snow and wind control

for farmstead and feedlot

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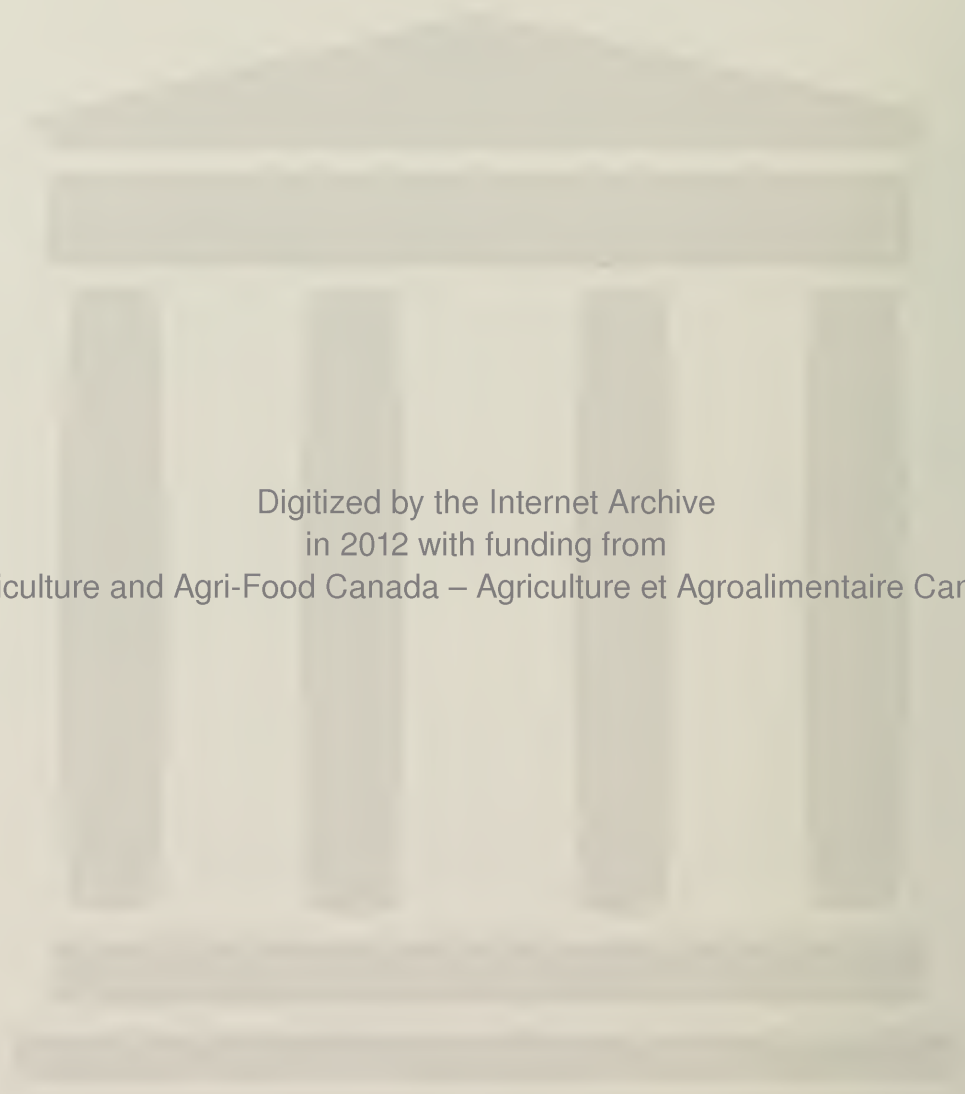

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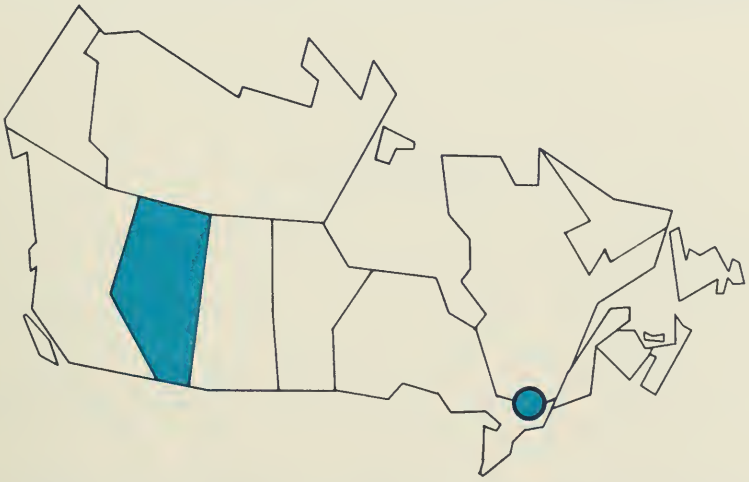

CANADA/ALBERTA

SNOW AND WIND CONTROL FOR FARMSTEAD AND FEEDLOT

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CONTENTS

EFFECTS OF SHELTER 7

WIND PROTECTION 9

SNOW DRIFTING 11

BUILDINGS AND SHELTERS 15

BUILDINGS AND FENCES 17

SUMMARY OF GUIDELINES 20

ACKNOWLEDGEMENTS 21

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Livestock operations in Canada have always been subject to the hazards and hardships of winter weather. Wind, snow and extreme cold have been accepted as a way of life for Canadian cattlemen during winter.

