TECHNICAL NOTES

U. S. DEPARTMENT OF AGRICULTURE SOUTH DAKOTA SOIL CONSERVATION SERVICE

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Benefits Associated With Feedlot And Livestock Windbreaks

Attached is Technical Note Series No. 190-LI-1, Benefits Associated With Feedlot And Livestock Windbreaks, prepared by David Hintz, National Windbreak Forester.

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Attachment

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INTRODUCTION

The following information is presented to acquaint foresters, range conservationists, district conservationists, soil conservationists, soil conservation technicians, and others with the major benefits which can be attributed to feedlot and livestock windbreaks. This information should be useful to planners and others for promoting feedlot and livestock windbreaks.

Feedlot and livestock windbreaks for the purpose of this technical note would be any tree and/or shrub windbreak which is used to protect any number of livestock. It is not limited to large commercial feedlots with large numbers of livestock.

It is assumed that windbreaks are properly designed, the feedbunks are located in the well protected zone leeward from the windbreak and there are no poor drainage or soil wetness problems within the feedlots. In areas subject to blowing snow, the windbreaks are designed to keep snow drifts from forming within the feeding areas.

BENEFITS ASSOCIATED WITH FEEDLOT AND LIVESTOCK WINDBREAKS

Feedlot and livestock windbreaks are used primarily to protect livestock from wind, wind borne soil, and wind borne snow. The protection afforded by these windbreaks can significantly reduce stress on the animals and feed requirements. This results in better animal health, lower mortalities, and lower feed costs. Other benefits such as protection of buildings, ease in feeding, improved wildlife habitat, and beautification of the area can also be attributed to windbreaks.

Feedlot windbreaks protect areas to be used for extensive periods (greater than 1 month) or on a continuous basis for feeding and holding livestock. Feedlot windbreaks require great care in the design of drainage systems within and adjacent to plantings and to the proper disposal of large amounts of waste.

Livestock windbreaks protect areas which will be used for livestock on an intermittent or emergency basis. Unless large herds are involved, there is less animal waste, which allows for more flexibility in design.

Effect of Windbreaks on Feed Requirements of Beef and Dairy Animals

In order to discuss this topic with livestock owners and to understand the effects of windbreaks on livestock, it is necessary to review the effects of cold and wind on the various types of livestock.

Most of the research on cold temperatures and wind has been conducted on the beef type of livestock. The effect of cold temperatures on beef animals is basically one of an increased need for energy. Animals must increase their intake of feed as temperatures fall below certain critical temperatures or windchill indexes to get the energy needed to keep their body temperatures within a specific comfort range.

Canadian researchers found that range cattle on winter range required a 50 percent increase in feed energy for the normal activities. They also found that an additional 20 percent increase in feed energy was needed to overcome the direct effects of exposure to a combination of cold temperatures and wind. They concluded that adequate wind protection could reduce the direct effects of cold by more than half. Canadians[1/] also found that the intensity and duration of the cold experienced during the prairie winters would have negligible effect on the energetic efficiency of synthesis of meat by feeder cattle if they were provided with shelter from wind and were able to keep dry.

Researchers at Purdue University found that the energy requirements for cows in good condition increased 13 percent for each 10 degree drop in windchill temperature below 30 degrees. Cows in poor condition needed 30 percent more energy for a similar 10 degree drop in windchill below 30 degrees.

[1/] Webster, A. J. F. Direct Effects of Cold Weather on the Energetic Efficiency of Beef Production in Different Regions of Canada. Can. J. Anim. Sci. 50:563-573. 1970.

Iowa studies with calves and yearlings concluded that the requirements for feed were 7 percent greater for those in open lots than for similar animals with shelter.

Very young animals may die as a direct result of very cold temperatures. This is especially critical if these calves are subjected to cold temperatures and wind. These young animals have a very limited ability to consume enough milk to provide the energy needed to overcome effects of cold temperatures.

All animals increase food intake and energy expenditure when subjected to temperatures below their comfort zone. The estimated lower critical temperatures for beef animals are listed in table 1. (Refer to the worksheet at the end of this section for complete calculation procedures on the effects of cold, wind, and windbreaks.)

