Agriculture and Agri-Food Canada
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Shelterbelts

Design Guidelines for Farmyard, Field, Roadside, Livestock, Wildlife, and Riparian Buffer Plantings on the Prairies

Canada

Agroforestry is an approach to land use that incorporates trees into farming systems to accomplish environmental, economic and social goals, and allows for the production of trees and crops on the same parcel of land.

Shelterbelts are an agroforestry practice. They contain linear plantings of trees and shrubs. Benefits that shelterbelts provide include protecting soil, improving air and water quality, enhancing wildlife habitat, and beautifying the landscape.

A large amount of scientific knowledge exists to help guide the designing of shelterbelts. The purpose of this publication is to provide a synthesis of this diverse knowledge into easy-to-understand guidelines.

This guide is not a cookbook of recipes for design. As a planner, you must put these guidelines together with your knowledge of the site, the landscape, and your goals to create a design that optimizes benefits and minimizes potential problems.

Consequently, this guide should not serve as a sole source for design information. Additional resources, standards and expert advice should be consulted as appropriate.

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Aussi disponible en français sous le titre: *Les brise-vent : Lignes directrices sur la conception de brise-vent pour les cours d'exploitations agricoles, les champs, le bétail, la faune et les bandes tampons riveraines dans les Prairies*

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Livestock Shelterbelt for protection of livestock and livestock facilities; also odour control.

Wildlife Planting for improvement of wildlife habitat, including enhancement of field shelterbelts.

Riparian Buffer to buffer between agricultural land and bodies of water, including floodplains and wetlands.

Planning Your Shelterbelt

✓ farmyard ✓ field ✓ roadside ✓ livestock ✓ wildlife ✓ riparian

The planning process is a learning process. New information often leads to better assessments of problems and limitations, changing priorities, and new or modified objectives.

Planning Your Shelterbelt

It is important to plan your shelterbelt. Planning involves reviewing what you have and determining what you will need. Choose plants that will grow well in your location. Decide what shelterbelt design you will need and the area available to plant it in. The design should match the equipment that you will use to prepare the site, plant the trees and most importantly, control weeds after the shelterbelt has been planted.

As you plan your shelterbelt, keep the following considerations in mind:

- Locate the shelterbelt where it will be most effective.
- Design the shelterbelt to fit the available space and to meet your objectives. The design must take into account proper spacing to allow for optimum tree growth and the use of maintenance equipment.
- Select tree and shrub species that are well adapted to your soil and climatic conditions.
- Prepare the planting site and fence areas to exclude livestock.
- Arrange for planting labour and equipment to plant the trees.
- Provide care and protection for young seedlings.
- Control weeds after shelterbelt establishment.

Determine Objectives

Before you design and plant a shelterbelt, ask yourself what you want to accomplish. Initially, you may have only a general idea of the problems on your site that can be solved with a shelterbelt. This provides a starting point, but you should conduct both a site and a landscape assessment.

- Site assessment – Identify initial areas of concern and verify needs. Also, identify other conditions that could be improved by, or limit the effectiveness of a shelterbelt at your site.
- Landscape assessment – Identify resource conditions and problems in the surrounding area that could affect, or be affected by, a shelterbelt.

Develop Alternatives and Select One

Developing a shelterbelt design may require creating a few alternatives to consider and choosing the most suitable. A complete shelterbelt plan will indicate its location, size, and tree and shrub composition. Also include management and maintenance options.

Implement and Monitor

Small shelterbelt projects may only require minimal planning. However large or more complicated projects will require more detailed planning to organize numerous activities, people, and equipment.

After the shelterbelt has been planted, monitor how well each of your planning objectives is being met. It may take several years to achieve some of your goals. For these, regular monitoring can help you determine the progress in meeting your objectives.

Modify if Needed

The planning process is a learning process. New information often leads to better assessments of problems and limitations, changing priorities, and new or modified objectives. If monitoring suggests that the planning objectives are not being met, modify your plan.

General Shelterbelt Design Considerations

✓ tree and shrub selection ✓ spacing recommendations

Consider the purpose for your shelterbelt and the site characteristics when selecting suitable trees and shrubs.

Selecting trees and shrubs for shelterbelts

Descriptions of trees and shrubs provided through the Agriculture and Agri-Food Canada - Agri-Environment Services Branch Prairie Shelterbelt Program can be found in the publication *Trees and Shrubs for Your Agroforestry Planting - Adapted Species Available through the Prairie Shelterbelt Program.*

Consider the purpose for your shelterbelt and the site characteristics when selecting suitable trees and shrubs. It is better to plant a multi-row shelterbelt using a variety of trees or shrubs rather than planting two or more rows of the same. A variety of trees and shrubs provides a wider range of benefits, which includes lowering the risk of losing the entire shelterbelt to events such as drought, insects or disease.

- The denser the shelterbelt, the greater the wind protection.
- Shrubs provide excellent snow trapping and wind protection over short distances due to their density and limited height. In areas prone to water erosion, you may not want to use dense shrubs since too much snow will be trapped in a short distance.
- Trees with an upright, narrow growth habit provide the most protection relative to the area of land occupied by the shelterbelt.
- Herbicide tolerance, especially to glyphosate, is important and is a major factor limiting the suitability of some tree species for field shelterbelts.
- In reduced-till or zero-till agricultural fields with adequate moisture, tall and narrow trees are the most effective at distributing snow evenly.
- A mixture of tree and shrub species will provide height and density in a shelterbelt planting for maximum protection. Fruit-bearing species will also provide food and habitat for wildlife.

Spacing trees and shrubs in shelterbelts

Spacing recommendations between trees and shrubs, as well as between shelterbelt rows, varies according to the planting type.

It takes longer for trees to form an effective wind barrier at wider spacing. This can be overcome by staggering the trees in adjacent rows. The delay in effectiveness will be more than offset by the increased growth and vigour of the trees that have adequate space to grow. Well spaced trees live longer, retain their lower limbs better and produce more foliage.

How Shelterbelts Work

✓ sheltering effect ✓ density ✓ length and protected area

Shelterbelts can be located around farmyards, adjacent to roadsides, on the boundaries, within fields or around livestock facilities.

Shelterbelts are linear plantings of trees and/or shrubs that form part of an agriculture production system. This includes trees and/or shrubs planted as a barrier to reduce wind speed and to protect crops, livestock, buildings, work areas and roads from wind and snow as well as enhance biodiversity. Shelterbelts can be located around farmyards, adjacent to roadsides, on the boundaries or within fields or around livestock facilities.

Many shelterbelt benefits are from their impact on wind speed. As the wind approaches the shelterbelt, some wind moves through the shelterbelt by the force of the wind. However, the resistance by the trees creates back pressure which causes some of the wind to be forced over the shelterbelt. The horizontal wind speed for a short distance upwind of the shelterbelt is less because of this back pressure. The air going through the shelterbelt moves more slowly and becomes turbulent because of the interference by the trees.

Shelterbelt Characteristics

Effect of Height

Shelterbelt height is the determining factor for the area of the protected downwind zone. This is controlled by the tallest tree or shrub row in the shelterbelt. This varies from shelterbelt to shelterbelt, and increases as the shelterbelt matures.

On the windward side of a shelterbelt, wind speed reductions are measurable upwind for a distance of 2 - 5 times the height of the shelterbelt. On the leeward side, wind speed reductions occur up to a distance of 20 times the height of the shelterbelt. (Figure 1)

Effect of Density

A dense shelterbelt will have less wind passing through it. Air pressure is reduced on the leeward side of dense shelterbelts. This low pressure area pulls air coming over the shelterbelt downward, creating turbulence. The zone of protection is somewhat smaller behind dense shelterbelts. For less dense shelterbelts, more air passes through the shelterbelt, resulting in reduced turbulence, and greater length of the downwind protected area. While this protected area is larger, the wind speed reductions are not as great. By adjusting shelterbelt density, different flow patterns and areas of protection are established.

The number of rows, the distance between trees, and species composition are factors controlling shelterbelt density. Increasing the number of shelterbelt rows or decreasing the distance between the trees increases density and provides a more solid barrier to the wind. The species chosen for the shelterbelt will determine height as well as density, and will influence the length of the sheltered area.

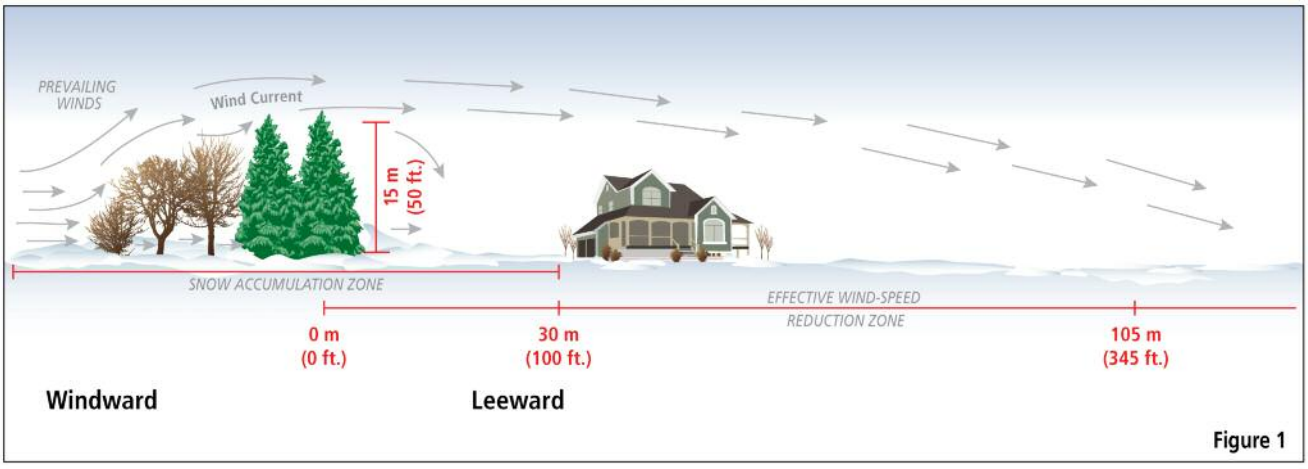


Figure 1

Shelterbelt density plays an important role. If the shelterbelt has a low density, wind can pass through open areas causing less downward turbulence on the leeward side and increasing the length of the protected area. Even though this protected area is larger, the wind speed reductions are not as great. A shelterbelt design with low density would be favourable for field shelterbelts where soil erosion and even distribution of snow is required. Whereas with high density, less wind passes through the shelterbelt and a low pressure area is created on the leeward side which pulls air downward causing turbulence which reduces protection downwind and increases wind reductions closer to the shelterbelt. In short, as density decreases, the amount of wind passing through the shelterbelt increases and the downwind protected area increases. (Figure 2)

Effect of Orientation

Shelterbelts are most effective when orientated at right angles to prevailing winds. The orientation of shelterbelts depends on the design objectives.

