KANSAS STATE UNIVERSITY | Extension Wildcat District

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Windbreaks: How They Work

Windbreaks have a great number of applications, from protecting cattle during the winter, keeping crop fields from blowing over, providing protection for gardens, and even improving the energy efficiency of a house. While it might seem that windbreaks are fairly simple physics, they are surprisingly complex. Windbreaks are usually sturdy trees and shrubs that work together to slow the wind behind the windbreak. However, they can also be buildings, metal or wooden walls, stacks of haybales, or even old farm equipment. Tree and shrub windbreaks are planted in a series of rows so that they can support each other and provide wind coverage at different heights. Single tree rows can also be used as a windbreak, but the species of tree needs to be one that can handle those conditions, and they are at more risk to the elements. A single line of trees also has the risk of 'holes' if a tree dies. This is why stacked rows of the same or mixed species are recommended. Usually, windbreaks are planted or constructed in straight lines, but in many ways, a curved or multi-sided windbreak can be superior. This comes down to the physics of how windbreaks work.

The effectiveness of a windbreak is determined by its height, length, continuity (how long between gaps), the shape of the windbreak, and how 'solid or dense' the windbreak is. Wind speed is slowed **up**wind of the windbreak two to five times the height, and up to 30 times the height **down**wind of the windbreak. Air pressure is also changed. Upwind, the air pressure is increased, as air 'stacks up'. Downwind, the air pressure is decreased. The wind above and around a windbreak increases as the wind 'slips' around the windbreak and follows the high to low pressure gradient. This creates an unexpected effect that a 100% solid windbreak, like a tin metal wall, will be less effective than a 75% solid windbreak, like a multiple tree row. The trees allow some wind through, which keeps the upwind and downwind air pressures closer together. The ideal location is not right behind a windbreak but behind the windbreak at a distance of five times the height. Right behind the windbreak is where the wind that has rushed over the top of the windbreak breaks, coming crashing down to fill the 'void' of the lower wind pressure. All of this creates a lot of gusty turbulence and is where ridges of snow will collect in the winter. The effect is worse with completely solid windbreaks. To give an example for a 30 feet tall windbreak, the wind is reduced around 60 to 150 feet upwind, 900 feet downwind, and the lowest consistent wind speeds will be 150 feet downwind from the windbreak.

Pressure gradients and wind direction are why the shape and length of the windbreak are important as well. An ideal windbreak length is 10 times or more the height of the windbreak. Wind speeds are increased around the edges of a windbreak, just the same as they are above the windbreak. This means a short windbreak won't give a very big area of effect. An ideal curved or multiple sided shape will better protect from different wind angles. Most of the time the winds come from the north or south, and are more commonly with a westward angle than from the east. Cattle windbreaks need to protect from the cold north and west winds. Gardens are ideally protected from the spring storms that blow in from the north or south.

Windbreaks can be useful for all sorts of reasons. Personally, I live on the side of a hill, and while the view is nice, the winds can be brutal. If you are like me and are considering a windbreak for the cattle

herd, and another little one for the garden, it's a good idea to keep design in mind. There are a number of publications to help give ideas. The University of Lincoln-Nebraska has a number of them for all kinds of applications (reference numbers EC 1763 to EC 1779).
The Kansas Forest Service can help design large windbreaks of tree and shrub plantings. Also, the Kansas Forest Service and the Missouri Department of Conservation sells tree bundles for such planting projects. Please give me a call if you need help finding any publication or for more 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"*.

For more information or questions about preparing for or planting, please contact James Coover, Crop Production Agent, at jcoover@ksu.edu or (620) 724-8233.

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