Table 1. Estimated Lower Critical Temperature for Beef Cattle

Coat Description	Critical Temperature
Summer coat or wet	59° F
Fall coat	45° F
Winter coat	32° F
Heavy winter coat	18° F

From: D. R. Ames, Kansas State University.

Each degree of temperature below that listed for each coat description is considered a degree of cold. Table 2 lists the increased maintenance energy costs for sizes of cattle for each degree of cold. For example, a 660 lb beef animal with a winter coat will need approximately 1.1 percent more feed for each degree of temperature (cold) below 32° F. For instance, if the temperature on a given day is 15° F with no wind, then there would be an increase in feed or maintenance costs of approximately 1.1 percent x 17, or 19 percent to keep the animal within the desired comfort zone.

Table 2. Increased Maintenance Energy Costs for Cattle Per Degree (F) Cold (Per Degree for Temperatures Below Critical Temperatures).

		Beef Animal Weight (Pounds)					
	Insulation	440	660	880	1100	1210	1320
Description	($C/kcal/m^2/da$)	Percentages					
Summer coat or wet	.010	2.3	2.1	2.0	2.0	1.9	1.9
Fall coat	.015	1.5	1.4	1.4	1.3	1.3	1.3
Winter coat	.015	1.2	1.1	1.1	1.0	1.0	1.0
Heavy winter coat	.030	.7	.7	.7	.7	.6	.6

Table 3. ESTIMATED WINDCHILL FACTORS FOR CATTLE WITH WINTER COAT AND PROTECTED BY WINDBREAK - ASSUMING A 70% REDUCTION IN WIND VELOCITY DUE TO THE WINDBREAK.

Windspeed actual open mph	Windspeed 70% reduction due to windbreak mph	Temperature (°F) -10	-5	0	5	10	15	20	25
Calm	Calm	-10 (-10)*	-5 (-5)	0 (0)	5 (5)	10 (10)	15 (15)	20 (20)	25 (25)
5	1.5	-16 (-12)	-11 (-7)	-6 (-2)	-1 (3)	3 (8)	8 (13)	13 (18)	18 (23)
10	3	-21 (-14)	-16 (-9)	-11 (-4)	-6 (-1)	-1 (6)	3 (11)	8 (16)	13 (21)
15	4.5	-25 (-15)	-20 (-10)	-15 (-5)	-10 (-1)	-5 (4)	0 (9)	4 (14)	9 (19)
20	6	-30 (-17)	-25 (-12)	-20 (-7)	-15 (-2)	-10 (2)	-5 (7)	0 (13)	4 (17)
25	7.5	-37 (-19)	-32 (-14)	-27 (-9)	-22 (-4)	-17 (1)	-12 (5)	-7 (10)	-2 (15)
30	9	-46 (-20)	-41 (-15)	-36 (-10)	-31 (-6)	-26 (0)	-21 (4)	-16 (9)	-11 (14)
35	10.5	-60 (-21)	-55 (-16)	-50 (-11)	-45 (-6)	-40 (-1)	-35 (3)	-30 (8)	-25 (13)
40	12	-78 (-23)	-73 (-18)	-68 (-13)	-63 (-8)	-58 (-3)	-53 (2)	-48 (6)	-43 (11)

(cont'd)		30	35	40	45	50
Calm	Calm	30 (30)	35 (35)	40 (40)	45 (45)	50 (50)
5	1.5	23 (28)	28 (33)	33 (38)	38 (43)	43 (48)
10	3	18 (26)	23 (31)	28 (36)	33 (41)	38 (46)
15	4.5	14 (24)	19 (29)	24 (34)	29 (39)	34 (44)
20	6	9 (22)	14 (27)	19 (32)	24 (37)	29 (42)
25	7.5	2 (20)	7 (25)	12 (30)	17 (36)	22 (40)
30	9	-6 (19)	-1 (24)	3 (29)	8 (35)	13 (39)
35	10.5	-20 (18)	-15 (23)	-10 (28)	-5 (33)	0 (38)
40	12	-38 (16)	-33 (21)	-28 (26)	-23 (31)	-18 (36)

*( ) Windchill factor assuming a 70 percent reduction in wind velocity due to windbreak.

Adapted from: D. R. Ames, Kansas State University.