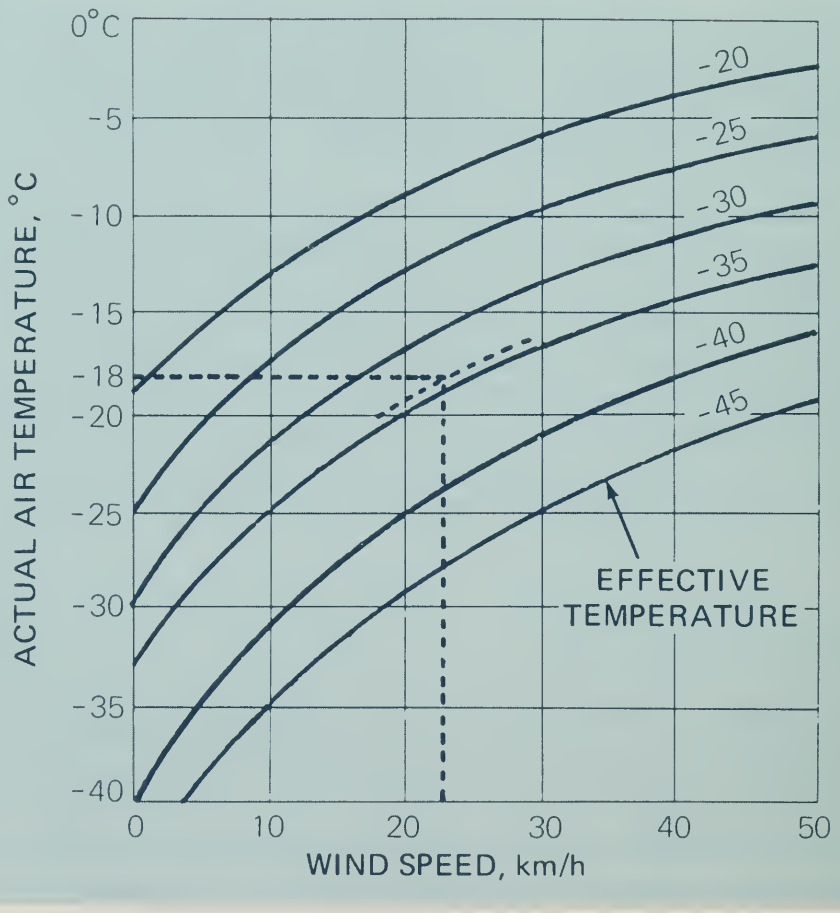
There are essentially two factors to consider in dealing with wind and snow problems about farmsteads. First, how do livestock react to the effects of winter or to shelter conditions that might be provided? The second aspect is more general and pertains to the physical problems, or the inconveniences, of snow drifting which can effectively stall activity on the farm. Farmsteads and feedlots were often put together without the benefits of sound planning information regarding wind and snow control. This publication suggests ways of reducing these problems.

EFFECTS OF SHELTER

The purpose of controlling wind and snow is to improve shelter conditions for livestock. It is therefore desirable to know as much as possible about the response of animals to the elements of weather. Some guidelines may then be established to evaluate shelters or the ill effects of winter weather. The response of livestock to weather cannot be measured in precise quantities; however, there are certain principles which can be applied.

First, consider the effects of extreme cold on cattle. The main concern is the loss of heat from the animal which in turn requires more energy and more feed intake. However, the natural processes in a living body, the activity of the heart, lungs, stomach and other organs, produces a constant heat supply which maintains body temperature over a wide range of outside temperatures without requiring extra energy. This temperature range is known as the comfort zone, and the lowest temperature of the zone is called the critical temperature. Steers on full feed will have a still air critical temperature of about −34°C. The comfort zone of cows and calves on a restricted ration may extend only to −18°C or −20°C.

Exposure to wind greatly increases heat losses from cattle. An equivalent wind-chill temperature on the basis of equal heat losses has been calculated for beef cattle and is represented by Figure 1. This graph is only approximate since the type of hair



IGURE 1. Effective wind-chill temperature that results in equivalent heat losses or beef cattle.

(Graph courtesy Dr. A. J. F. Webster, University of Alberta.)

coat, color, and sunshine have an influence on the results. Suffice it to say that a 32 km/h wind is equivalent to an extra 17°C of cold, and that wind protection is important.

One of the less obvious effects of wind, but every bit as important, is the added stress and discomfort it causes to livestock. Comparison of daily service records of some larger feedlots to weather data revealed that the number of animals requiring attention was considerably higher on the day immediately following a strong wind than on other days. This situation seemed to hold true during warm weather as well as cold. Feedlot cattle are the healthiest during prolonged spells of cold when there is no wind or sudden temperature change. The above-mentioned effect of wind can be explained in part by the effective temperature chart; a strong wind may have the same effect as exposing the animal to a sudden change in temperature.

In summary, wind is a far more serious hazard to cattle performance than is extreme cold. Given still-air conditions, there are very few days in a year when the feedlot animal is exposed to temperatures below its comfort zone. Cold by itself has a negligible effect on feed efficiency of feedlot cattle. However, it is also evident that simple shelters and windbreaks are necessary.

