

Utah Forest Facts

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Rural/Conservation Forestry

NR/FF/005

Windbreak Benefits and Design

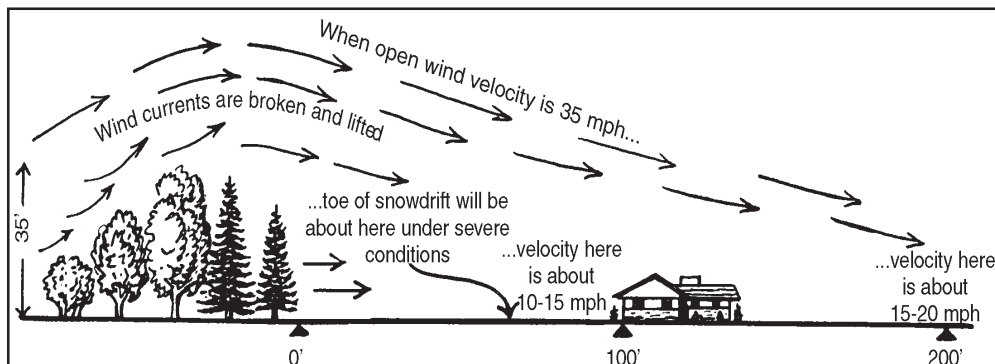
Mike Kuhns, State Extension Forester

This fact sheet gives an overview on the use of tree and shrub windbreaks. It describes the many benefits of windbreaks and goes over important aspects of windbreak design.

Why Windbreaks?

Utahns have a heritage of tree planting going back to when the state was first settled. Early settlers often would bring seeds or cuttings of favorite trees from their former homes to grow in Utah. Many planted windbreaks and hedgerows to protect crops, orchards, livestock, and homesteads.

Unfortunately, this tree planting heritage, and particularly windbreak planting, has faded. Most windbreaks in Utah are old-fashioned, outdated, and sometimes ineffective. Others that were in the way or considered unnecessary have been removed. Windbreaks still belong in modern agriculture though, and should be used more in non-agricultural areas as well.



A dense windbreak provides good wind protection and snow drift control. Adapted from Montana State University Extension Bulletin 366.

Windbreak Benefits

Tree and shrub windbreaks are valuable conservation tools with many functions. Their benefits include:

- ✓ *Reduced soil erosion* — Windbreaks prevent wind erosion for 10 to 20 times their height downwind. They also filter wind-blown soil particles from the air.
- ✓ *Crop protection* — Windbreaks can increase crop yields up to 44%. Wind protection reduces crop water use, increases a plant's ability to make food, and may increase pollination. Quality of fruit and other high value crops can be increased due to reduced sand and soil abrasion.
- ✓ *Energy conservation* — Windbreaks can reduce winter heating costs 20 to 40% by reducing cold air infiltration into buildings. In summer water evaporation from leaves directly cools the air. Windbreaks can be designed to provide energy savings for a small residential lot, a farmstead, or an entire housing development.
- ✓ *Snow control* — Windbreaks can serve as “living snowfences”, controlling drifts near roads, buildings, or livestock or distributing snow evenly over large areas like crop fields. Money and energy are saved by reduced need for snow plowing and artificial snowfences.
- ✓ *Livestock protection* — Windbreaks can be used as “outdoor barns,” sheltered areas for feeding, calving, and other livestock-related activities.

✓ *Wildlife habitat* — In open areas where windbreaks are needed for wind reduction, they may also provide the only woody cover and food necessary for some wildlife species.

✓ *Beauty* — Trees provide visual screening and permanence in the landscape that other types of plants can not.