Table 3, Estimated Windchill Factors for Cattle with Winter Coat and Protected by Windbreak, illustrates the combined effect of wind and temperature on cattle and windbreak effects. For instance, if the temperature was 15° F and the wind was blowing at 15 mi/h, the windchill factor would be 0° F, (from the column outside the parenthesis). This means that an animal would be reacting as if the temperature was 0° F. In this case, the increased feed or maintenance costs would be 1.1 percent x 32, or approximately 35 percent for a 660 lb beef animal on a day when the temperature was 15° F and the wind was blowing at 15 mi/h.

Windbreaks are important for reducing feed or maintenance energy costs for cattle because they reduce wind velocities and, therefore, reduce the effect of windchill. Table 3, Estimated Windchill Factors for Cattle with Winter Coat and Protected by a Windbreak (assuming a 70 percent reduction in wind velocity due to the windbreak) shows the value of a windbreak for reducing windchill. For example, if on a given day the outside temperature is 10° F and the wind is blowing 20 mi/h, the windchill factor in the open for cattle would be -10° F. An 880 lb beef animal would require approximately 46 percent more feed or maintenance energy costs (42 degrees of cold, -10° to 32° F x 1.1 percent) to maintain itself in the comfort zone. A windbreak which provides for a 70 percent reduction in wind velocity would change the windchill factor from -10 to 2. There would be a decrease in the maintenance energy feed costs from 46 percent to 33 percent or a savings of approximately 13 percent. Colder temperatures and higher wind velocities could result in

For instance, if the outside temperature is -5° F and the wind velocity is 30 mi/h, the windchill index is -41°. On this day, an 880 lb beef animal in the open without shelter would require approximately 80 percent (73 degrees of cold x 1.1 percent = 80 percent) more in maintenance energy costs or feed to be maintained in the comfort zone. This same animal in the protected area of a windbreak would require 52 percent more in maintenance energy costs (47 degrees of cold x 1.1 percent = 52 percent). This results in a savings of approximately 28 percent in feed or maintenance energy costs.

When cattle become wet, the insulation value of their coat is drastically reduced. To determine increased maintenance energy cost for cattle with wet coats, use the information in table 2 for Summer Coat or Wet. If on a given day the outside temperature was 35° F and the wind velocity is 30 mi/h, a wet 660 lb beef animal would require approximately 126 percent increase in feed or maintenance energy costs without a windbreak. In this case, the windchill factor would be -1° F. The degrees of cold would be 60 (-1° to 59° F) (see table 1). Note that the increased maintenance costs in percent changes from 1.1 percent for winter coat to 2.1 for summer coat or wet coat. To determine the increased maintenance energy costs, multiply 60 (degrees of cold) x 2.1 percent which equals 126 percent. This same animal protected by a windbreak would be subjected to a windchill factor of 24 under the same set of temperature and wind conditions. In this case, there would be an increase in maintenance energy cost of approximately 73 percent (35 degrees of coldness x 2.1 percent. This would result in a savings of approximately 53 percent in food or maintenance energy costs due to the effect of the windbreak.

Although the above examples refer to beef animals, the same tables can be used for dairy animals.

The above method for determining the value of tree an shrub windbreaks for reducing the amount of feed needed or reducing maintenance energy costs can be used to estimate these benefits. Personal discussions with livestock owners indicate that this method of determining benefits is a practical approach. However, some have stated that the results maybe conservative. There is a critical need for additional research on properly designed feedlot and livestock windbreaks to determine actual benefits under field conditions. Without the needed research, the above method for determining benefits is the best tool we have available at this time.

The following worksheet is designed to show comparisons for unprotected animals with those protected by a tree and shrub windbreak.

Effect of Windbreaks on Food Requirements and Energy Savings Associated with Swine.

Swine are poorly adaped to cope with extreme heat or cold. Since they have very little hair, there is not much to protect them from extreme cold. It is known that the rate of gain and feed efficiency are lowered when swine must endure temperatures above and below their comfort zone of 60° to 70° F. Table 4 illustrates that amount of feed required to produce 100 and 200 lb hogs at controlled temperatures between 40° and 100° F.