WIND PROTECTION

Natural windbreaks or well established shelterbelts provide the best means of wind protection (Figure 2). Trees take time to grow, and for many feedlots it may not be feasible to establish trees. An artificial windbreak such as a high board fence is a good alternative.

FIGURE 2. A good shelterbelt affords the best protection for both wind and snow

The effectiveness of a windbreak in reducing wind velocity depends on the density of the windbreak and, of course, on the height. Density refers to the proportion of solid area in a porous structure. The most effective windbreak density for maximum wind protection is 75 to 80%. Natural shelterbelts will usually have a density of only 30 to 50% during winter, when there are no leaves on the trees. Cottonwood or poplar trees are particularly ineffective because they usually have a low branch density. Such tree rows should be supplemented by thick-growing trees such as caragana or Manchurian elm. Shelterbelts that contain a row of evergreens are exceptionally good.

Figure 3 illustrates the effectiveness of various fences in reducing wind velocity. At least 75% reduction in velocity is considered desirable for protection of livestock.

Solid fences are not as effective because they create high turbulence on the downwind side. Highest turbulence occurs about four fence heights from the fence, where the wind direction at the ground is actually reversed. Swirling eddies

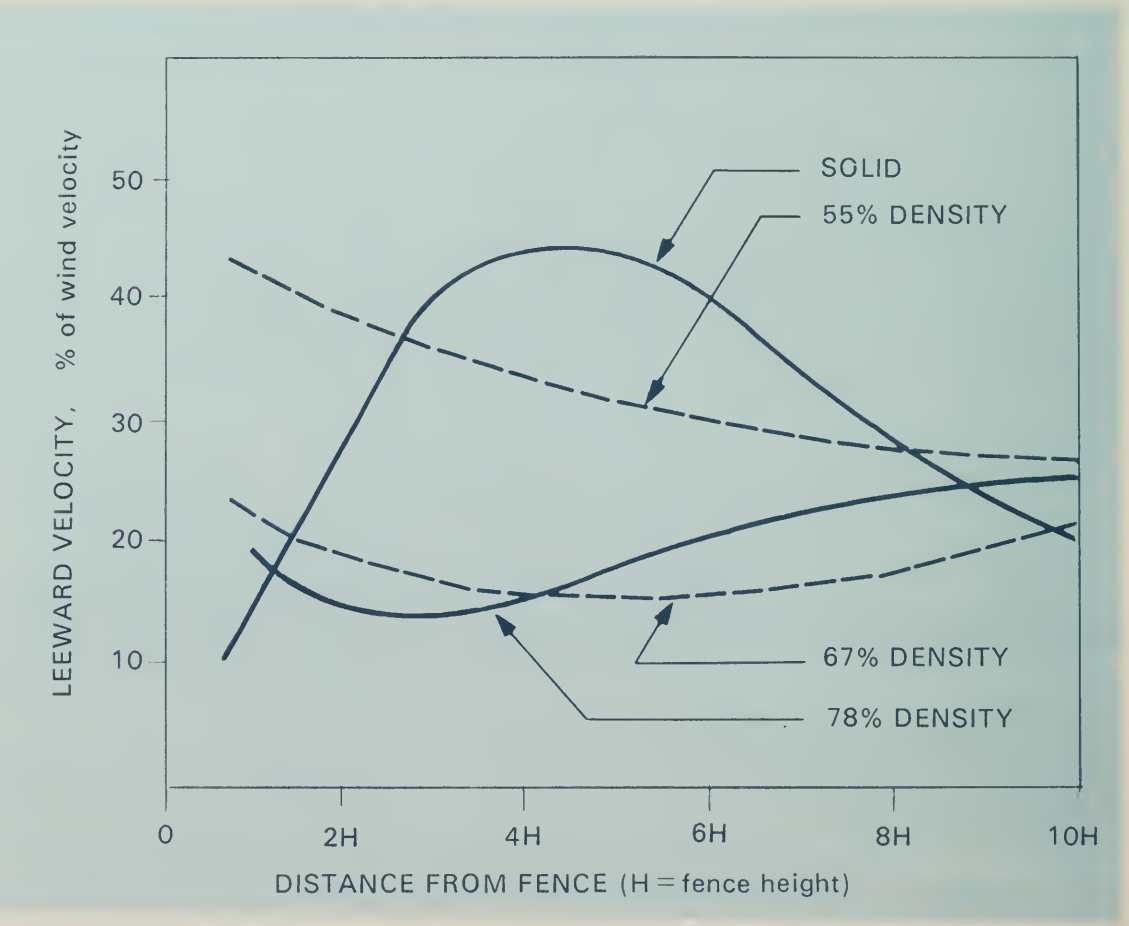


FIGURE 3. Velocity reduction for fences of different densities.
(From Moysey and McPherson, University of Saskatchewan)

can be observed sweeping snow or dust towards the fence (Figure 7). Solid fences, however, do have an important place in farmstead protection as described in the section on snow control.

A 2.5 m board fence having 20% porosity (density of 80%) will provide good wind protection for a distance of 25 to 30 m downwind. To obtain the required porosity, 20 cm boards could be spaced 5 cm apart, or 15 cm boards 4 cm apart. Provided that the proper porosity is achieved, it makes no difference whether spaces are vertical or horizontal; or whether a solid plywood fence is drilled with holes. Vertical board fences are easiest to construct. Boards should be placed slightly above the ground to avoid rotting.