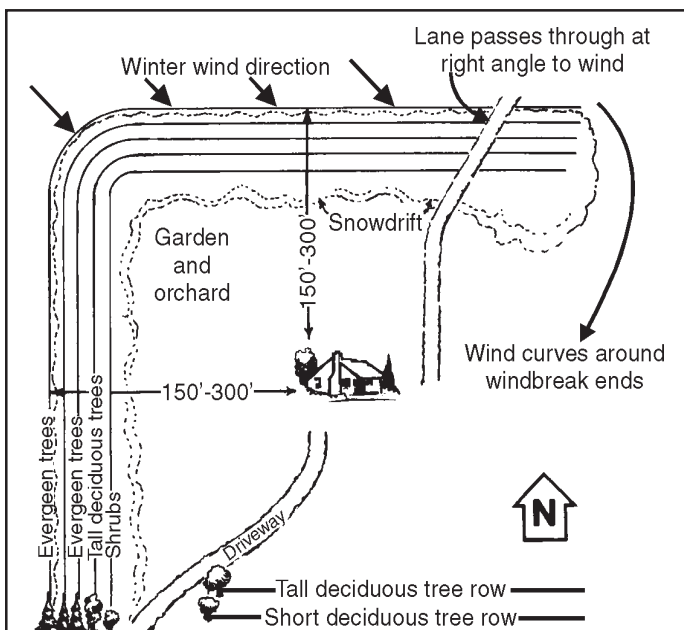
✓ *Tree products* — Windbreaks can supply firewood or other products while maintaining conservation functions.

Windbreak Design

Windbreak design depends on your objectives. A basic requirement of any windbreak is a fairly continuous row of trees and/or shrubs placed to provide wind protection or other benefits (we will not cover fences or windbreaks of non-woody plants here, but the principles are similar). The most important factors in windbreak design for wind protection are height, density, orientation, and length.

Height — Windbreaks reduce wind speeds up to 30 times their height (H) downwind. Height increases with age (to a point) and depends on the tree species used. The effective height of a multi-row windbreak is that of the tallest row. Large areas must have a windbreak every 10H to 20H for full protection. For example, 30 foot tall windbreaks should be planted every 300 to 600 feet to effectively protect a large area.

Density — All windbreaks, except solid fences or walls, let some wind through. Dense windbreaks stop more



Typical dense farmstead windbreak for north to west winter wind direction. Distances are from house to windbreak's upwind edge. Snowdrift will move downwind and be shallower with less density. Adapted from Kansas State University Extension Bulletin C-645.

wind by having a greater proportion of solid area to open area, but density is not always good. As wind is deflected up and over a windbreak, low pressure on the downwind side draws the wind back down. This low pressure is stronger in dense windbreaks, drawing the wind down quickly and reducing the protected area size. Letting some wind through reduces the low pressure and results in a larger protected area.

Density is affected by the number of tree rows, branch and foliage density (determined by tree species), and tree spacing within rows. Flexible branches and foliage move out of the way as wind speeds increase, making windbreaks less dense. Horizontal or vertical gaps in an otherwise dense windbreak funnel wind and locally increase wind speeds.

Windbreak density is the ratio of the solid portion of the windbreak to its total area and is not easy to measure. A windbreak with zero density has maximum openings and lets wind through unchecked, while a windbreak with 100% density lets no wind through (both situations are impossible). Conceptually, a 50% dense windbreak should let about one-half of the wind through.

Windbreaks with 60 to 80% density give very good protection over a fairly small area like a farmstead, residential lot, or feedlot. A windbreak with 40 to 60% density can protect a large area like a crop field. Windbreak densities below 20% provide little wind reduction.

Snow deposition also is affected by windbreak density. Very dense windbreaks cause a deep but narrow drift to be deposited near the windbreak, usually within 3H to 5H. To spread snow out evenly over a large area, use a windbreak with a density as low as 25 to 35%.

Orientation — Windbreaks should be oriented at right angles to the prevailing wind direction to protect the greatest land area. Remember that prevailing wind directions may vary between summer and winter. Use multiple-leg windbreaks in areas with variable-direction winds to give the most protection. In hilly areas, locate windbreaks just upwind of the hill crest for greatest benefit. Placing a windbreak on the crest will result in a small protected area because of extreme low pressure and turbulence created on the downwind and downhill side.

Length — Longer windbreaks protect more area. Wind tends to curve around the ends of a windbreak because of the low pressure effect mentioned above. Therefore, windbreaks should be long in relation to their height. A length of at least ten times the windbreak height is best.