Farmyards and feedlots usually need protection from cold winds and blowing snow or dust. Field crops usually need protection from hot, dry summer winds, abrasive wind-blown soil particles, or both.

Orienting shelterbelts perpendicular to the prevailing wind direction provides the most protection. As the wind changes direction and no longer blows directly against the shelterbelt, the protected area decreases. Although the wind may blow predominantly from one direction, it rarely blows exclusively from that direction. For this reason, shelterbelts for feedlots or farmyards should protect from more than one direction. (Figure 3)

Effect of Length

Shelterbelt height determines the extent of the protected area downwind. Shelterbelt length determines the amount protected area. For maximum efficiency, the uninterrupted length of a shelterbelt should exceed the height by a minimum factor of 10 to 1. This ratio reduces the influence of end-turbulence on the total protected area.

Continuity of a shelterbelt is important because gaps can become funnels that concentrate wind flow so that wind speed is accelerated. Since gaps reduce the effectiveness of the shelterbelt, lanes or field access through shelterbelts should be located to avoid this effect. (Figure 6)

Microclimate Modifications

Reduced wind velocity behind a shelterbelt changes the microclimate within the protected zone. Temperature and humidity levels usually increase. The result is decreased soil moisture evaporation and plant water loss. Actual temperature modifications depend on shelterbelt height, density, orientation, length and time of day. At a distance within 10 times the height of the shelterbelt, the leeward side daily air temperature is generally several degrees higher than the temperature in the open. At a distance beyond 10 times the shelterbelt height, air temperature near the ground tends to be cooler during the day.

Shelterbelt Density

Density of Tree and Shrub Species

Low	Oak, Poplar, Trembling Aspen
Medium	Ash, Larch, Pincherry, Pine, Siberian Crab
Medium-High	Buffaloberry, Caragana, Choke Cherry, Hawthorn, Hedge Rose, Maple, Red-osier Dogwood, Red Elder, Sea Buckthorn, Snowberry, Lilac, Willow
High	Spruce

Figure 2

At nighttime, temperature near the ground in sheltered areas is slightly higher than in the open. However, on calm nights sheltered areas may be several degrees cooler than in the open.

Summer soil temperatures in sheltered areas are usually higher than in unsheltered areas. Warmer temperatures may allow earlier crop planting and accelerate germination in areas with short growing seasons. In the area next to an east-west shelterbelt, soil temperature is higher on the south side due to heat reflected by the shelterbelt. On the north side of an east-west shelterbelt, soil temperatures close to the shelterbelt may be lower, especially in the early spring, due to shading. These cooler temperatures may reduce the rate of snow melt, and cause problems with access to fields in the early spring.

Relative humidity in sheltered areas is often higher than in open areas, depending on shelterbelt density. Higher humidity decreases the rate of plant water use, so crops more efficiently use water than in unsheltered areas. However, enhanced humidity levels may, in some cases, increase diseases such as mildew.

Heat loss due to wind chill is reduced on the leeward side of a shelterbelt. Moderation of the wind chill factor is most significant with farmyard and livestock shelterbelts where people, animals, and buildings benefit from increased energy efficiency. A good shelterbelt can reduce the use of home-heating fuel by as much as 25 per cent.

Most shelterbelt benefits are indirect because of changes in the microclimate of the sheltered zone. One exception is the direct benefit of reducing wind speed to control soil erosion. A shelterbelt can reduce soil erosion on the leeward side to near zero within 10 times the height of the leeward side of the tree row.

Shelterbelts reduce wind speed on both the leeward and windward sides. The resulting reductions in wind speed lead to moderation of the microclimate in these protected zones. With careful planning, microclimate modifications can create desirable environments for growing crops, raising livestock, and protecting living and working areas.

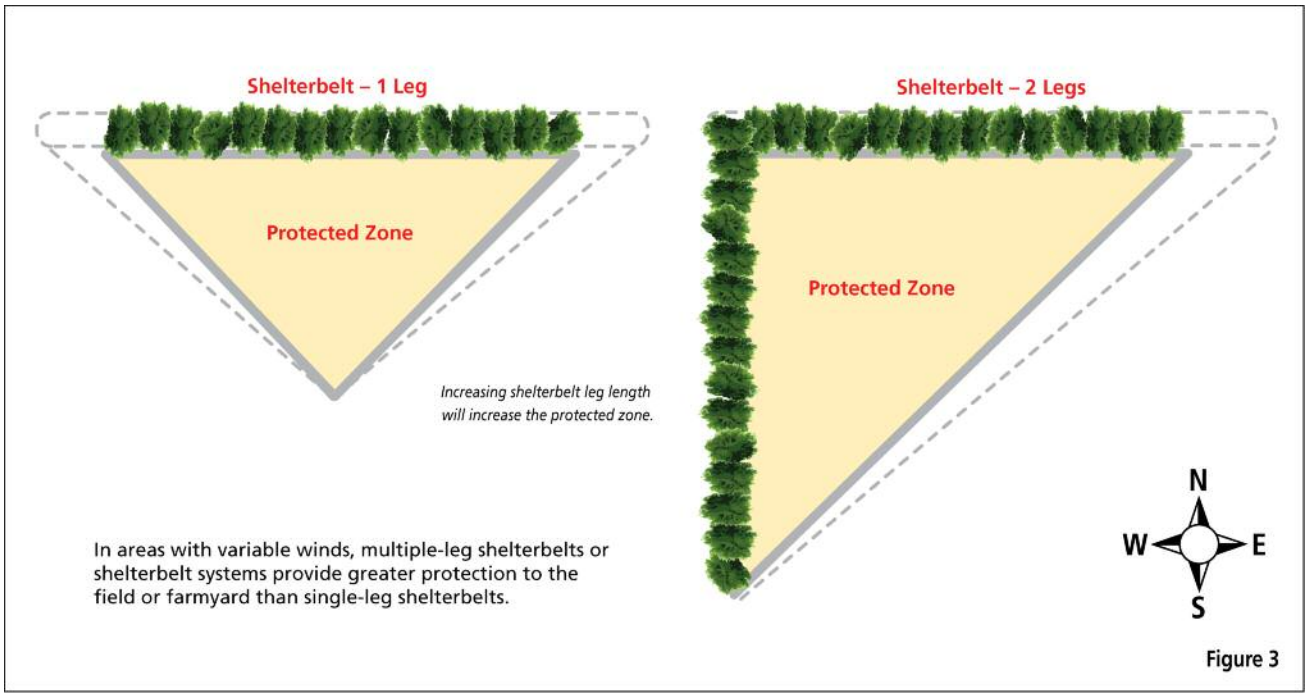


Figure 3

Sketch Pad

A shelterbelt planting is a long-term investment, and careful planning can improve benefits and help avoid problems. A sketch of the planting area helps the planning process.

Identify and locate the following in your sketch:

- Note orientation (north) on the sketch pad
- Prevailing or troublesome winds
- Locate existing buildings or structures and any future developments
- Note all distances between structures
- Identify property lines, fences and roads
- Locate existing trees (bluffs or planted rows)
- Identify power lines / utility service lines (include buried lines)
- Identify trouble areas where there is snow build up, flooding, soil problems, steep slopes or lagoons
- Indicate landscape features (hills, water areas, stubble, grass, summerfallow)
- Include location of new tree rows, species selection, row spacing and length of rows

Farmyard Shelterbelts

✓ snow control ✓ reduce energy costs ✓ increase aesthetic value

Farmyard

Farm families value the protection and other benefits provided by shelterbelts planted around their farmyard. In the winter, shelterbelts control snow and protect farm buildings from cold winds. During summer they protect against hot, dry winds. This gives the farm family a sense of home as the shelterbelt creates a yard where they can relax outdoors or grow a garden.

A shelterbelt's main function is to reduce wind velocities and affect wind currents. Some of the benefits from controlling wind in and around farmyards are: reduced snow removal costs by controlling blowing snow, building protection, decreased energy consumption, increased water supplies by trapping snow for dugouts, creation of microclimate conditions and protection for gardens. Other advantages include wildlife habitat enhancement, carbon sequestration, reduced dust, privacy, beautification and creation of a nicer environment to live and work in.

Location and Shape

A shelterbelt should be positioned perpendicular to prevailing winds and located approximately 30 m (100 ft.) away from buildings or other structures in order to allow drifting snow to accumulate on the leeward edge of the shelterbelt. This distance allows the trees to provide excellent protection when they reach a height of 15 m (50 ft.). For optimum benefits, plan your shelterbelt so that buildings are located in the maximum wind-speed reduction zone, i.e. from 2 to 7 times the height of the shelterbelt. (Figure 4a) Future yard expansion, overhead lines, buried lines should be taken into consideration when selecting a planting location.

Older shelterbelts should be maintained and removed only if necessary. In most cases, an aging shelterbelt continues to provide adequate wind and snow protection, but it may be no longer aesthetically pleasing. Older shelterbelts were planned for the farm practices and needs at the time of planting. With changing and expanding farm operations more space within the yard site may be needed for additional buildings and equipment storage. Plan and prepare a new shelterbelt site further out from the existing trees. When the new shelterbelt begins to provide the benefits you need, you can consider removing the old shelterbelt if it is beyond restoration.

