THE EFFECT OF SHELTERBELTS ON SNOW DISTRIBUTION

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Shelterbelts trap drifting snow and, by reducing wind speed, prevent snow from being carried from the place where it has fallen. They can be used to manage fallen snow and conserve moisture on the prairies. This paper presents results of snow measurements made near shelterbelts from 1984 to 1991 in Saskatchewan and Manitoba and reviews results of relevant literature.

Shelterbelt porosity affects snowdrift geometry and the amount of snow trapped or retained. Greb and Black (1971) used wood-slat snow fences to show that dense barriers resulted in deep, narrow snowdrifts while porous barriers caused shallow, wide drifts to form. They found that the most snow was trapped behind the denser snow fences (Fig. 1). Although shelterbelts are three-dimensional, contrasting with two-dimensional snow fences, the same relationship between porosity and snowdrifts was found in a number of shelterbelt studies. In 1989-90 snow measurements were done leeward of a series of replicated caragana, Siberian elm and green ash shelterbelts at Lipton, Saskatchewan, with in-row spacings of 0.3-0.6 m, 2-3 m and 0.6-0.8 m, respectively. The snowdrifts near the caragana and Siberian elm shelterbelts were similar but the green ash, despite the close spacing between trees, was more porous and resulted in much smaller snowdrifts (Fig. 2). At Carberry, Manitoba, a shelterbelt which had been replicated along its length with 100 m stretches of alternating Siberian elm (2 m spacing) and caragana (0.3-0.6 m spacing) resulted in deeper snowdrifts behind the caragana although the snowdrift width did not vary greatly (Fig. 3).

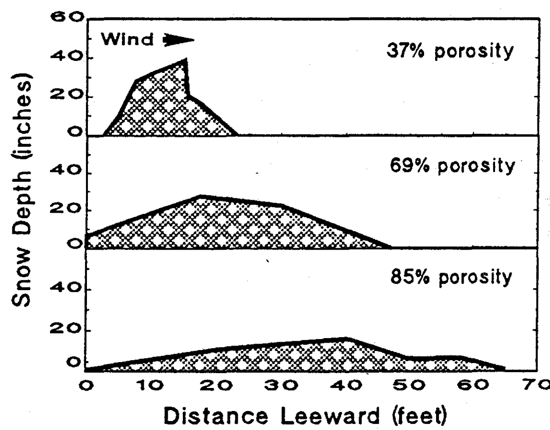

FIGURE 1. The effect of snow fence porosity on snowdrift geometry (from Greb and Black, 1971).

Spacing between trees within a shelterbelt also affects the porosity of the barrier. Scholten (1981) showed that

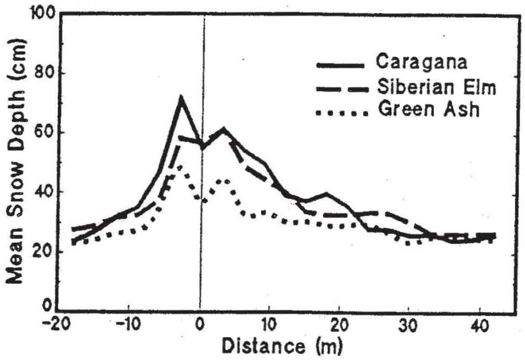

FIGURE 2. The effect of shelterbelt species on snowdrift formation at Lipton, SK.

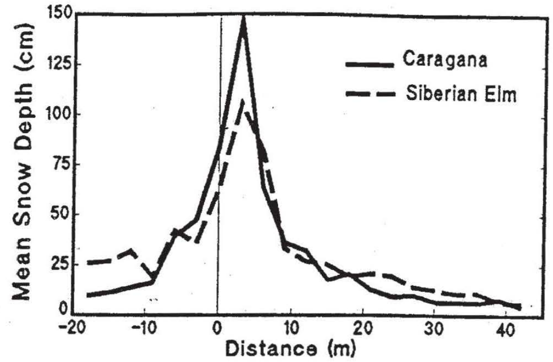

FIGURE 3. The effect of shelterbelt species on snowdrift formation at Carberry, MB.