Species — Trees and shrubs for windbreak planting are selected for hardiness, good form and foliage, fairly fast growth, longevity, low maintenance needs, and pest resistance. Be sure to choose species that are suitable for your planting site and that fit your windbreak design. Good species for windbreaks in Utah include:

✓Evergreen trees (conifers) — junipers (*Juniperus* species), pines (*Pinus* species), spruces (*Picea* species)

✓Deciduous trees — poplars and cottonwoods (*Populus* species), willows (*Salix* species), honeylocust (*Gleditsia triacanthos*), black locust (*Robinia pseudoacacia*), hackberry (*Celtis occidentalis*), ashes (*Fraxinus* species), elms (*Ulmus* species), mulberries (*Morus* species)

✓Shrubs — false indigo or indigobush (*Amorpha fruticosa*), Siberian peashrub (*Caragana arborescens*), sumacs (*Rhus* species), cotoneasters (*Cotoneaster* species), plum and cherries (*Prunus* species), shrub roses (*Rosa* species), silver buffaloberry (*Shepherdia argentea*), common lilac (*Syringa vulgaris*), golden currant (*Ribes aureum*), and other hardy natives depending on site

Other Design Considerations — Windbreaks can be effective with few rows. Single-row windbreaks can be used where space is limited. These consist of an evergreen row for year-around protection, a single shrub row, or a densely-branched deciduous tree row. Though a deciduous trees loses its leaves in winter, it still can provide good crop protection during the growing season, provides some wind protection, and can control snow in winter. Proper tree spacing and maintenance are very important in single-row windbreaks. Gaps cannot be allowed since there are no trees in adjacent rows to fill them.

Another possibility for an area with limited space is a twin-row high-density windbreak. This design uses two evergreen rows, normally redcedar or juniper, planted close together with a tree in one row filling a gap in the next row. This design fills in and becomes effective very quickly after planting and takes little space.

Using several different tree and shrub species in a windbreak decreases the likelihood of serious disease or insect problems. Wind protection can be improved by combining a row of low, dense shrubs, a row of medium-tall

Species or Windbreak Type	Within Row Spacing	Between Row Spacing
Shrubs and narrow-crowned deciduous trees	3' to 6'	minimum 12' to 20'; 4' wider than cultivating equipment
Smaller evergreen trees	6' to 12'	same as above
Larger evergreen trees	8' to 14'	same as above
Small deciduous trees	8' to 12'	same as above
Large deciduous trees	8' to 18'	20'
Single-row evergreen or twin-row high-density	6' to 8'	same as within row (for twin-row high-density)

evergreens that retain foliage on their lower branches throughout their life, and a row of tall deciduous or evergreen trees. Species diversity also improves a windbreak's wildlife habitat value.

Windbreaks do not need to be straight to be effective. Curves and angles often are more visually appealing and natural looking. Considerable experience is needed, however, to predict the effects of such designs on windbreak function.

For More Information

For more information on windbreaks contact the USU Extension office in your county, the Utah Division of Forestry, Fire & State Lands (FF&SL; phone 801-538-5555 for the location of your local office), or the Natural Resources Conservation Service (NRCS). FF&SL and the NRCS can help with design and planting, and cost-share assistance may be available.

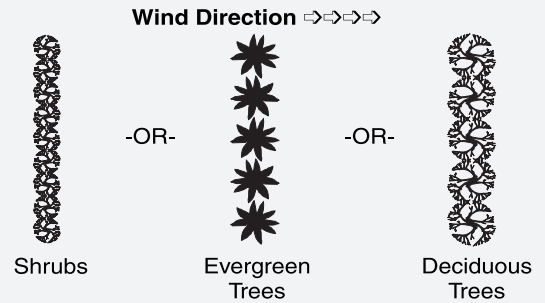
Tree and shrub seedlings for conservation plantings are available through FF&SL's Lone Peak Conservation Nursery, 271 West Bitterbrush Lane, Draper, UT 84020-9599; phone 801-571-0900; fax 801-571-0460; www.nr.state.ut.us/slf/lonepeak/home2.htm. The nursery has seedlings of nearly 90 species of trees, shrubs, and other plants at reasonable prices. Private nurseries also carry appropriate plants. Large transplants usually are not cost effective for windbreaks because of the large numbers of plants needed.

