therefore protects a much smaller area. For a 30-foot-tall windbreak, a length of at least 300 feet helps reduce these effects.

Windbreaks are generally most effective when positioned perpendicular to the prevailing winds. However, curved or multi-sided windbreaks can provide better protection when winds come from different directions. In Kansas, cattle windbreaks should generally provide protection from cold north and northwest winter winds, while gardens may need protection from strong winds and storms coming from several directions during the growing season.

Windbreaks are commonly made from sturdy trees and shrubs working together to slow the wind, but they can also consist of buildings, metal or wooden walls, stacked hay bales, or even old farm equipment. Tree and shrub windbreaks are often planted in multiple rows to provide protection at different heights and maintain coverage as the trees mature. Single rows of trees can also serve as windbreaks, but they are more vulnerable to damage and developing gaps if individual trees die. These openings can funnel wind through the windbreak, reducing its effectiveness. Multiple rows of the same or mixed species help maintain more consistent protection over time.

Personally, I live on the side of a hill, and while the view is nice, the winds can be brutal. This spring my garden tomatoes were protected with a row of old pallets held up by T-posts. It made a huge difference in wind protection. The pallet wall was far from solid, but the physics worked even better than I had imagined. If you are like me and are considering a windbreak for the cattle herd and perhaps another smaller one for the garden, taking the time to consider the design can make a significant difference.

A good windbreak is more than simply a row of trees or a wall to stop the wind. Its height, density, length, and placement all determine how effectively it protects the area behind it. Understanding a little of the science can help ensure a windbreak works as intended.

For those considering a windbreak, the University of Nebraska–Lincoln has an excellent series of publications covering different applications and designs, including *How Windbreaks Work* (EC1763) and related publications through EC1779. The Kansas Forest Service can also assist with planning larger tree and shrub windbreaks and offers conservation seedlings for planting projects. The Missouri Department of Conservation operates a similar seedling program.

Please give me a call if you need assistance locating these publications or would like additional information.Girard Extension Office: 620-724-8233



Open Wind Speed 20 mph
Multi Row 60-80% Density

H distance from windbreak	5H	10H	15H	20H	30H
miles per hour	5	7	13	17	19
% of open wind speed	25%	35%	65%	85%	95%



Open Wind Speed 20 mph
Solid Fence 100% Density

H distance from windbreak	5H	10H	15H	20H	30H
miles per hour	5	14	18	19	20
% of open wind speed	25%	70%	90%	95%	100%

Figure 1. From University of Lincoln-Nebraska. *"How Windbreaks Work – EC1763"*.

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