WORKSHEET TO CALCULATE COLD, WIND, AND WINDBRE... EFFECTS ON CATTLE MAINTENANCE ENERGY REQUIREMEN

		Example	Your situation Case 1	Case 2	Case 3	Case 4
imal in pounds (use to enter Table 1)	a	880				
at from Table 1		winter				
emperature from Table 1. °F	b	32°F				
ature °F	c	10°F				
nd velocity mph without windbreak	d	10 mph				
nd velocity mph with windbreak, 70% reduction	e	3 mph				
maintenance or energy factor (Table 2)	f	1.1				
factor (Table 3) without windbreak	g	-1°F				
factor (Table 3) with windbreak	h	6°F				

lculations:

t windbreak

x f = increased energy requirement

)) x 1.1 = 36.3% increase in energy requirements

indbreak

x f = increased energy requirement

x 1.1 = 28.6% increase in feed for energy requirement due to cold & wind

ial savings

.3% increased need w/o windbreak

.6% increased need with windbreak energy costs

.7% potential savings with windbreak

Case 1

A. Without windbreak

(b-g) x f = increased energy need

$\frac{\_\_\_}{b} - \frac{\_\_\_}{g} \times \frac{\_\_\_}{f} = \_\_\_\%$

B. With windbreak

(b-h) x f = increased energy need

$\frac{\_\_\_}{b} - \frac{\_\_\_}{h} \times \frac{\_\_\_}{f} = \_\_\_\%$

C. Potential savings

A - B = potential savings

$\frac{\_\_\_}{A} - \frac{\_\_\_}{B} = \_\_\_\%$

Case 2	Case 3	Case 4
b -g ___ x f ___%	b -g ___ x f ___%	b -g x f ___%
b -h ___ x f ___%	b -h x f ___%	b -h x f ___%
A -B ___%	A -B ___%	A -B ___%

Temperature °F	100 lb Hog	200 lb Hog
100	750	--
90	470	1,100
80	310	500
70	255	400
60	320	360
50	410	500
40	530	1,100

Table 4. Amount of feed Required to Produce 100 and 200 lb Hogs at Various Controlled Temperatures.

One can easily determine that 100 lb hogs are most efficient at converting feed into weight gain at approximately 70° F. Two hundred pound hogs are most efficient at approximately 60° F. This table also indicates some substantial benefits, which could be attributed to windbreaks, for swine raised in the open.

In situations where hogs are raised in confinement with controlled temperatures, windbreaks would be of no benefit to swine. However, windbreaks could have a significant effect on heating costs where heat is provided to keep building temperatures within the zone needed to maximize feed efficiencies. Savings in energy costs of 10 percent to more than 30 percent should be possible.

Significant benefits from windbreaks could be expected in those situtations where hogs are not raised in total confinement and would be exposed to windchill indexes below the desired temperatures indicated in table 4.

For example, research has shown that it takes approximately 410 lb of feed to produce each 100 lb hog at a constant temperature of 50° F in an open situation with no wind. If a steady 10 mi/h wind were introduced to the situation, the windchill index would fall to 40. If the 10 mi/h wind remained constant it could require 530 lb of feed to produce each 100 lb hog. This represents a 29 percent increase in feed or maintenance energy costs. In theory, a windbreak could reduce the wind velocity down to approximately 3 mi/h (assuming a 70 percent reduction due to the windbreak). The windchill index for a temperature of 50° F and 3 mi/h wind would be approximately 49. At 49° F, only a small amount of any additional feed would be needed. This would represent a potential savings of approximately 29 percent for each 100 lb hog. This example is presented to illustrate potential savings. Under actual field conditions hogs would be subject to a wide range of temperature changes and wind velocities. Research to date does not verify this type of savings in feed or maintenance costs, but studies indicate substantial savings may be possible by reducing the effects of windchill with properly designed windbreaks.