A 50 minute video titled "Green Side Up" is available that covers pre-planting tree care, hand planting, and machine planting. Send a check for \$15 to "Green Side Up," Extension Forestry, Utah State University, Logan, UT 84322-5215.

Windbreak Design Examples

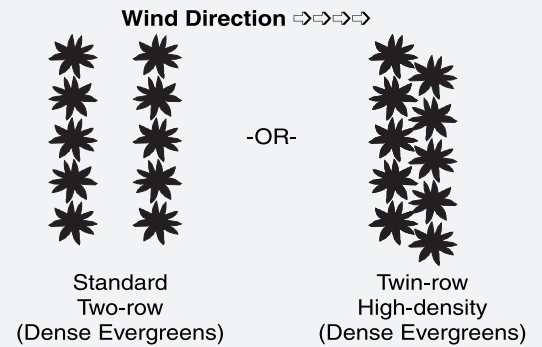
One-Row Windbreak

- ✓for field or orchard protection, snow "trip" row, or in urban setting with little space; uses little land; limited value to wildlife.
- ✓densely planted for maximum effect.
- ✓maintenance and replanting essential to avoid gaps from dead or weak trees.
- ✓use shrubs, dense evergreens that retain lower limbs and foliage like junipers, spruces, and arborvitae (for moister sites), or densely branched deciduous trees, preferably with narrow crowns.



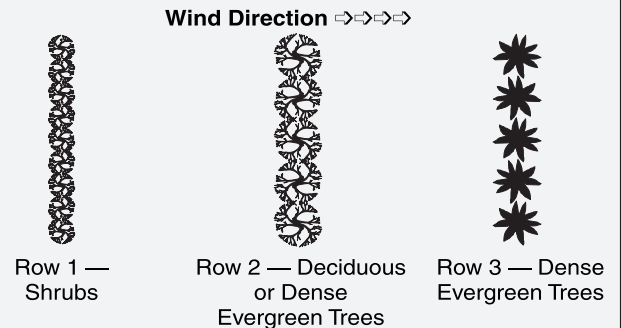
Two-Row Windbreak

- ✓for field or orchard protection, outdoor barn, or urban setting; some wildlife value.
- ✓densely planted as with one-row above.
- ✓twin-row high-density has trees planted alternately, with a space in one row filled by a tree in the other row; rows close together; usually use junipers, spruces, arborvitae (for moister sites), or Austrian pine
- ✓standard two-row uses two rows of dense evergreens (juniper, etc.), or one evergreen and one shrub or deciduous tree row; standard between-row spacing.



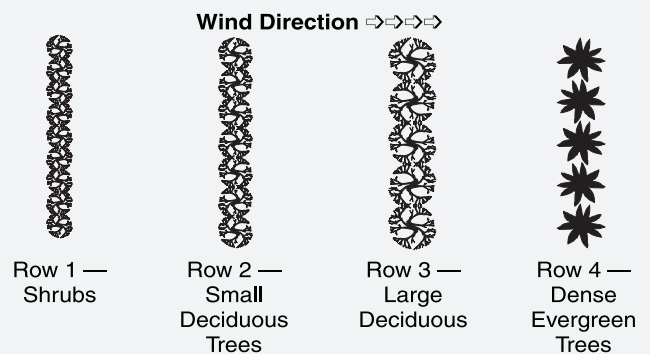
Three-Row Windbreak

- ✓for field protection where more land is available; farmstead and feedlot protection; wildlife value increased with row of food-bearing shrubs.
- ✓at least one row of dense evergreens (juniper, etc.), other row(s) consisting of deciduous trees, shrubs, or pines.
- ✓standard between-row spacing.
- ✓can alternate similar species within rows.



Four-Row (or more) Windbreak

- ✓for farmstead and feedlot protection; excellent for wildlife.
- ✓use mix of shrubs, deciduous trees, and at least one row of dense evergreen trees.
- ✓standard between-row spacing.
- ✓can alternate similar species within rows.
- ✓great design flexibility; uses a lot of land.



Acknowledgments

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