Winter Protection

Prevailing winds in winter are usually from the north and northwest. Therefore shelterbelts should be located along the north and west sides of the farmyard. The effective protection zone extends from a distance out to 7 times the height of the trees. Drifting snow varies with the direction and velocity of the wind, the type of snow, the fetch distance and the composition of the shelterbelt. However, snow often piles up on the windward side of the shelterbelt at distances 1 - 3 times the height of the trees. An additional snowtrap row could be planted 15 - 30 m (50 - 100 ft.) from the windward side of the shelterbelt to reduce the effect of excessive snow accumulations within the primary shelterbelt. (Figure 4b)

Do not plant shelterbelts close to your home or other buildings. Trees planted too close will cause snow to drift into areas that should be snow-free. Plant shelterbelts for winter protection at least 30m (100 ft.) from farm buildings that are on level land. Remember, shelterbelts may create snow problems when planted too close to buildings or roads. If the purpose of the shelterbelt is to trap snow, then your planting should be located 30 - 90 m (100 - 300 ft.) away from existing or proposed buildings or roads. Keep in mind that shrubs create short and deep snow drifts whereas deciduous trees create longer and shallower drifts. (Figure 5)

Certain situations like steep slopes, low areas, farm access roads or municipal regulations may not allow planting shelterbelts the recommended distance away from your yard. In these cases reduce the number of rows and plant high density shelterbelts. If your land slopes steeply downward on the north or west side of your farmyard, consider planting closer to the farmyard than the traditional recommended distances. However, do not plant closer than 18 m (60 ft.) from main buildings or driveways if snow drifting is a concern. Shelterbelts planted closer than recommended may cause snow problems around buildings and roads especially during heavy snowfalls and severe winds.

If your farmyard is located close to a public road with insufficient space to plant a shelterbelt, you may want to try establishing a shelterbelt across the road. Remember to follow municipal or highway regulations regarding new plantings next to roads. If you must plant across the road from buildings, recognize that drifting snow may block the road.

Because wind and snow whip around the ends of a wind barrier, the ends of the shelterbelt should be extended approximately 15 m (50 ft.). beyond each corner of the area to be protected. Shelterbelts do not have to be planted in rigid, straight lines. A curved shelterbelt on a natural topographical contour line around the north and west sides of your farmyard will look more pleasing. Shelterbelts can follow the contour of a valley or creek, run in an angle, or even have a circular shape around the yard site. The main consideration is to keep the spacing parallel between rows for ease of between-row cultivation and maintenance.

Summer Protection

Shelterbelts can be planted to control hot, dry summer winds. Prevailing winds in the summer are generally from the south and southwest. Shelterbelts should therefore be located along the south and west sides of the area to be protected.

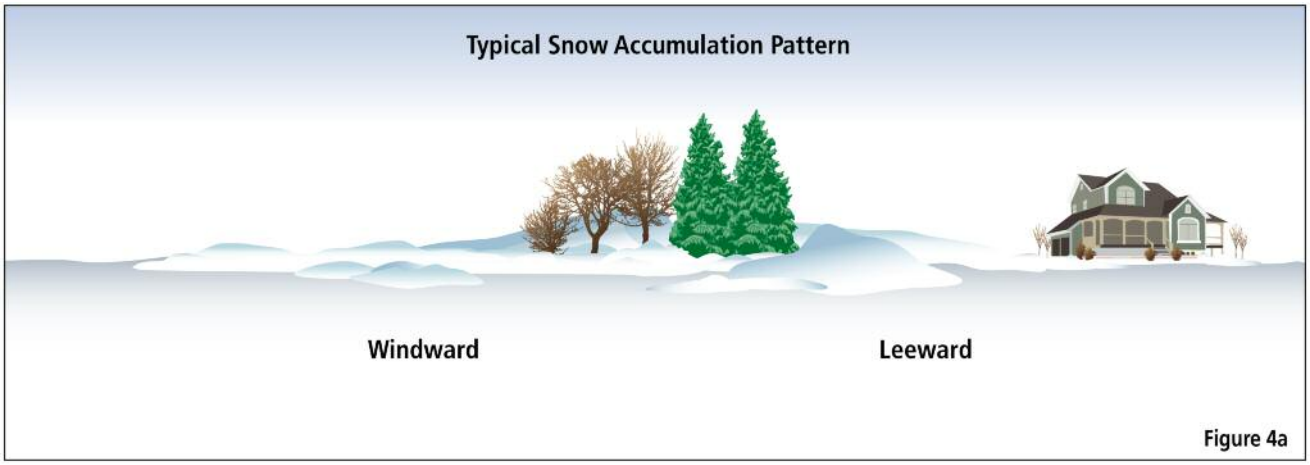


Figure 4a

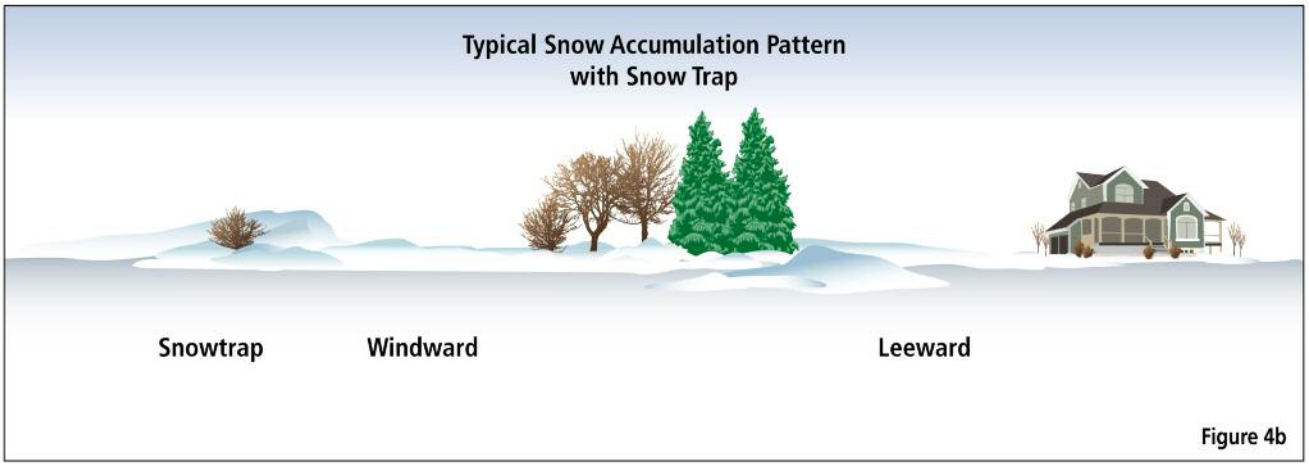


Figure 4b

A well-designed shelterbelt reduces wind velocity but still allows a breeze for ventilation. If a shelterbelt is planted without allowing air flow for ventilation, the summer conditions within the farmyard may be uncomfortably hot. Shelterbelts planted for summer wind protection usually consist of one or two rows of trees located to the south and west of the farmyard. A one-row shelterbelt may be composed of either deciduous or coniferous trees. The outside row of a two-row shelterbelt (i.e. southward) usually consist of deciduous shrubs or small deciduous trees, and the inside-row, of moderate to tall deciduous trees.

Other Considerations

Do not plant shelterbelts across old feedlots, near manure piles or across barnyard drainage ways. Trees, particularly conifers, will perform poorly in such locations if they even establish. Also, when soils or drainage conditions change drastically, it may be necessary to correct the drainage or change the species of trees and shrubs in the shelterbelt to match the new site conditions.

Plan for future yard expansion, whether for buildings, grain storage and handling, equipment parking area, livestock feed storage, corrals, or a new dugout. Other important location considerations include buried electrical, phone, gas, water and sewer lines; overhead electrical lines; and topography.

Avoid field access openings in shelterbelts to the west and north sides of the yard. If you must have an opening to these directions, stagger the shelterbelt planting to reduce the wind-tunnel effect. If it is necessary to cross field roads, driveways or large ditches with a shelterbelt, avoid creating wind tunnels by making the crossings at an angle. (Figure 6)

Check with your municipal, county or district office or with the Provincial Highways Department on set back distance regulations for the allowable minimum distance between a shelterbelt and the main road or highway. In most municipalities, set backs range from 40 - 45 m (125 - 150 ft.) from the centre of the main road and 90 m (300 ft.) from the highway right of way. In some cases, written permission may be obtained for using a smaller set back.