SNOW DRIFTING

It is evident that any attempt to impede the course of the wind will create snowdrifts; therefore, in the design of windbreaks attention must be paid to potential snow drifting problems. Of equal importance is the location of buildings, machinery and feed stacks and their contribution to snow drifting about the farmstead.

Several factors pertaining to snow drifting are worthwhile noting. The first is that over 90% of drifting snow moves along within a foot of the ground. Snow fences are therefore rather effective in catching a large proportion of snow. In the Prairie Provinces, most snow-drifting problems are caused by the blowing of snow that was previously on the ground, rather than by actual snowfall conditions.

Secondly, loose snow will not commence to drift until the wind reaches a certain critical velocity, usually about 15 km/h. Drifting may occur at an even lower velocity for the very lightest snow. For every increase in wind speed above this critical velocity, the snow-moving ability of the wind increases in proportion to the cube of the velocity increase. For example, if snow drifting commences at 15 km/h and the wind is 19 km/h, the difference is 4 km/h. The difference for a 25 km/h wind would be 12 km/h or three times greater than 4 km/h. However, the drifting potential is $(3)^3$, or 27 times greater. Small reductions in wind velocity therefore result in proportionately large quantities of snow being deposited.

When wind carrying snow encounters a solid obstacle in its path, the airflow is forced to separate. A zone of turbulence is created to the leeward of the object and, because of reduced velocity, large amounts of snow are deposited. Deepest drifts occur where wind velocity is least. In some areas, notably about corners or in an alleyway, the wind velocity will be increased and snow is swept from these locations. Within the wake region

FIGURE 4. A solid fence provides excellent snow protection. These pictures are from the outside and inside of the same yard. Drifts outside a solid wall always exhibit this classic cliff-like profile.

FIGURE 5. Drifts are formed on the leeward side of a porous fence. This fence of 70% density resulted in a drift of medium length.

FIGURE 6. Windbreak fences can create real problems if space is not provided for drift formation.

of a building, swirling eddies will pick up and relocate snow. It is often this relocation of snow that creates the most problems about farm buildings, and since the wind is never from a constant direction these problems are the most difficult to combat.

Just as windbreaks exhibit certain airflow characteristics, they also have peculiar snowdrift patterns, depending on the density of windbreak. The choice of windbreak fence, and the location, must take into account both wind and snow conditions.

Figure 7 illustrates snowdrifts formed by a solid fence and porous fences of different densities. A solid fence, the same as a building, causes a characteristic cliff-like drift to form upwind. Note the characteristic cupping action of the wind against the fence (see also Figure 4); such a fence is very effective in keeping snow out of a yard or feedlot. Because of the high turbulence inside the fence, this fence is only about half as effective a windbreak as a porous fence.

Porous fences allow snow to drift through the fence. The lower the density of a fence, the longer the drift as illustrated in Figure 7. Highway snow fences are generally the more open