Note:

Not all studies have shown that windbreaks benefit livestock. However, in the known studies with negative results, it was found that there were serious in rate of weight gain or feed intake for cattle in feedlots for 140 days during the winter of 1971-72. In this study, the feedbunks were located 200 feet south of the windbreaks. This is well beyond the 10H zone of protection where livestock stock should concentrate or feed during windy periods of cool and cold temperatures. Also, artificial barriers or windbreaks because of their lack of sufficient height and often sufficient length do not always relate very well to properly designed windbreaks composed of trees and shrubs. Trees and shrub windbreaks of adequate length and height provide for extended zones of protection which provide for the feeding and feeding operations to be conducted in the 2-10H zone immediately leeward of the windbreak. Another study indicated that windbreaks were not beneficial to livestock because they caused snowdrifts to form within the feedlot causing a wetness and mud problem. Other studies without windbreaks also show that water and muddy conditions cause cattle to consume more feed and be subjected to more stress. Both are undesirable from the standpoint of the livestock feeder. Snowdrift problems and soil wetness problems within feedlots demonstrate the lack of proper design. Properly designed windbreaks will not cause significant snowdrifts to form or soil wetness problems within feedlots. In most cases they will provide protection from snow drifting onto lots and access roads.

Effects of Windbreaks on Feed Requirements of Sheep

Little is known about the effect of tree and shrub windbreaks on the feed requirements of sheep. Some sheep ranchers have indicated that feed savings and lower maintenance feed costs are possible but research to date does not verify these testimonials. This is one area of needed research.

Effect of Windbreaks on Milk Production of Dairy Cattle

Studies have shown that temperatures can have a significant effect on milk production. Some breeds are more sensitive than others to temperature. Table 5 compares the milk production of four breeds at different temperatures. Table 6 illustrates the effect of temperature, wind, and humidity on the milk production of Holstein cattle.

Within a temperature range of 32° to 70° F, the yield and composition of milk remains fairly constant. Beyond 70° to 80° F, the yield decreases slowly and the percentage of fat is reduced. Above 80° F, there is usually a significant decrease in yield, increase in the percentage of fat, and decreases in the content of nonfat solids. Except for the Holstein and Jersey breeds, milk production information is lacking for temperatures below 32° F. The Holstein and Jersey breeds show significant declines in milk production starting at temperatures between 35° and 50° F. Information on yield and composition of milk is not known for temperatures below 8° F. However, it is quite likely that certain low temperatures or windchill indexes will cause dramatic decreases in milk production.

In this technical note, only the effect of cold and the potential effect of modifying cold and chilling temperatures on dairy cattle will be discussed.

Windbreaks would have their greatest impact on improving milk production in areas that are windy and subject to cold temperatures or windy with cool