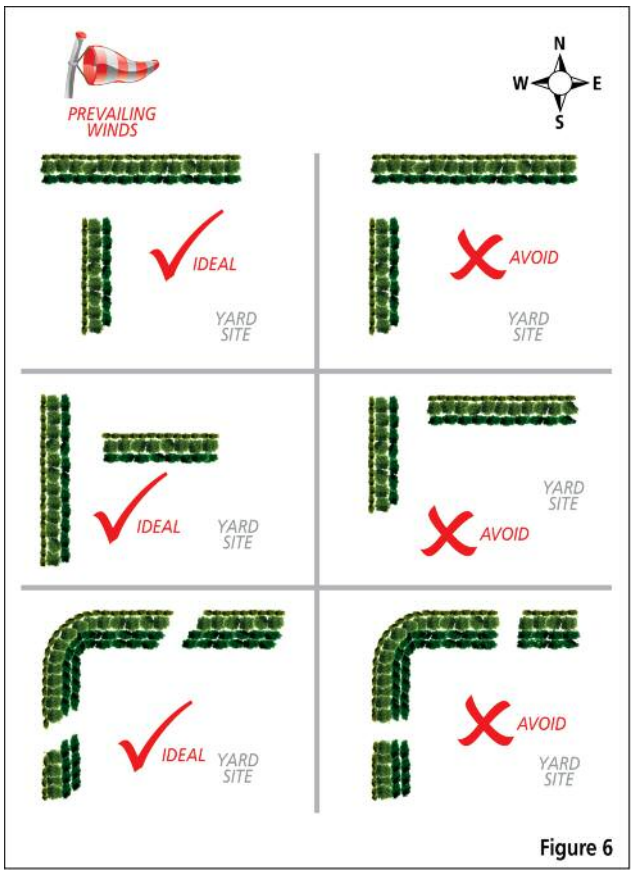
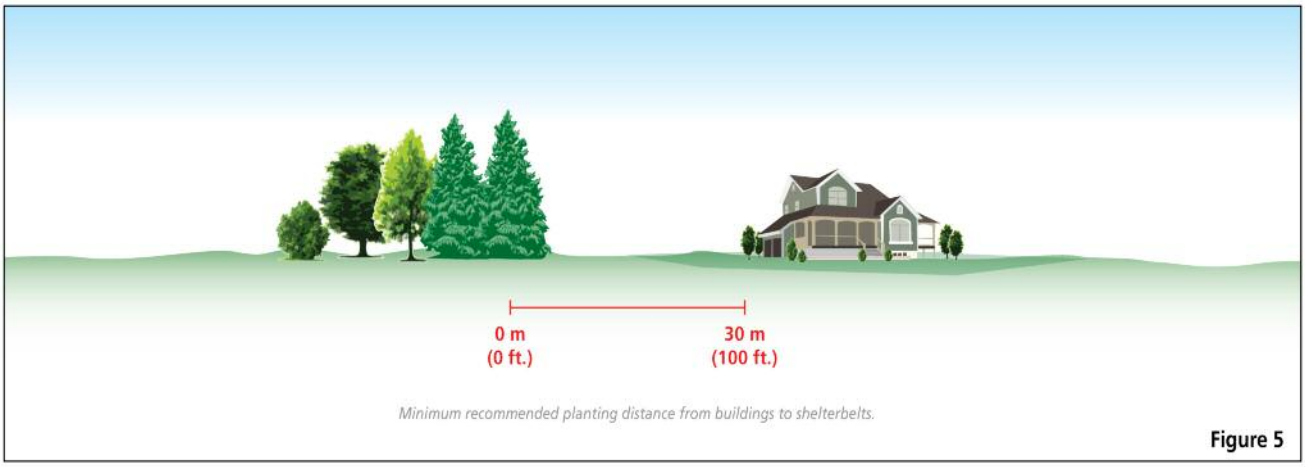


Figure 6

Shelterbelt Design

Shelterbelts require several kinds of trees and shrubs with different growth characteristics to provide foliage density at various heights over a period of years. As trees age, their form and crown characteristics change. The ability of a tree planting to provide protection depends on a combination of tree and shrub species characteristics such as shelterbelt height, density and longevity.



Minimum recommended planting distance from buildings to shelterbelts.

Figure 5

Height influences the extent of the protected area. The taller the shelterbelt, the greater the area protected. For a quick effect, plant fast-growing trees that reach maximum height in a short time. Since fast growers are usually also short-lived, you should also plant slower-growing trees that mature later but remain functional for a long time.

Density influences the extent of downwind protection. Young trees provide foliage density near the ground, at a height range of 0-3m (0-10 ft.). As the trees mature, density near the ground will have to be provided by thick growing shrub species. Most conifers have dense, compact tops that retain foliage throughout the year. In contrast, deciduous trees and shrubs lose foliage in the fall causing shelterbelts to have lower densities in winter than summer. Foliage density in the middle level of shelterbelts, 3 - 5 m (10 - 16 ft.), will be provided by the fast-growing broadleaf trees. As the broadleaf trees age and grow, conifers begin to assume the mid-level density function.

An effective shelterbelt is composed of five rows of trees and shrubs. If limited space prevents planting five rows with adequate space between rows, it is better to plant fewer rows than to crowd the trees. Three rows, with room to grow, will result in better long-term results than five crowded rows. When there is not even enough room for three rows, a narrow shelterbelt of two rows of dense conifers, provides the most practical protection under the circumstances. Staggering the trees, so they are not directly behind the tree in the adjacent row will optimize protection.

Determining the number of rows to plant

The farmyard shelterbelt should consist of a combination of tall, fast-growing, long-lived and dense trees and shrubs. Of course no one tree or shrub has all these characteristics. However, by combining a variety of species, each having one or more of the desired characteristics, you can create a multi-functional shelterbelt.

Your knowledge of how the density, height and length of a shelterbelt affects wind, will play an important role in helping you design your planting plan. Five shelterbelt rows are recommended on the north and west sides of the yard to provide protection from prevailing winds. Two or three rows are usually adequate on the east and south sides. Prevailing wind directions vary from season to season, and according to your

Five Row Shelterbelt — Figure 7

ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
SHRUB	TALL DECIDUOUS		CONIFEROUS	
Caragana	Willow	Ash	Colorado Spruce	
Chockecherry	Poplar	Maple	White Spruce	
Lilac	Maple	Oak	Scots Pine	
Hawthorn	Ash	Larch	Larch	
Buffaloberry				
Sea Buckthorn				
Dogwood				
Siberian Crab				

Species can be planted either as a pure row or in some cases, a mixture of species can be planted within the same row.

Shelterbelts with fewer than 5 rows

For two-row shelterbelt, use rows [1-2, 1-3, 2-3[For three-row shelterbelt, use species listed for rows [1-2-3, 1-2-(4/5), 1-3-(4-5), 2-3-(4/5)]

For four-row shelterbelt, use species listed for [1-2-3-4, 2-3-4-5, 1-2-3-5, 1-2-4-5, 1-3-4-5]

location on the prairies. This may require you to establish a denser shelterbelt on other sides of the yard than the north or west.

In winter, winds from north to west directions bring in the colder temperatures, while southerly winds seem to bring in milder temperatures usually with snow. Winds are usually strong creating high wind chill factors and typically blow freshly fallen snow around buildings and onto roads. If this is the case for you, plan for at least three or more rows of trees and shrubs in those areas of the yard. Keeping in mind the hot summer months when temperatures can reach into high 30 degree Celsius range (85-100˚F), air flow through the yard is necessary to achieve a comfortable temperature for your living space. Review your particular situations and address your needs accordingly.

Certain attributes of the yard may not allow you to plan for the recommended shelterbelt but wherever possible, a multi-row planting will provide better benefits. A minimum of three rows, using a combination of deciduous shrubs, trees and conifers are needed to provide proper wind reductions. The number of shelterbelt rows that you have room for plays an important role in species selection.

Some circumstances may not allow for a full five-row shelterbelt, and rather than decrease the distance recommendations between rows, or plant the shelterbelt too close to buildings, reduce the number of shelterbelt rows as required. If you require protection that a properly designed five-row shelterbelt would give, but only have room for three rows, compromise by planting a dense shrub row to trap snow, a tall deciduous tree to lift the wind and a conifer row for added year-round protection. Another option when working with limited space is to combine shrubs and tall deciduous trees in the same row to increase the sheltering benefit.

The shrub row or low dense species provides protection from ground level winds and act as the main snow trap. Selecting some fruit bearing shrubs provides additional wildlife habitat benefits. These rows should be planted on the windward side as an outer row to trap snow and to deflect the wind upwards. Dense shrubs cause an accumulation of snow close to the belt which provides the inner tree-rows with the needed soil moisture for the growing season. Taller deciduous rows may lose their lower branch density and provide little or no protection at lower levels. However, their height and density in the upper canopy direct wind currents upward and reduces wind over a larger area on the leeward side of the shelterbelt.

It is important to only plant long-lived deciduous species in the central rows of the shelterbelt. Fast growing species like poplar tend to have a shorter lifespan especially if affected by poor moisture conditions. Removal in later years could pose a problem if planted between rows of other long-lived species. Therefore, ensure adequate distance is left between rows to facilitate removal later. (Figure 7)

Spacing and arranging trees in shelterbelts

Some consideration should be given to spacing seedlings according to their estimated mature crown size. While it takes longer for trees to form an effective windbreak at wider spacing, this shortcoming can be overcome by staggering the trees in adjacent rows. The delay in effectiveness will be more

Tree and Shrub Species	Minimum Recommended Within-row Planting Distances	
	Metres	Feet
Caragana	0.3	1.0
Choke Cherry, Hawthorn, Hedge Rose, Pincherry, Red Elder, Red-osier Dogwood, Sea Buckthorn, Silver Buffaloberry, Snowberry, Villosa Lilac	1.0	3.0
Siberian Crab	2.0	6.5
Bur Oak, Cottonwood, Green Ash, Hybrid Poplar, Manitoba Maple, Siberian Larch, Trembling Aspen, Willow	2.5	8.0
Scots Pine, Spruce	3.5	12.0

Table 1

than offset by the increased growth and vigour of the trees that have adequate space to grow. Well spaced trees live longer, retain their lower limbs better and produce more foliage.

Shelterbelts with both deciduous and coniferous species must have adequate space. If deciduous and coniferous tree rows are planted too close together, the faster growing deciduous trees soon overtake the conifers in height. When this happens, the conifers become shaded resulting in deformed growth, stunting and reduced effectiveness. To avoid problems, leave the recommended minimum 6 m (20 ft.) spacing between rows of deciduous and coniferous species. All other between-row spacing should be 5 m (16 ft.) Spacing within-row depends on the species. (Table 1)

NOTES

Field Shelterbelts

✓ reduce soil erosion ✓ increase crop productivity

Field

Primary objectives of field shelterbelts are protecting crops and soil from wind erosion; catching and distributing snow; and improving the micro-climate for crop production.

Field shelterbelts are rows of trees and shrubs planted on agricultural lands. The primary objectives of field shelterbelts are protecting crops and soil from wind erosion, catching and distributing snow and improving the micro-climate for crop production. Long-term benefits to you and the environment include wildlife habitat enhancements and visually appealing landscapes.