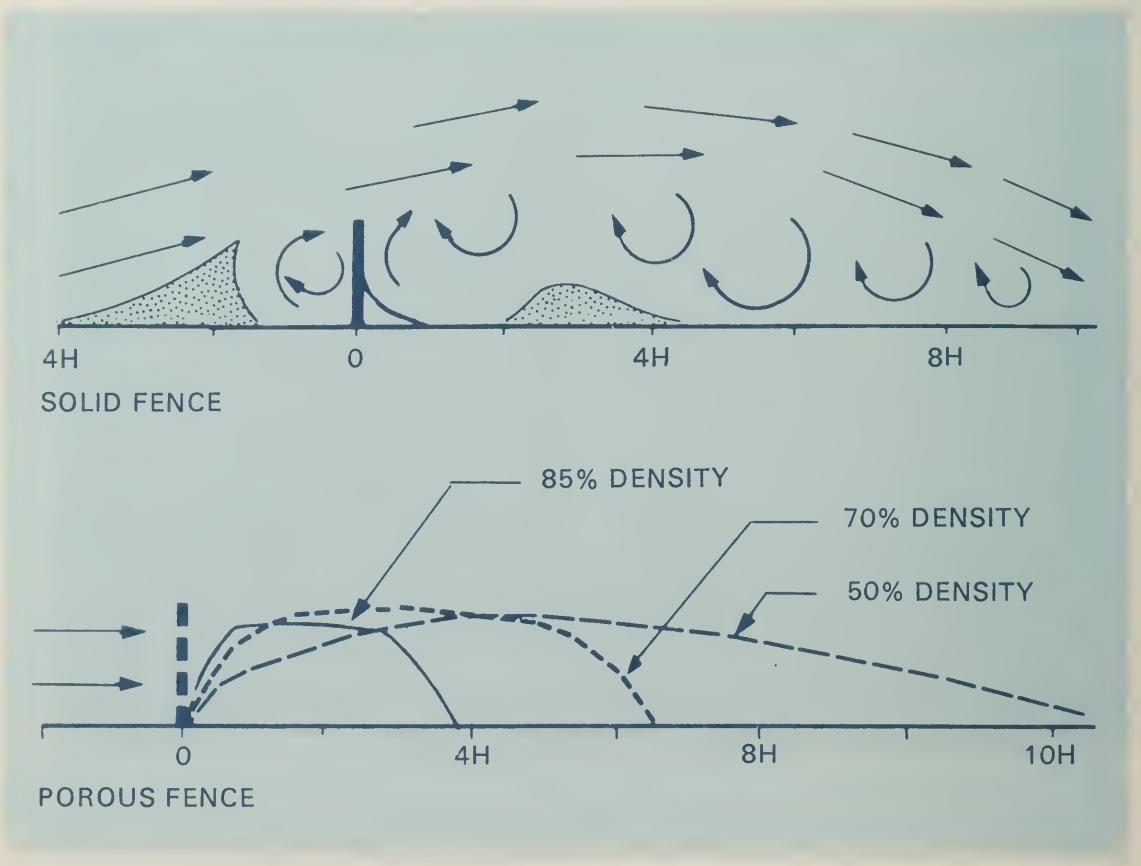


FIGURE 7. Snow drifting about solid and porous fences. Fence height is H; drift length is expressed as a multiple of H.

type, 50 to 60% density, to catch the greatest amount of snow. Typical slatted board fences for feedlots, 80% density, will create short, deep drifts, usually no more than 10 m wide and slightly deeper than the fence. This fence, besides being an excellent windbreak, can offer good snow control provided space is allowed for the resulting snowdrift. Figure 6 represents just this type of situation except that the drift has clogged the entire feeding area because adequate drift space was not allowed. Drainage for the resulting snowmelt must also be considered.

Shelterbelts have rather low density and will usually result in long drifts, extending up to 60 m from the trees. Buildings and feedlots should be located outside of this drift zone, unless there is good evidence that drifting will not be that extensive for any particular situation.

BUILDINGS AND SHELTERS

The main requirement in cattle housing is good wind protection. Sheds for cattle contained in any type of outdoor lot should be kept cold and dry, to avoid temperature extremes when animals move from one location to another during a day.

FIGURE 8. A common open-front shed. The inset illustrates the recommended slot opening under the eaves. Note also the simple method for tying rafters to the supporting beam.

Some type of simple shed is desirable for calves. For feeder steers or range cattle, there will always be controversy as to whether a shed is an economical investment.

Simple single-sloped open-front sheds are the most common shelter design in Alberta (Figure 8). This basic design may be modified by using trussed rafters to provide a clear span gable-roof structure. Sheds of this type should be less than 10 m deep to allow sunlight to penetrate to the rear of the shed. Opening panels in the rear wall will convert the shed to an excellent shaded area for summer use. Sheds should be open away from the prevailing wind, thus in most localities they should face southeasterly, east or south, in that order of preference.

The worst wind situation for an unprotected open-front shed is wind from a 45° angle, such as a southwest wind on a south-facing shed. Particularly with long sheds, this type of wind will cause draughts to whistle down the length of the shed. To avoid this problem, sheds should be divided by interior partitions into sections not exceeding 10 m in length. Windbreak fences along the west side of a lot will do much towards providing the necessary protection. Shed and fence design must go hand-in-hand (Figure 11).

One of the most common problems with open-front sheds results when snow is blown over the shed from the rear. The resulting turbulence causes snow to be drifted back into the shed forming a deep drift directly under the entrance. This characteristic is very similar regardless of the shape of the roof or the type of overhang at the front of the shed (Figure 9). A study of flow characteristics for this type of shed indicates that a slot opening in the back wall under the eaves will eliminate most of the problem. Figure 10 illustrates the change in snow and wind patterns as a result of such a slot opening. The correct size of opening is about 200 mm, and a fascia board should be placed over the opening to prevent snow from blowing directly in.

A clear-span structure using trussed rafters may be desired for some housing situations. As illustrated by Figure 9, a gable-roof shed is subject to this same snow-drifting problem. A slot opening under the eaves, combined with a continuous ridge vent, will control the drifting the same as for a shed roof. An important bonus feature of these slot openings in either type of shed is that they provide the ventilation necessary to keep the shed cool and dry.

Where winds blow directly at the front of an open-front shed, snow drifting into the shed may be reduced by locating a solid fence about 30 m from the building. During the most severe storms, it would be desirable to close off all or part of

the open front. Some sheds are built with a portion permanently closed. An effective means of closing the shed is to build canvas panels on a long rail which may be lowered from the roof when needed, much in the fashion of a venetian blind.

BUILDINGS AND FENCES

The swirling action of wind about buildings results in peculiar snow-drifting habits. Snow may be swept clear of some areas in a yard and drifted into other locations, often to the detriment of livestock operations. For a farmstead that is well protected, isolated instances of snow drifting may constitute the most troublesome problem.

Two rather general circumstances can be described. The swirling of snow about corners of open-front sheds results in unwanted drifts and draughts inside the shed. Windbreak fences can reduce or eliminate this problem; however, such fences should not be attached directly to the corner of a shed, since they could deflect snow into the shed and do more harm than no fence at all.

Figure 11 illustrates the wind currents and snow-drifting problems caused by a northwest wind on a shed open to the south. This is the situation with no fence protection or with a fence attached directly to the front corner of the shed. This incorrect fence location is most serious for winds from the southwest or southeast. A shed of this length should also be divided by a solid partition.

The most effective method of connecting the fence is in a boxlike manner, referred to as a "swirl chamber" (Figures 11, 12). As a rule of thumb, the swirl chamber should be as wide as the shed is deep. A swirl chamber causes wind and snow to swirl into that area rather than into the shed and is more effective in controlling winds from an angular direction. Depending on whether wind or snow is the main problem, fences may be either porous or solid.