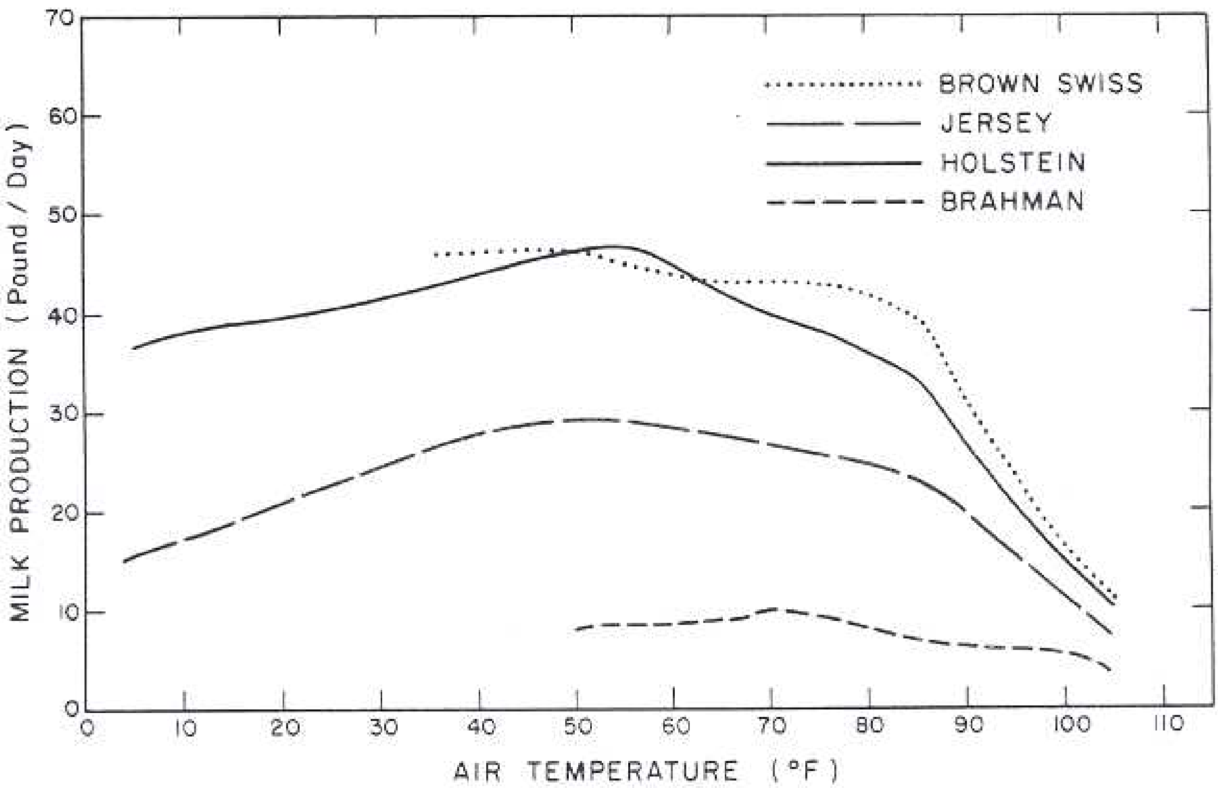

Table 5. Adapted from Harold D. Johnson, Inter. J. Biometer, 1965, Vol. 9.

Illustration of temperature effect on milk production. The vertical arrows suggest the alteration of the temperature comfort zone for milk production by 3 direct climatic factors associated with temperature, such as wind, radiation, and humidity. This comfort zone pertains to milk production of Holstein cattle based on extensive data from Ragsdale et al. (1950) and, more recently, Johnson et al. (1962). The more narrow comfort zone is suggestive of differences in this zone due to species level of acclimation, and other influences.