Design your field shelterbelt to accommodate the size of your agricultural equipment. Consider field access, shelterbelt location and equipment maneuverability in your plan.

Main objectives include reducing wind erosion, providing crop protection, increasing irrigation efficiency and improving wildlife habitat. To control soil erosion, shelterbelts should be planted to block the prevailing winds during the times of greatest soil exposure – winter and early spring. Shelterbelts protect fall-seeded small grains like winter wheat from summer and winter winds. To recharge soil moisture with drifting snow, shelterbelts should be placed perpendicular to the prevailing winter winds.

Planning

Using the recommended species and spacing is an important component of planning.

Good planning can reduce tree competition with adjacent crops and prevent excess snow entrapment. Increased crop yield and moisture accumulation in the sheltered zone more than compensates for the moisture used and land occupied by field shelterbelts.

The protection zone provided by a single shelterbelt is limited. Therefore multiple shelterbelts may be required to protect the entire field. The area protected will increase as the shelterbelt matures. On most soils, shelterbelt rows can be spaced 200 - 250 m (660 - 820 ft.) apart. Up to four shelterbelt rows can be planted in a square 64 hectare (160 ac.) field. Plant your rows at right angles to the prevailing winds. In most areas on the Prairies, prevailing winds come from the northwest and west directions, so the recommended shelterbelt planting is north to south. The first shelterbelt should be on the extreme west side of the field, with the remaining shelterbelts dividing up the area. (Figure 8)

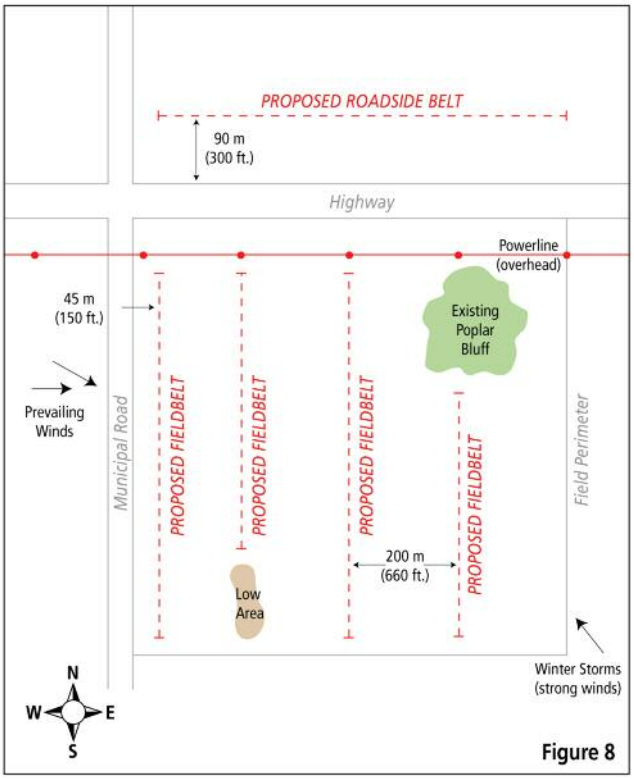


Figure 8

Leave adequate room at the ends of each shelterbelt row to allow equipment access to the field rather than inserting an opening within the shelterbelt. Wind, when funneled through a gap, increases in speed. If you need field access within the shelterbelt rows, stagger the access points (i.e. not in a straight line) to limit wind funneling.

Snow drifts accumulate mostly on the leeward or protected side of a shelterbelt. In high snowfall areas, a single, low density row distributes snow evenly across the field. This reduces deep snow drift formation. A gap between the ground and the shelterbelt's lowest branches increases this effect. A multiple-row shelterbelt will trap snow between its rows. Additional benefits include other wood and fruit products as well as enhanced wildlife habitat. Areas with low to moderate snowfall may require a denser shelterbelt to capture as much snow as possible. Additional field management practices can aid in improving in-season soil moisture conditions: tall stubble to enhance snow trapping in-field, and crop residue to reduce soil moisture evaporation.

Shelterbelts for Dugouts

Snowmelt and spring runoff can be an important water source for dugouts. Strategically placed shelterbelts can trap significant amounts of snow for the eventual filling of a dugout.

Design tree rows so that snow collection is maximized and runoff water is directed to the dugout. Generally, trees should be planted on the north and west sides of a dugout to trap snow and to reduce evaporation caused by prevailing winds. Shelterbelts on the south and east sides may also be

an effective snow trap where winds contribute to large snow accumulations. (Figure 9)

The number of rows required depends on the desired results. A single row effectively traps snow and reduces wind velocities. Plant multiple rows to increase the amount of snow trapped.

Plant deciduous trees at least 50 m (164 ft.) from the dugout in order to maintain water quality by reducing contamination from branches and leaves. At this distance, the tree roots will not steal stored water from the dugout. Small-leaved shrubs or conifers can be planted as close as 20 m (66 ft.) from the dugout, as few of the small leaves or needles will blow into the dugout. Aeration to prevent water stagnation may be required if trees are planted closer than 50 m (164 ft.) from the dugout.

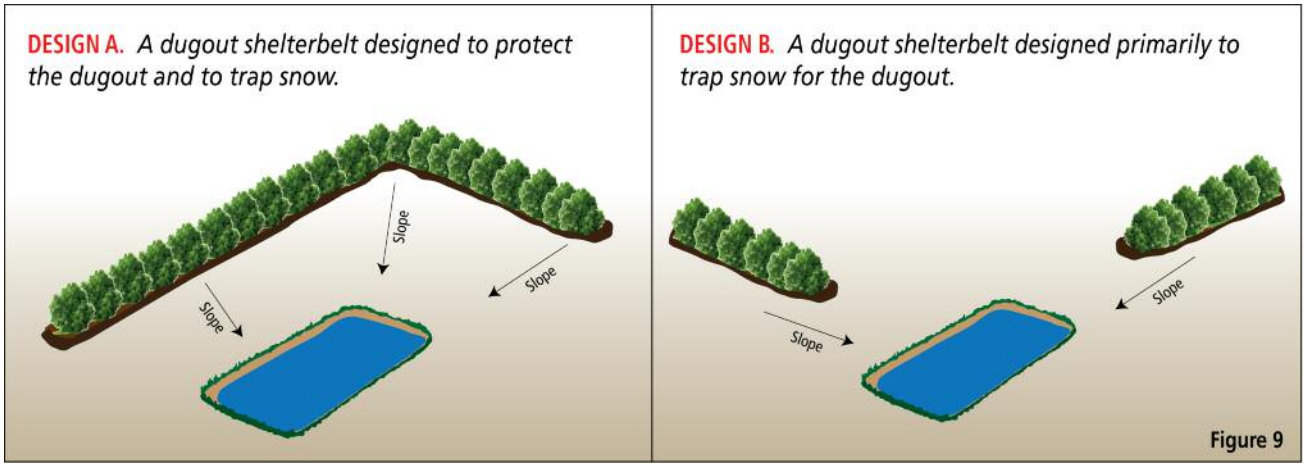


Figure 9

Roadside Shelterbelts

✓ trap blowing snow ✓ privacy for your yard ✓ reduce dust and noise

Roadside

Roadside shelterbelts create some privacy in your yard and reduce dust from traffic on nearby roadways.

Roadside shelterbelts trap blowing snow and reduce the possibility of blizzard-like conditions. This makes for safer winter driving and significantly reduces the burden of road maintenance. They also create some privacy in your yard and reduce dust from traffic on nearby roadways.

The amount of snow to be trapped will affect the required number of rows. If the fetch distance is short or if only moderate amounts of blowing snow occur, dense evergreens or one row of shrubs may be enough. But if more snow storage capacity is required, multiple rows of shrubs and/or conifers may be needed. Two rows planted close together store practically no more snow than one row. Therefore, plant your rows at least 15 m (50 ft.) apart to maximize snow trapping.

Place roadside shelterbelts as close to the road as possible, yet far enough away so that snow drift edges do not touch the road. Also, shelterbelts planted too close may affect road conditions: trees planted too close may affect road-surface temperatures, resulting in icy patches.

The length of the snow bank depends on the height and density of the shelterbelt. Therefore the shelterbelt should be placed parallel to the road at a distance no closer than 30 m (100 ft.). In open areas with large fetch distances, you may have to increase this distance.

Do not plant roadside shelterbelts where they will create visibility hazards at road intersections now or as they mature. Check with your municipal, county or district office or with the Provincial Highways Department on set back distance regulations. These specify the minimum distance between a shelterbelt and the main road or highway. In most municipalities, set backs range from 40 - 45 m (125 - 150 ft.) from the centre of the main road and 90 m (300 ft.) from the highway right of way. (Figure 10)

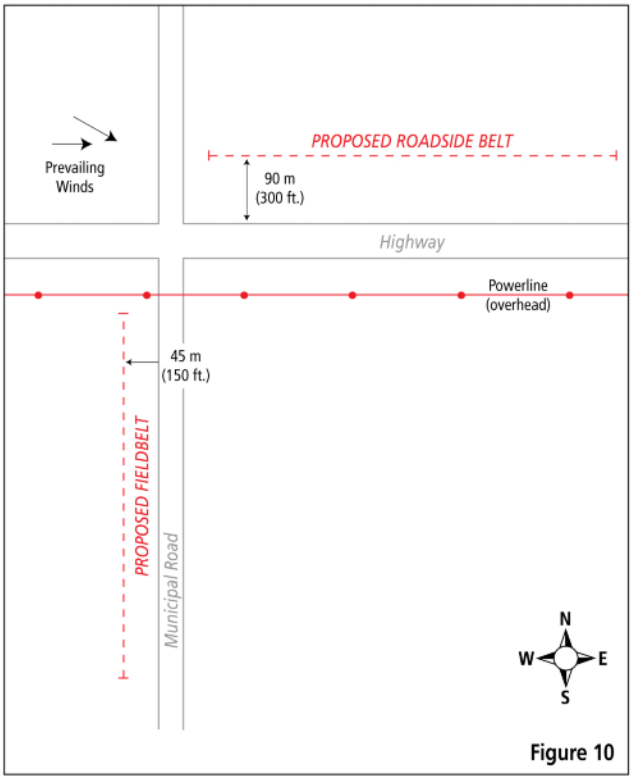


Figure 10

NOTES

Livestock Shelterbelts

✓ protect livestock ✓ screen unsightly areas ✓ filter dust and odours

Livestock

Reduced wind speed in winter lowers animal stress, improves animal health, and increases feeding efficiency.