The second and very common problem is the adverse effects of adjacent buildings, which cause wind and snow to be deflected into a shed. Other buildings, silos or feed stacks should not be located close to an open-front shed. A space of 10 to 20 m should be allowed between buildings to prevent draughts and undesirable snow drifting in sheds (Figure 11). This space is often draughty and can be protected by a fence as shown. Old-fashioned horse barns, or similar high buildings, are particularly bad if attention to their location is not considered. Stacks of feed or bedding can be located to advantage for added protection, or they may only contribute to the problem.

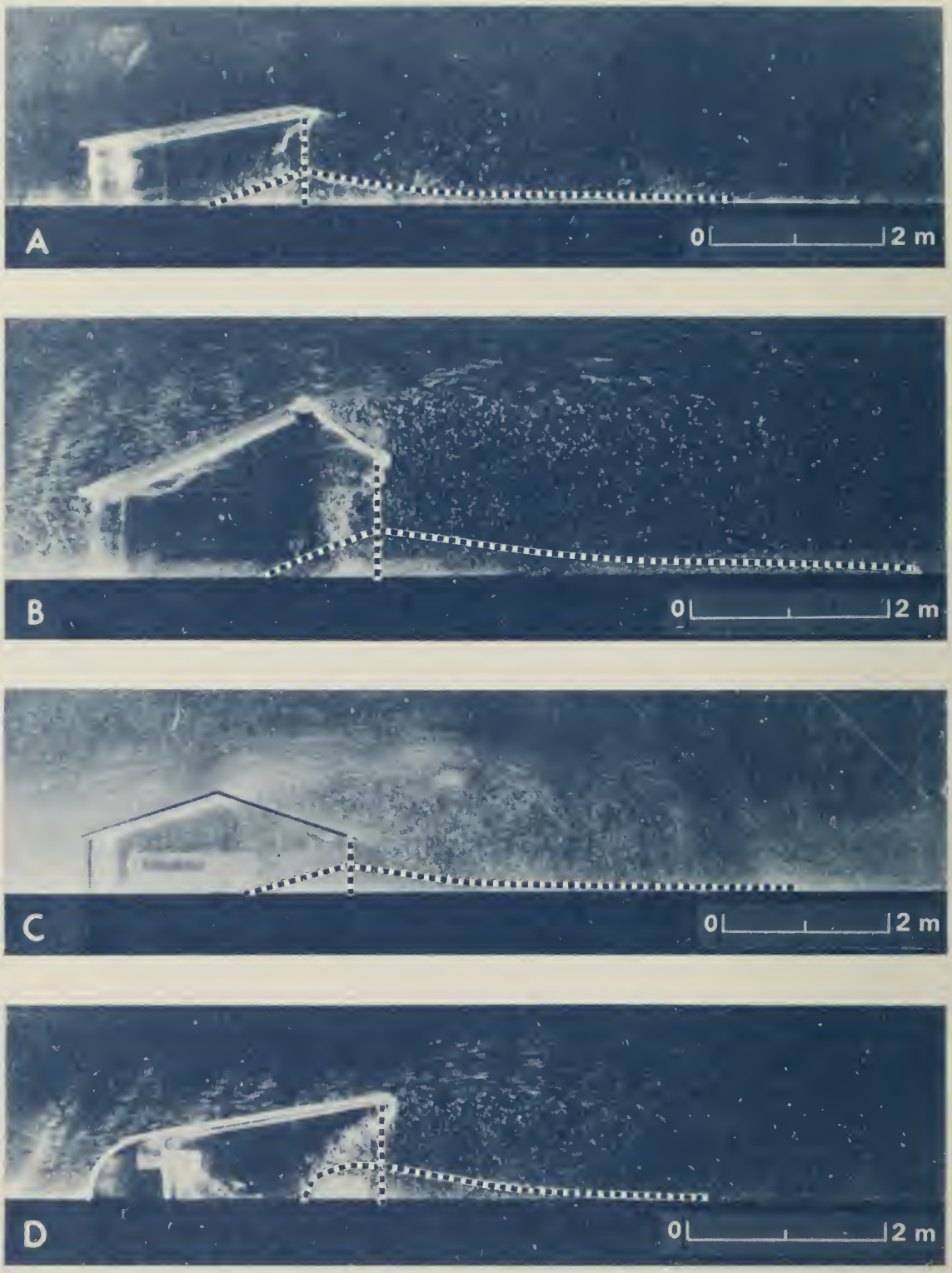


FIGURE 9. Snow and wind patterns about sheds with different roof shapes. All sheds have similar drifting problems. The snowdrift location is indicated by a dotted line.