increasing the distance between green ash trees from 1.5 m to 3-4.5 m, almost eliminated the snow trapping value of the shelterbelt (Fig. 4). Since such wide spacing of trees also reduces wind erosion control, green ash spacing of 1.2 to 1.8 m are currently recommended for field shelterbelts. Current recommendations also include the combination of caragana and green ash within a shelterbelt. Such a shelterbelt traps snow in a similar way to a caragana shelterbelt since the caragana determines the lower level density of the shelterbelt. A shelterbelt snowdrift was measured near Carman, Manitoba in which half of the shelterbelt consisted of green ash at a spacing of 1.8 m interplanted with caragana at 0.3 to 0.6 m and half had the caragana removed leaving only green ash at a 1.8 m spacing. Much less snow was trapped by the green ash alone than the green ash-caragana mixture (Fig. 5).

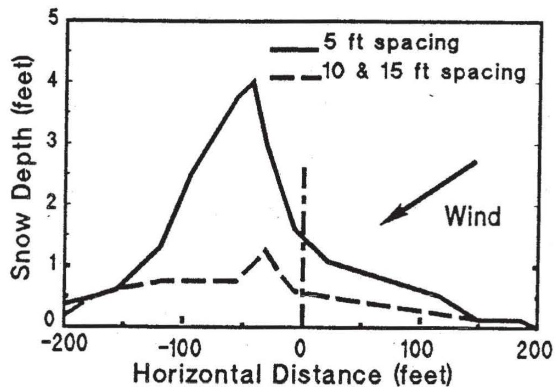

FIGURE 4. The effect of in-row spacing of green ash on snowdrift geometry in Minnesota (from Scholten, 1981).

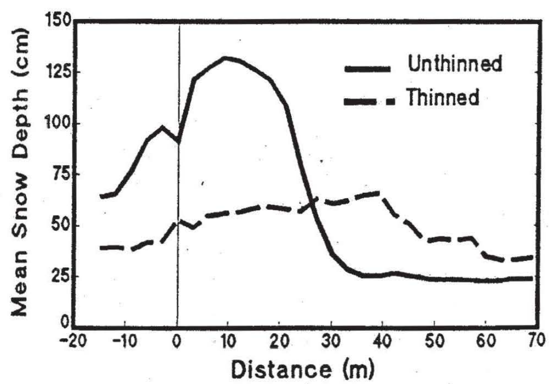

FIGURE 5. The effect of caragana removal from a mixed shelterbelt on snowdrifts at Carman, MB.

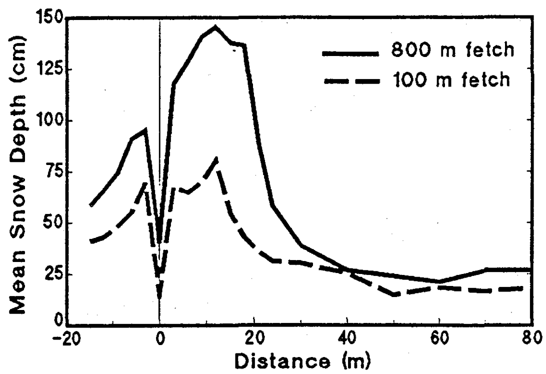

FIGURE 6. The effect of fetch distance on snowdrifts by mixed shelterbelts at Winkler, MB.

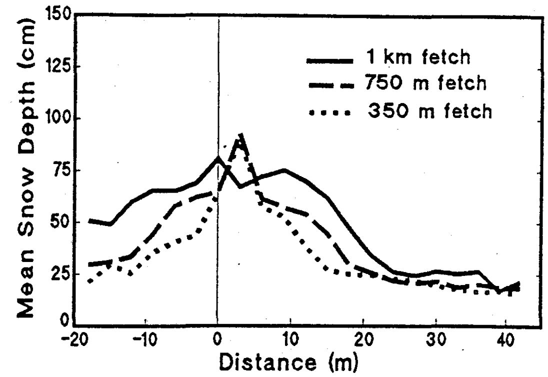

FIGURE 7. The effect of fetch distance on snowdrifts near shelterbelts at Carberry, MB.