Shelterbelts provide benefits to feedlots, livestock pastures, and calving areas. Reduced wind speed in winter lowers animal stress, improves animal health, and increases feeding efficiency. Shelterbelts protect the working environment in and around the livestock area. They also screen noise and odours associated with livestock operations.

Protecting livestock with trees can be accomplished several ways. Shelterbelts planted at the end of pastures provide herds with protection from wind and blowing snow. Shade trees in a pasture provide welcome relief for livestock on hot summer days. Feedlot shelterbelts can reduce wind velocity, reducing animal stress. Swine and poultry benefit from protective shelterbelts and shade-providing trees. Barns, pens and milking parlours that are protected by trees can lead to increased milk yields from dairy herds.

Shelterbelts can screen unsightly areas from the road and living area. They filter dust from tillage operations and road traffic. They also muffle machinery and traffic noise. Some odours are absorbed and diffused by plants within the shelterbelt while others are masked by the more desirable smells of aromatic leaves and flowers.

Each shelterbelt should be designed to meet the needs of your specific livestock operation. A well-planned and properly cared for shelterbelt protects livestock in both the winter and summer and will provide benefits to you over the long term. It is important to fence shelterbelts to protect them from the livestock. Livestock can damage trees and shrubs directly by consuming leaves and stems and indirectly by compacting the soil in the root zone.

Summer and Winter Protection

Shelterbelts can protect livestock from cold winter winds while still allowing summer winds to circulate in the feedlot or pasture area, reducing the potential heat stress to the animals.

During the winter, shelterbelt protection provides significant benefits to livestock producers in reduced feed requirements, increased weight gains, and improved animal health. When livestock are raised in confinement buildings with controlled temperatures, shelterbelts reduce the amount of energy necessary to heat or cool the building depending on the season.

Locate feed bunks 25 m - 40 m (75 - 125 ft.) south of the inside row of the shelterbelt to avoid both winter and summer problems. In the winter, the access road and feeding apron will be located beyond the area where snow will accumulate. In the summer, cattle will rarely experience significant heat stress since they are outside the area of significant wind speed reduction. (Figure 11)

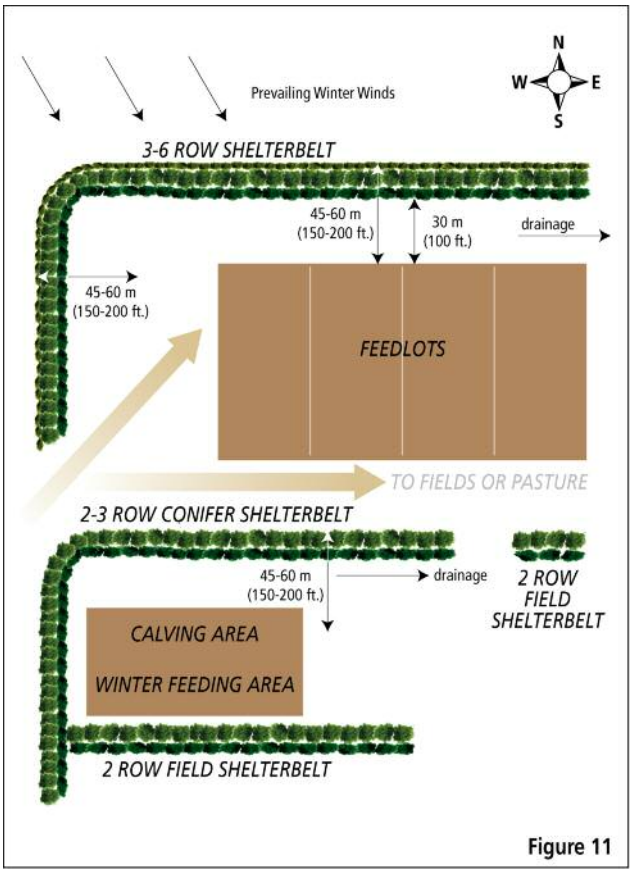


Figure 11

Designing the Shelterbelt

Shelterbelts should be located perpendicular to prevailing winter winds. Make sure that shelterbelts located on the south side do not block summer breezes. Summer breezes are important in reducing heat stress.

Proper drainage for melting snow must be provided in order to reduce the level of mud in feedlot areas. Direct the runoff away from the trees since high nitrate levels from urine in the runoff will damage the shelterbelt.

There are two major types of shelterbelt designs typically used for livestock confinement areas. One, the traditional multi-row design and two, the twin-row, high density design. The design choice depends on the available area, the desired protection zone, and shelterbelt objectives.

Multi-Row Shelterbelt Design

The traditional livestock shelterbelt design incorporates three or more rows of trees and shrubs, with at least one conifer row. Typically, within-row spacing is 0.3 - 1m (1 - 3 ft.) for shrubs, 2 - 2.5m (6.5 - 8 ft.) for deciduous trees and 2.5 - 3 m (8 - 12 ft.) for coniferous trees. Spacing between the rows is typically 5 - 6 m (16 - 20 ft.) but should be adjusted to accommodate your tillage equipment used to maintain the planting. The multi-row shelterbelt design is a high density planting that protects a large area. (Figure 12)

Twin-Row, High Density Design

The twin-row, high density design utilizes closer spacing, both within and between rows than the multi-row design. Space shrubs 0.9 - 1.2 m (3 - 4 ft.) apart and trees 2 - 3 m (6 - 10 ft.) apart. Rows should be planted 1.5 - 2 m (5 - 6 ft.) apart. A second, and possibly third, set of twin-rows may be planted 7.5 - 15 m (25 - 50 ft.) from the first. The larger spacing between sets makes room for snow storage and provides an access route to the interior of the shelterbelt. Also, this area between twin-row sets can be cropped or left for wildlife habitat.

Two major advantages of the twin-row design over the mulit-row design are: 1) greater density and 2) less weed control maintenance between rows. One disadvantage is that shelterbelt renovation may be required earlier in its lifespan because of the closer spacing.

A combination of both multi-row and twin-row designs can be used around feedlots and other livestock production areas. A twin-row planting of closely spaced shrubs, 15 m (50 ft.) from the windward side of a multi-row shelterbelt will act as a snow trap, depositing snow between the two tree plantings. Again, be sure to plan for proper drainage for melting snow.

A shelterbelt designed to protect livestock should meet the specific needs of the site and the farm operation. The complexity increases when additional benefits or objectives are involved.

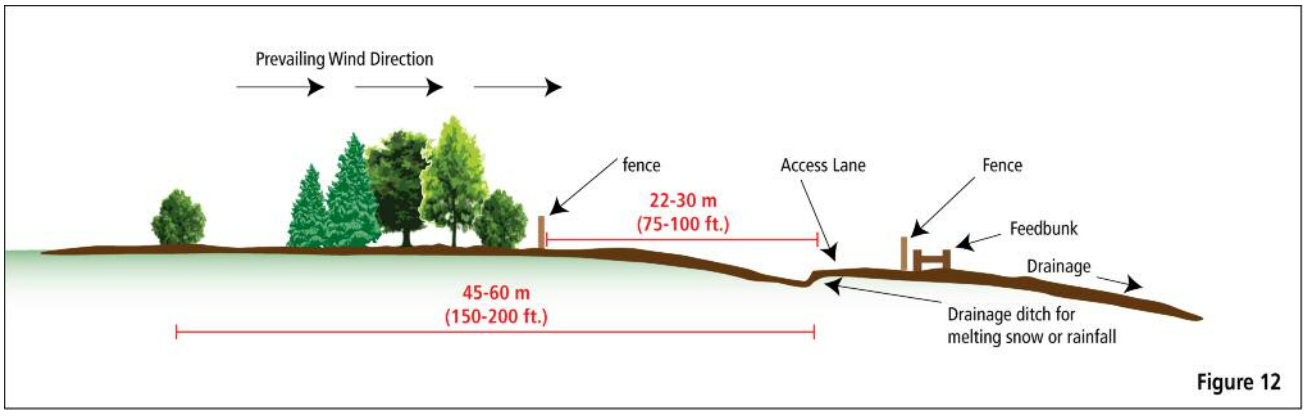


Figure 12

Wildlife Plantings

✓ increase habitat area ✓ provide food and shelter

Planting trees and shrubs can provide excellent refuge from predators, offer protection from inclement weather and create travel corridors to allow safe movement between habitat areas.

Wildlife plantings provide areas for nesting, feeding, perching, singing and breeding for many birds and other animals. They also provide shelter from severe weather and protection from predators. By planting a variety of tree and shrub species, you can attract a greater diversity of wildlife.

Habitat can be defined as the kind of place where a living organism (e.g. bird, fish, mammal, plant) lives. All species need food, water, shelter (cover) and space to survive. Wildlife plantings can contribute food and a secure habitat for a diverse wildlife community, including game and other birds and animals.

Food supplies energy and nutrients. Each wildlife species has its own needs and these change from season to season and throughout their life cycle. Natural food sources available from trees and shrubs include flower nectar, fruits, nuts, acorns, seeds, tree sap and browse (i.e. twigs and buds). Insects and other invertebrates that are attracted to trees and shrubs provide food for many birds especially during nesting and rearing young. Alternate food sources available near the wildlife planting are also important. Leave small plots of standing grain or retain areas of native vegetation near the planting site to improve the overall habitat quality. Additional food is most important during winter when energy needs of wildlife are greatest and other food sources may be scarce.