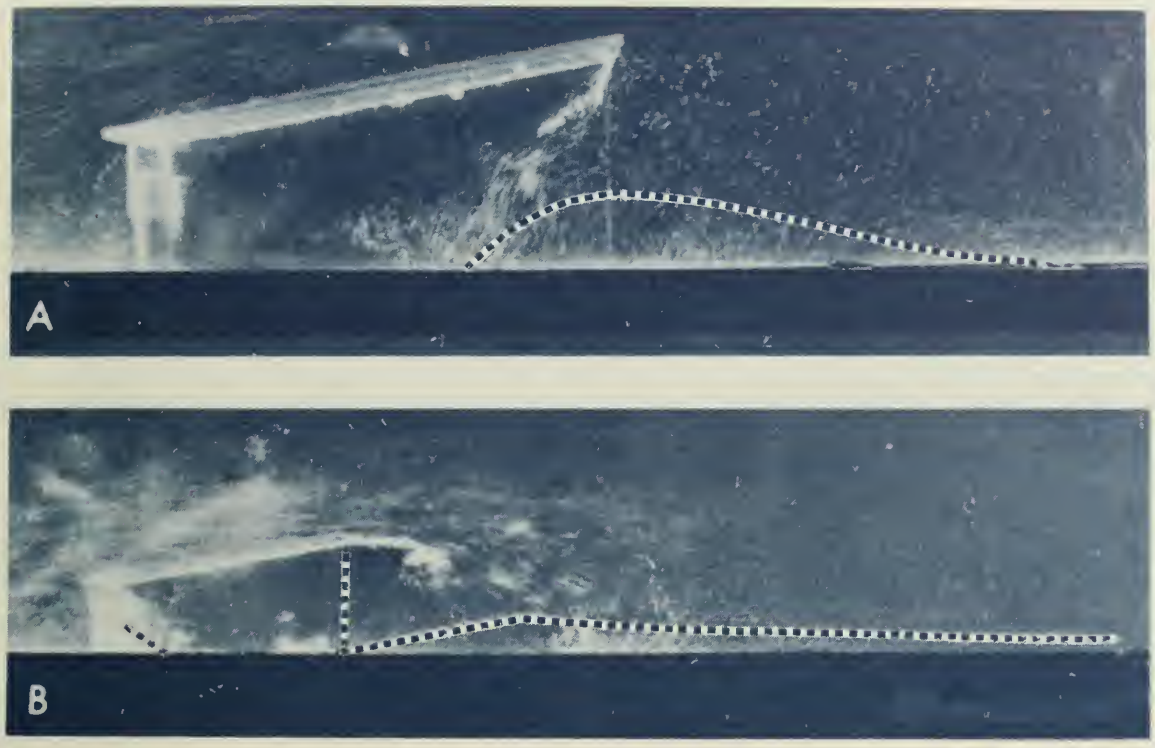


FIGURE 10. Snow and wind patterns about open-front sheds: (a) with a solid rear wall; (b) having a 25 cm slot in the rear wall. The proper slot width is 15 to 20 cm.

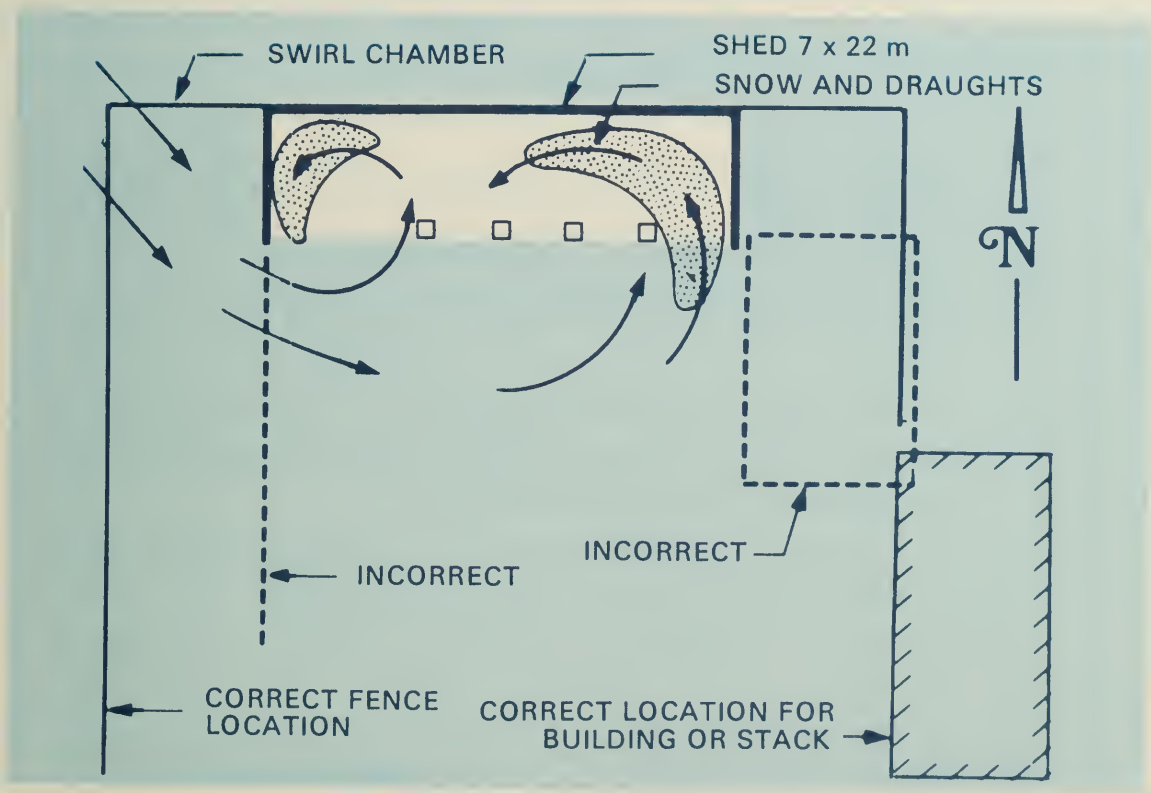


FIGURE 11. Snow and wind problems with open-front sheds having no fence protection, or with fences improperly located. Correct fence and building locations are also indicated.