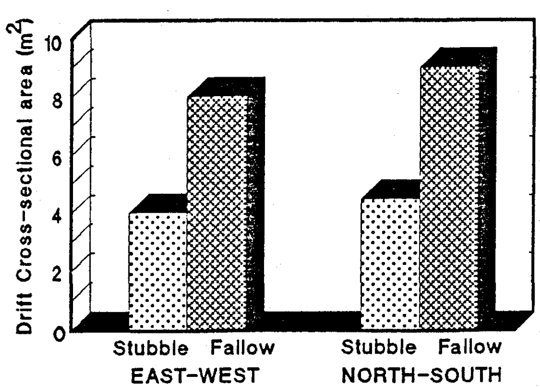

FIGURE 8. The effect of wheat stubble on the amount of snow trapped by a 1.2 m snowfence.

Conditions on the field upwind of a shelterbelt also has a major effect on the size and geometry of the resulting snowdrift. The nearness of other shelterbelts or other obstacles determines the amount of snow that is available to be deposited in the snowdrift. A study done at Winkler, Manitoba in 1985-86 showed that two identical shelterbelts trapped different amounts of snow (Fig. 6). The main difference was that the shelterbelt trapping the large snowdrift was 800 m downwind of another shelterbelt while the smaller snowdrift resulted from an upwind field only 100 m wide. Similarly, larger fetch distances resulted in larger snowdrifts at Carberry, Manitoba in 1989-90 (Fig. 7). Other obstacles such as valleys, ditches, roads or farmyards also reduce fetch distances and influence snowdrift size. Good stubble management traps and holds snow on fields and prevents the movement of large amounts of snow into leeward shelterbelts. A study at Indian Head, Saskatchewan in 1987 showed the effect of wheat stubble on the snowdrift size behind snow fences (Fig. 8).

Many shelterbelt investigations in the past have focused on snow trapment and overlooked snow retention by shelterbelts. By reducing wind velocity, shelterbelts reduce the erosion of snow from the fields on which it has fallen or, if the snow is transported by the wind, shelterbelts can reduce the distance that it travels. Tabler (1975) showed that sublimation of drifting snow

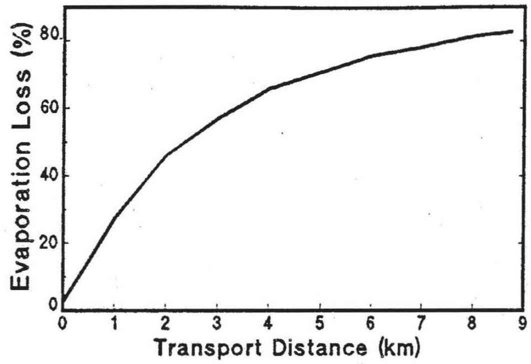

FIGURE 9. The effect of snow transport distance on sublimation in Wyoming (adapted from Tabler, 1975)

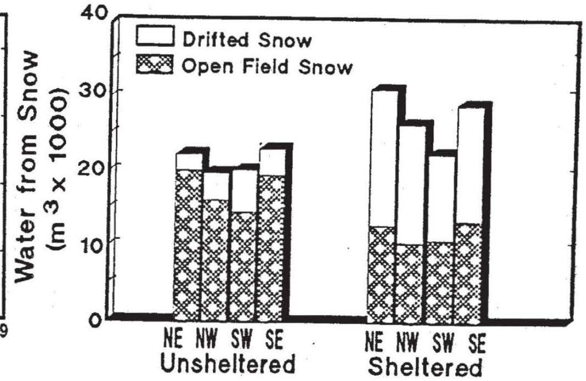

FIGURE 10. The effect of shelter on regional snow loads at Conquest, SK.

particles can represent a large proportion of the fallen snow. He showed that when snow was transported 2 km, in Wyoming 50% of the total sublimated and that 80% was lost to the atmosphere in 5 km (Fig. 9). On the prairies, fetch distances of 5 km or more are frequently found, so that sublimation may represent a major loss of moisture. A study was conducted at Conquest, Saskatchewan in 1989 in which the snow was inventoried thoroughly on an unsheltered section and compared to that on a sheltered section containing more than 10 km of shelterbelts. It was found that the sheltered section had 29% more snow than the unsheltered section (Fig. 10). Since the unsheltered section was surrounded on all sides by other unsheltered sections and the sheltered section was surrounded on all sides by other sheltered sections, it was concluded that each section was in equilibrium with it surroundings (i.e. that the amount of snow blowing onto each section from adjacent sections was balanced by the amount of snow blowing onto adjacent sections). This led to the conclusion that the higher snow load on the sheltered section was due to reduced sublimation from moving and stationary snow.