Shelter is one of the most important components that trees and shrubs contribute to wildlife habitat. Planting trees and shrubs can provide excellent refuge from predators, offer protection from inclement weather and create travel corridors to allow safe movement between habitat areas. Shelter from wind is critical for wildlife survival especially in winter. Wildlife species are under less stress, maintain warmth and feed energy requirements are lower when in a protected area. Wildlife plantings with dense branching also provide ideal nesting spots for a wide variety of birds and other wildlife that nest under the cover of trees.

Location

There is evidence that suggest creating a habitat isolated from natural areas can create a predator trap. A small linear habitat area can be preyed on very effectively. In some cases, entire local populations have been eliminated through predation after being attracted to these sites. Locate wildlife plantings in areas that already have some natural habitat present. They can be used to connect native forested areas, create travel corridors and to enhance or enlarge the existing habitat. As a general rule, a wildlife planting should be no smaller than 1 hectare (2.5 ac.).

Design

Multi-row shelterbelts can be designed and established to provide superior wind reductions and to create better habitat for wildlife. A wildlife shelterbelt should have three or more rows to allow for a wide mixture of tree and shrub species. This increases the variety of habitats which increases the diversity of wildlife that can be supported.

Placement within landscape

The arrangement of elements within the larger landscape determines the habitat value for different wildlife species. Food, cover and water located in the same vicinity creates optimal habitat. If planning to attract specific wildlife, consider their normal range of mobility when determining the placement and distance between these habitat elements.

Diversity of Vegetation

Combine a variety of coniferous and deciduous trees and shrubs. Include herbaceous vegetation to extend flowering and fruiting dates over the growing season. Use native plants whenever possible. They usually provide better habitat and are adapted to local growing conditions.

Vertical Structure

Multiple vegetation layers allow an assortment of wildlife to utilize the same area. Each tier creates distinct niches. Five or more layers are optimal and include the canopy, understory, shrub layer, herbaceous layer, and the floor.

Horizontal Structure

Arrange vegetation to provide the greatest practical width and create a smooth transition from the wildlife habitat. Incorporate clump plantings under a tree canopy or along the edge to improve horizontal structure. Minimize straight lines in the design.

Travel Lanes

Many wildlife species need a minimum amount of a particular habitat type. Too small an area will not be used. Vegetation can be used to connect several small isolated areas within a landscape, thus making it more viable and increasing the usable space for wildlife.

Create contour plantings that follow natural waterways, creeks and the topography of the land to provide more edge appeal for wildlife. This produces pockets where wildlife prefer to feed, nest and seek refuge from predators (including man). Gently curving tree rows creates more edge and attracts more wildlife to the planting.

Travel corridors provide safe routes from one habitat area to another. Species such as pheasants, songbirds, squirrels, rabbits and deer use these as feed plots and travel routes. Design travel corridors with three or more rows. If the limiting factor is food use fruit bearing shrubs; if it is shelter and winter protection, then use conifers. If both limiting factors are present use combinations of shrubs and conifers but locate the tall species in the center rows. Wider travel corridors (15 - 30 m = 50 - 100 ft.) is better than narrow. Even though wildlife will use narrow corridors, predators find their prey more easily in this environment.

Species selection

There are several points to consider when selecting tree and shrubs species for your habitat planting.

As with any planting, species selection depends on the site, growing conditions and the wildlife species you want to manage. Choice of trees and shrubs can influence the types of birds and other animals living there. Wildlife habitat that provides food, nesting and shelter requires a variety of trees, shrubs and other plants. When selecting plant species, it is important to use a variety of trees and shrubs to minimize the likelihood of the planting dying due to extreme periods of drought, flooding or from disease and insect outbreaks. (Figure 13)

Another consideration in species selection is to think about the wildlife needs during each season. The longer the flowering period and seed and fruit availability, the better. Fall, winter and early spring sources of food are important for survival. Late spring and summer food supplies are especially important to supply the energy needed for reproduction, growth, and development and for building up energy stores (e.g. fats for animals; starches for plants) for the dormant season.

Select a wide variety of dense, fruit-bearing shrubs to create a season-long food supply. Cover is always important during nesting or when shelter from adverse weather conditions, especially during winter, is required. Two or more rows of evergreens and shrubs with dense foliage close to ground are recommended to create thermal cover and reduce winds which in turn reduces wind chill factor. (Table 2)

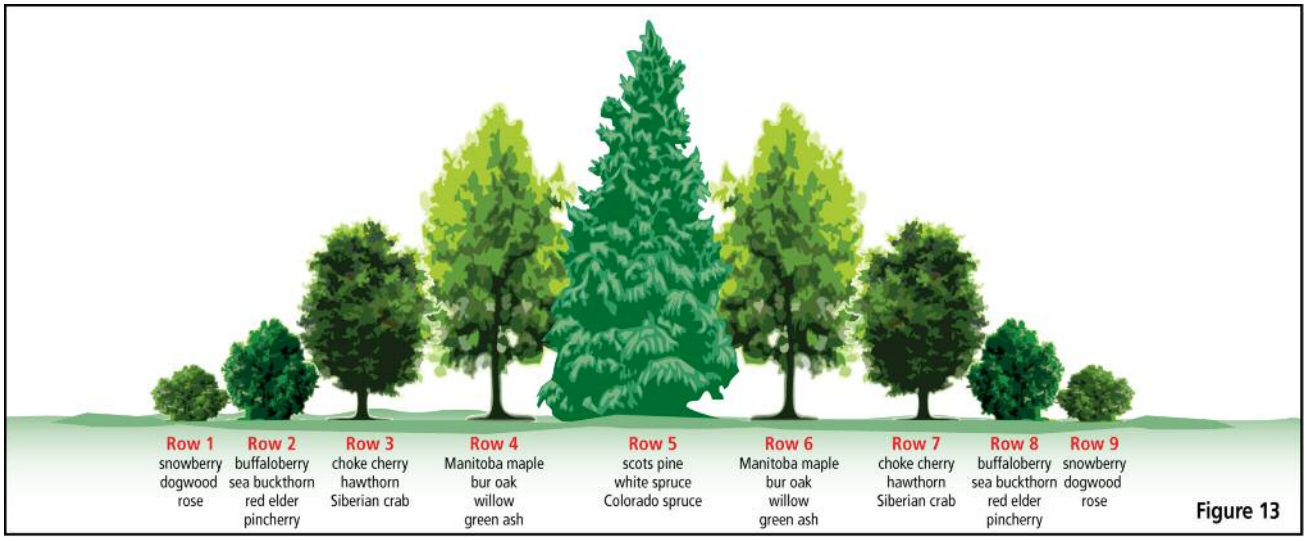


Figure 13

Spacing

Follow the recommendations for within row spacing of the trees and shrubs as a guide for your wildlife habitat planting. Some modifications to within-row spacing may be required especially if a mixture of shrubs, tall deciduous and coniferous species are planted in the same row. The spacing between rows may vary depending on the goals and surrounding habitat conditions. Wide spacing between rows (4 - 6 m / 13 - 20 ft.) reduces competition between plants, delays crown closure, permits more sunlight penetration and allows for the planting of annual and perennial forbs. Narrower row spacing (2 - 4 m / 6.5 - 13 ft.) on the other hand may better suit the wildlife's habitat needs, providing an early canopy closure, better protection for nesting and thick winter cover.

Species	Wildlife Value	Wildlife Species
Choke Cherry	Browse, cover, food, winter food	Butterflies, mammals, songbirds, upland game birds
Hawthorn	Browse, cover, food, nesting, winter food	Bees, songbirds, upland game birds, shrikes, thrashers, doves
Hedge Rose	Browse, cover, food, nesting, thermal cover, winter food	Butterflies, game animals, mammals, songbirds, upland game birds
Red Elder	Browse, cover, food, nesting, winter food	Butterflies, game animals, mammals, songbirds, upland game birds
Red-osier Dogwood	Browse, cover, food, winter food	Butterflies, game animals, mammals, songbirds, upland game birds
Sea Buckthorn	Browse, cover, nesting, winter food	Game animals, songbirds, upland game birds
Silver Buffaloberry	Browse, cover, food, perching, winter food	Antelope, upland game birds, shrikes, thrashers
Snowberry	Browse, cover, food, nesting, thermal cover, winter food	Game animals, mammals, bees, butterflies, songbirds, upland game birds
Villosa Lilac	Cover, nesting, perching	Songbirds, sparrows, juncos
Bur Oak	Browse, cover, food, nesting, winter food	Butterflies, game animals, mammals, upland game birds, jays, flickers
Cottonwood	Browse, nesting, perching	Game animals, raptors
Green Ash	Cover, food, nesting, perching	All birds (crossbills, grosbeaks)
Hybrid Poplar	Browse, nesting, perching	Game animals, raptors
Manitoba Maple	Cover, food, nesting, perching	All birds
Pincherry	Browse, food, winter food	Songbirds, mammals
Siberian Crabapple	Browse, cover, food, nesting, winter food	Bees, butterflies, game animals, mammals, songbirds, upland game birds, orioles
Trembling Aspen	Browse, cover, food, nesting, winter food	Game animals
Acute Willow	Browse	Game animals
Peachleaf Willow	Browse	Game animals
Silverleaf Willow	Browse	Game animals
Siberian Larch	Nesting, perching	Birds
Scots Pine	Nesting, perching, thermal cover	Birds
Colorado Spruce	Thermal cover, winter food	Crossbills, grosbeaks
White Spruce	Thermal cover, winter food	Crossbills, grosbeaks

Table 2


Wildlife

Riparian Buffers

✓ stabilize soil ✓ filter and absorb sediments to improve water quality ✓ enhance habitat

Riparian buffers are planted around diverse types of water bodies such as rivers, streams, creeks, lakes, sloughs or wetlands.

A riparian buffer is planted to create a buffer zone between agricultural land and bodies of water, including floodplains and wetlands.