FIGURE 12. A "swirl chamber" is effective in reducing snow accumulation inside a shed. This is the correct method of connecting a fence to an open-front shed.

SUMMARY OF GUIDELINES

1. Wind has the most serious effects on livestock performance. Cold by itself has little influence on feed performance, particularly for animals on full feed.
2. Wind and snow must always be considered as a joint problem.
3. Simple shelters, sheds or windbreak fences are essential.
4. Slight reductions in wind velocity result in relatively large quantities of snow being deposited.
5. The swirling and relocation of snow within a farmstead is often the main cause of drifting problems.
6. Porous fences of 80% density offer the best wind protection.
7. Snow drifts through a porous fence; a solid fence locates most of the snow outside a yard and provides the best snow barrier. Porous fences can provide good snow control provided an allowance is made for the resulting drift.

8. Shallow, inexpensive open-front sheds provide excellent shelters for livestock. Slot openings should be provided under the eaves for ventilation and to prevent snow from swirling into the front of the shed. The best slot size is 200 mm; in practice 150 mm is satisfactory.

9. Do not attach windbreak fences directly to the front corner of an open-front shed; use the swirl-chamber arrangement.

10. Long open-front sheds should be divided into sections to reduce draughts.

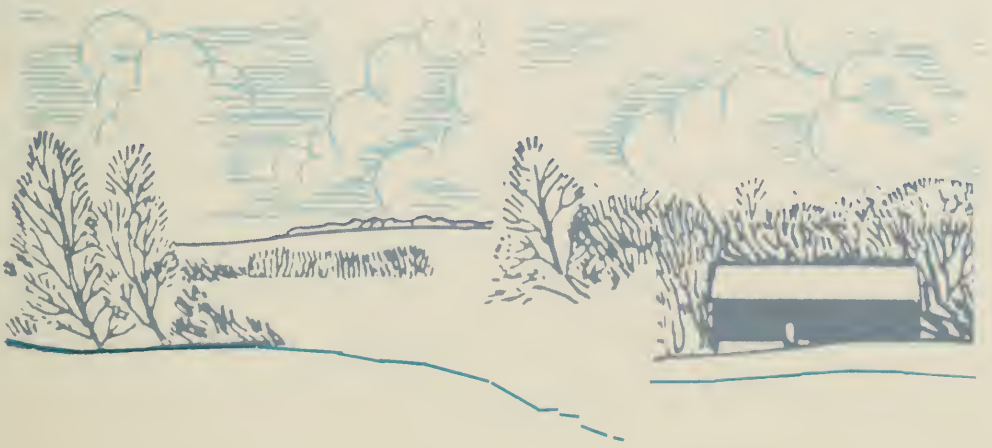
11. Locate adjacent buildings so they will not deflect wind and snow into a shed.

12. Under extreme conditions, wind and snow control is never 100% successful; however, attention to the above guidelines will reduce problems to a minimum.

ACKNOWLEDGEMENTS

Information and ideas for this publication were gleaned from a number of sources, as indicated in the text. Particular thanks must go to Dr. A. J. F. Webster of the University of Alberta, whose work on the effects of wind and cold on livestock contributed valuable background information to this project.

Sincere thanks are extended Mr. H. E. Bellman of the Ontario Department of Agriculture who supplied the pictures appearing in Figures 4 and 12. Pictures of snow flow patterns about open-front sheds, Figures 9 and 10, were taken at the University of Guelph, Agricultural Engineering Laboratory. The author is grateful for having had the opportunity to study shed designs at that institution.



CONVERSION FACTORS

Metric units	Approximate conversion factors	Results in:
LINEAR		
millimetre (mm)	x 0.04	inch
centimetre (cm)	x 0.39	inch
metre (m)	x 3.28	feet
kilometre (km)	x 0.62	mile
AREA		
square centimetre (cm^2)	x 0.15	square inch
square metre (m^2)	x 1.2	square yard
square kilometre (km^2)	x 0.39	square mile
hectare (ha)	x 2.5	acres
VOLUME		
cubic centimetre (cm^3)	x 0.06	cubic inch
cubic metre (m^3)	x 35.31	cubic feet
	x 1.31	cubic yard
CAPACITY		
litre (L)	x 28.3	cubic feet
hectolitre (hL)	x 22	gallons
	x 2.5	bushels
WEIGHT		
gram (g)	x 0.04	oz avdp
kilogram (kg)	x 2.2	lb avdp
tonne (t)	x 1.1	short ton
AGRICULTURAL		
litres per hectare (L/ha)	x 0.089	gallons per acre
	x 0.357	quarts per acre
	x 0.71	pints per acre
millilitres per hectare (mL/ha)	x 0.014	fl. oz per acre
tonnes per hectare (t/ha)	x 0.45	tons per acre
kilograms per hectare (kg/ha)	x 0.89	lb per acre
grams per hectare (g/ha)	x 0.014	oz avdp per acre
plants per hectare (plants/ha)	x 0.405	plants per acre

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