Snow trapment by shelterbelts varies from year to year and from region to region (Fig. 11). Generally, green ash is used in field shelterbelts in northern and eastern regions while caragana is used in the southwest. But both green ash and caragana can be used to protect highways and roads. Due to its higher porosity and

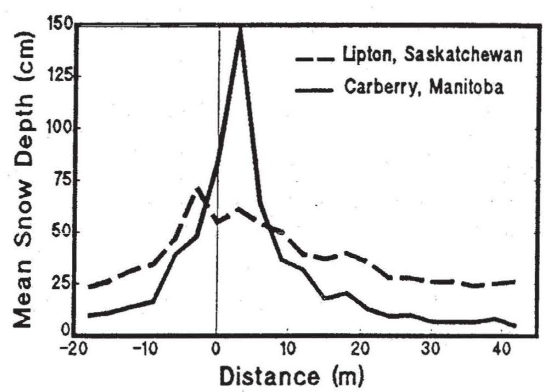

FIGURE 11. The regional differences in snow trapped by identical shelterbelts at two locations.

greater height, green ash should be set at least 100 m back from the road while caragana can be planted between 50 and 100 m from the road. Since most prairie roads are built higher than the surrounding land, snow clearing costs are reduced by shelterbelts only in certain instances. This benefit of shelterbelts is very important in farmyards and along laneways. Reduced visibility, however, is a serious problem on roads during snowstorms. Tabler and Furnish (1982) showed that snow fence protection on Wyoming roads reduced accident frequency during blizzards (Fig.12).

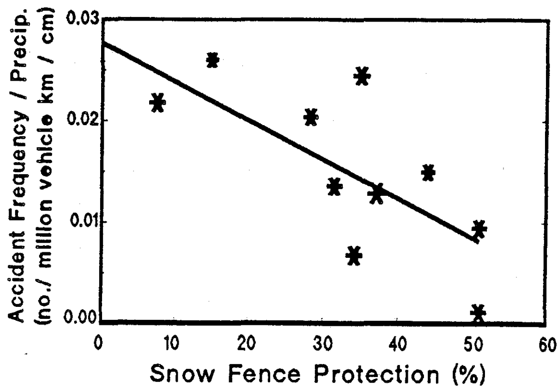

FIGURE 12. The effect of snow fences on accident rates during blizzards in Wyoming (from Tabler and Furnish, 1982)

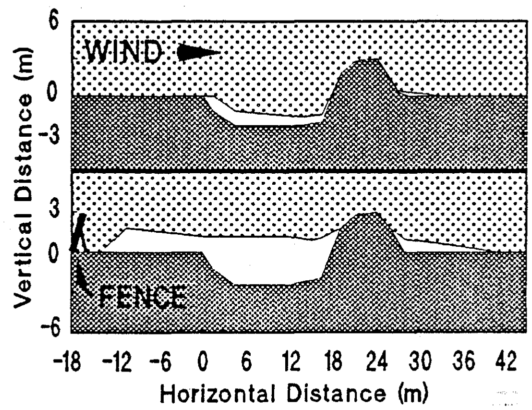

FIGURE 13. Snow trapped in a scale model dugout with and without a snow fence (from Jairell and Schmidt, 1990).

Shelterbelts can effectively supplement surface water runoff for dugouts. Jairell and Schmidt (1990) showed that a strategically placed snow fence would trap over five times as much snow in a pasture dugout in Wyoming (Fig. 13) as a dugout without a fence, while Walker (1945) showed that shelterbelts were effective in harvesting water for domestic dugouts. Nicholaichuk et al (1990) showed that snow fences could also augment ground water supplies when located over a small local aquifer.

CONCLUSION:

Shelterbelts are effective snow traps and can protect snow cover and prevent sublimation of snow from agricultural fields. Their structure and porosity can be managed to control the geometry and unit of snow occurring in drifts. They can be used as a tool to trap snow where it can be used to advantage such as in dugouts and aquifers and on fields and to prevent snow buildups in undesirable places such as on roads and in farmyards.

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