A riparian buffer can:

- Stabilize eroding banks or shorelines of adjacent water bodies.
- Provide physical separation of agricultural activities from sensitive aquatic areas.
- Protect water quality by acting as an organic filter by trapping sediment laden with nutrients while tree, shrub and plant roots absorb nutrients such as nitrogen, phosphorus and pesticides, etc.
- Supply diverse food and cover for upland wildlife.
- Improve aquatic and terrestrial habitats for fish, wildlife and other organisms.

Planning

Prior to developing a planting plan for a riparian buffer, conduct an inventory of the riparian area, including existing vegetation, slopes, soil types, potential problems (e.g. slumping, erosion), signs of current wildlife use, adjacent land use and natural areas. A riparian buffer should be designed to mitigate the impact of land use adjacent to the water body.

Riparian buffers are planted around diverse types of water bodies such as rivers, streams, creeks, lakes, sloughs or wetlands. To be effective the composition of these buffers should be tailored and relevant to each riparian planting type. Implement a planting option that is suitable for the area chosen to be planted. Some water bodies have irregular perimeters, topography and other physical characteristics that may affect your planting options. For example, a typical planting modification to consider is the variability in the width of land available for planting within the riparian zone. The width of a riparian buffer is a key factor in the overall design of the planting. As you increase the width of the riparian buffer you enhance the beneficial results generated from the planting. The width you choose is highly dependent on the function of the buffer e.g. bank stability 5m (16 ft.), sediment removal 10 - 30 m (30 - 100 ft.), and wildlife habitat 10 - 300 m (30 - 1000 ft.).

Species selection

An effective riparian buffer strip has two to three vegetation zones, each parallel to the water body. In a two-zone buffer strip, zone one would be composed of trees and shrubs, while zone two would include grass species. To improve bank stability, plant native shrub species such as dogwood and willow. (Figure 14)

Two-Zone Design

This type of buffer strip may be most suitable for creeks and streams adjacent to intensively used pasture or cropland. Zone one consists of three to four rows of trees and shrubs planted next to the water body. They can be planted either in rows or a mixed grid orientation to provide a dense diverse plant canopy and rooting structure. Zone two is composed of grassy species. Select grass varieties for their function and match their growth characteristics and requirements to the site. The minimum width of a two-zone buffer strip is 5 m (16 ft.).

Three-Zone Design

In a three-zone buffer strip design, trees, shrubs and grasses make up the three zones. Zone one, closes to the bank or shore, consists of trees. Zone two is composed of shrubs or a mixture

of trees and shrubs. Grass or grass-forb mixture is planted to the outside of the buffer planting (i.e zone three). The three-zone buffer strip should be a minimum of 10 m (30 ft.) wide. This design is suitable for low order streams with wider flood plains; narrow watercourses with small flood plain; highly erodible lands; or gently sloping shorelines or riverbanks. It is less suitable for wetlands (bogs, fens, swamps, ephemeral wetlands, potholes, etc.) or intensively cropped farmland.

A two or a three zone buffer, should have the tree rows planted approximately 2 m (6.5 ft.) apart and close to recommended within-row spacing. Riparian buffers planted in a mixed grid orientation will appear more random and natural. The distance between plants should be close to recommended within-row spacing. Increasing the planting density of woody species in a riparian buffer results in earlier canopy closure and reduced weed control issues.

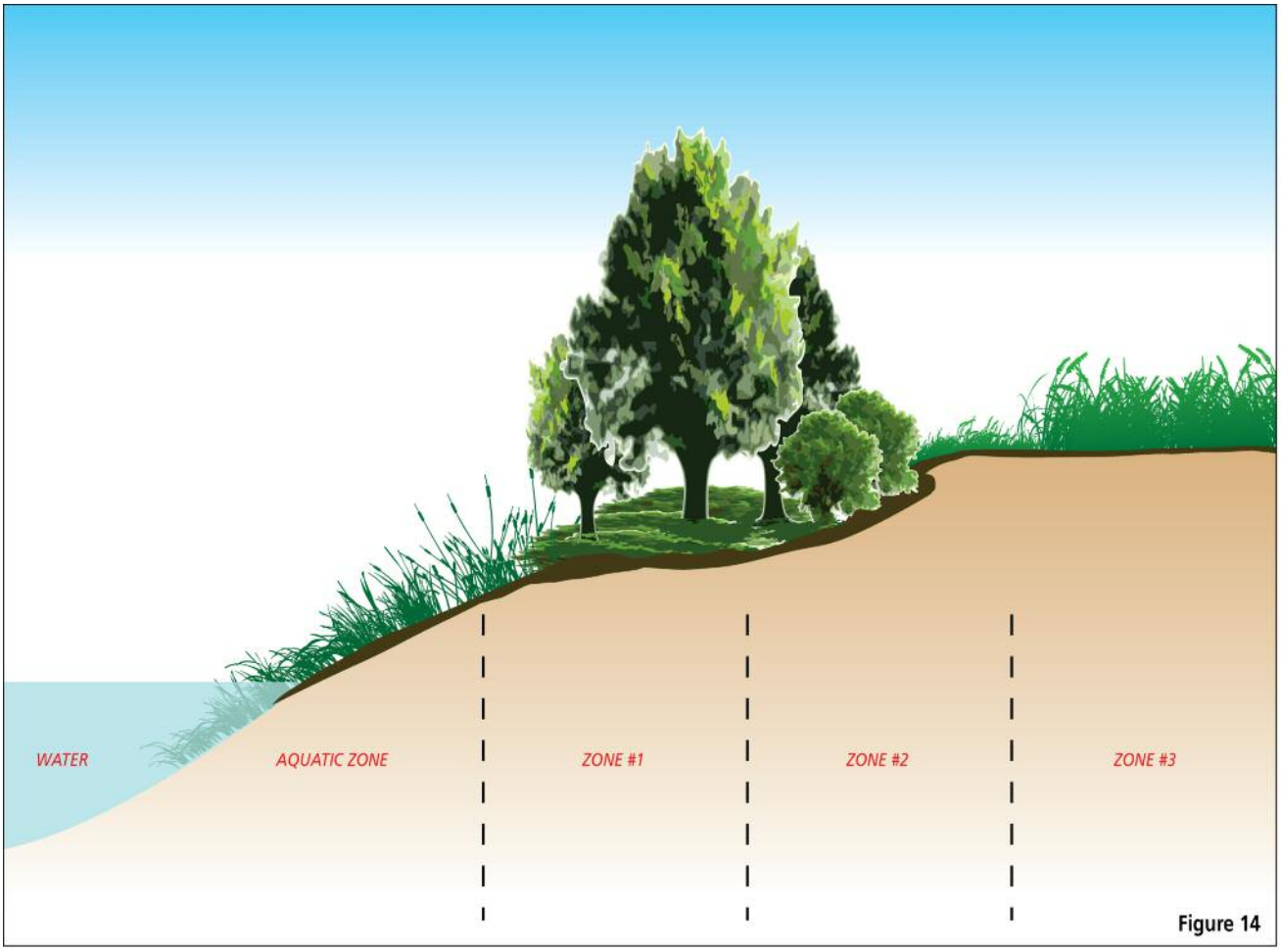


Figure 14

Glossary

Agroforestry: An intensive land management system that optimizes the benefits from the biological interactions created when trees and/or shrubs are intentionally combined with crops, forage and/or livestock.

Conifer: A tree or shrub that bears cones; coniferous tree. Most conifers are evergreen. Spruce and pine are evergreen but larch is not; it is in fact deciduous.

Deciduous: A tree or shrub that drops its leaves or needles in the fall and produces new ones the following spring.

Density: The ratio of solid portion of the shelterbelt to the total area of the shelterbelt.

Evergreen: A tree of shrub that retains its needles or leaves for 2 or more years. As not all evergreens are conifers, not all conifers are evergreens – see Conifer.

Fetch Distance: The distance that the wind has to pick up and transport snow before being intercepted by a shelterbelt.

Leeward: The side of a shelterbelt away from the wind.

Prevailing Wind: The wind that blows predominantly from a single general direction.

Riparian Area: The transition zone between dryland and aquatic environments. The components include the floodplain, the streambank or shoreline, and the buffer to the upland habitat. There is usually one marked change in vegetative or physical characteristics, composition and abundance in the adjacent upland due to the increased availability and influence of water. Riparian areas are ecologically diverse and contribute to the health of aquatic ecosystems by filtering out pollutants and preventing erosion. Often these productive and vital zones are only narrow strips outlining waterways and wetlands.

Riparian Buffer: Managed strips of vegetation, consisting of trees, shrubs and grasses that are planted between agricultural land and water bodies. Agricultural lands include annually cropped land and lands utilized for either forage or pasture production. Water bodies may consist of rivers, streams, creeks, lakes, sloughs or wetlands. The presence of trees, shrubs and grass species in a riparian environment improves both aquatic and terrestrial ecosystems by reducing runoff, flooding, erosion and pollution while stabilizing the streambank.

Shelterbelt: An agroforestry practice of planting trees and/or shrubs as a barrier to reduce and redirect wind which will provide shelter and other environmental benefits.

Shrub: A woody plant that is few to multi-branched arising from the base, usually under 8 m (26 ft.) tall at maturity. Shrubs in shelterbelts reduce low level winds, control erosion and trap snow. Many shrubs also provide important cover and food for wildlife. Planted in riparian zones, some shrubs are particularly effective at stabilizing streambanks, trapping soil and sediments, and protecting water quality.

Tree: A woody plant with a single trunk or few trunks and typically over 8 m (26 ft) tall at maturity. Trees add height to shelterbelts to control wind speeds over a greater distance (distance of control = 10 x height of shelterbelt), protecting buildings, crops and livestock. Wildlife may use trees variously depending on the species: residence, food, and/or thermal cover. Tree species adapted to high moisture conditions can be planted in riparian zones to control erosion, stabilize streambanks, capture/absorb nutrients, and protect water quality.

Wind Direction: The direction from which the wind is blowing is the wind direction. For example, a north wind blows from the north towards the south.

Windward: The side of a shelterbelt towards the wind.