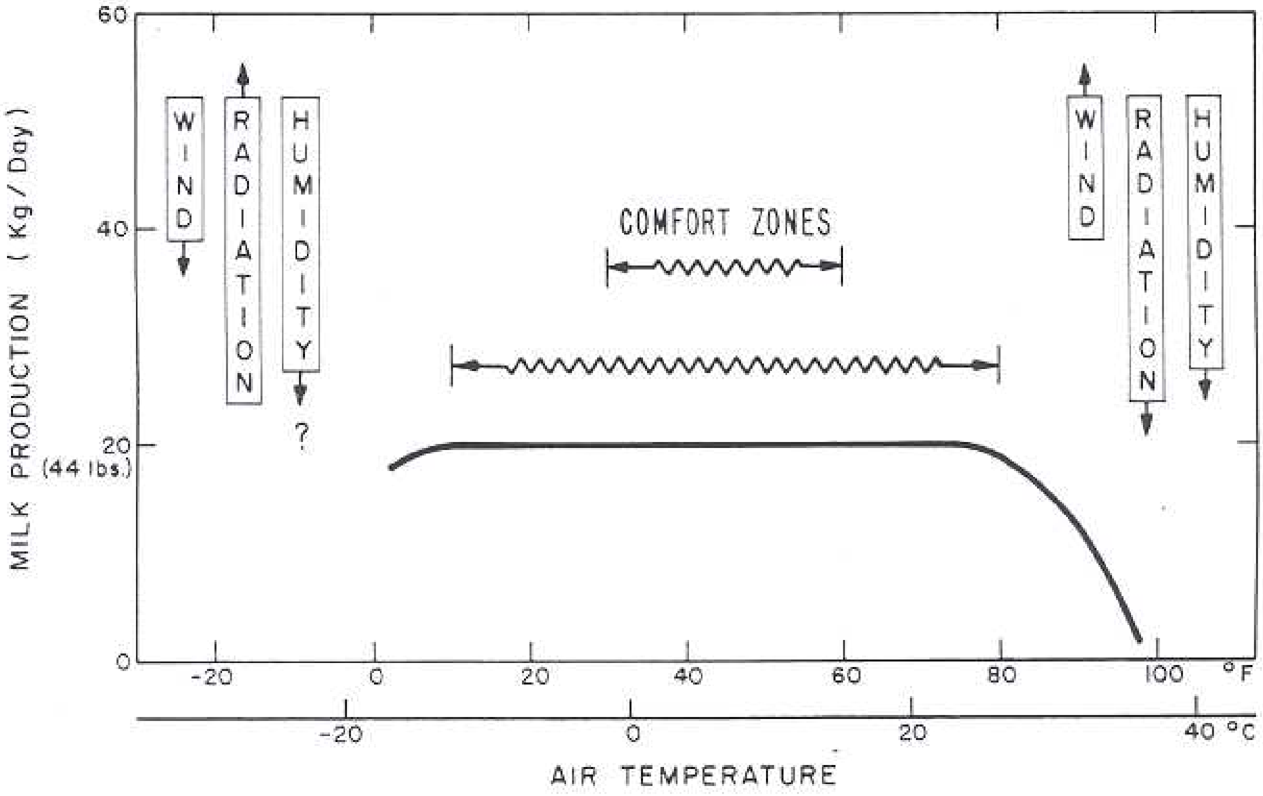

Table 6. Effect of Temperature, Wind and Humidity on the Milk Production of Holstein Cattle

Adapted from: Harold D. Johnson, Int. J. Biometer, 1965, Vol. 9.

windchill indexes and aids in keeping dairy cattle within their comfort zone. Although the graph in Table 5 shows milk production starting to drop at an outside temperature or windchill index of somewhere between 50° and 70° F, it does not show the effect of temperature or windchill indexes below these temperatures for most breeds. There is reason to believe that milk production will continue to decline as outside temperatures or windchill indexes decline. The line in the graph for the Holstein and Jersey breeds clearly shows this.

The information in Table 5 can be used to obtain some idea of the benefits of windbreaks for improving milk production (this would be independent of the savings to be realized from reduced feed costs). Using the line representing milk production of the Jersey breed at different temperatures and the windchill index table in Table 7, the benefits to be realized from windbreaks can be easily estimated. At a temperature of approximately 32° F and no wind, the milk production would be approximately 25 lb of milk per day. If the dairy animals were subjected to a 20 mi/h wind, the windchill index for an outside temperature of 32° F would be approximately 3° to 4° F. Milk production without the benefit of a windbreak would be approximately 13 lb per day. (This assumes that the rate of decline shown would continue at a similar rate to a temperature of 3° to 4° F). This represents an estimated decline in production due to the combined influence of wind and temperature of approximately 12 lb of 48 percent. If a windbreak reduces the wind velocity from 20 mi/h to 6 mi/h (70 percent reduction), the windchill index would be approximately 27. Milk production with the windbreak would be approximately 23 lb. This would represent a decline in milk production of approximately 2 lb or 8 percent. In this case, the windbreak would reduce the decline in milk production from 48 to 8 percent. Using the line representing the Holstein breed, the savings would be significantly different because this breed responds differently to cold. At approximately 30° F with no wind, the milk yield would be approximately 42 lb per day. If the animals were subjected to a wind with a velocity of 20 mi/h and an outside temperature of 30° F, the milk production would fall to approximately 37.5 lb (this assumes that the line will continue to decline at a similar rate to 3° F). The windchill index would be 3° F for the combined effect of a 20 mi/h wind and outside temperature of 30° F. This represents a drop in milk production of approximately 11 percent. A windbreak which reduces the wind velocity 70 percent or down to 6 mi/h would result in a windchill index of approximately 25° F. The milk production with a 6 mi/h wind and outside temperature of 30° F would fall to approximately 41 lb per day. This represents a drop in milk production of approximately 3 percent. Potentially, a windbreak could reduce the drop in milk production from 11 to 3 percent under the given set of conditions. Both examples represent a significant potential economic benefit to the dairyman from the use of windbreaks.

There is reason to believe that milk production will decline with colder temperatures and lower windchill indexes. However, studies and research are not available at this time to confirm this view. If milk production would fall at progressively colder temperatures at a rate similar or faster than shown in tables 5 and 6, it would be possible to obtain significantly higher benefits from the use of windbreaks.

Table 7

WINDCHILL INDEX

Wind speed mph	Actual thermometer reading °F											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent temperature °F											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	7	-6	-15	-26	-35	-47	-57	-68
10	40	28	16	2	-9	-22	-31	-45	-56	-70	-83	-95
15	36	22	11	-6	-18	-33	-45	-60	-70	-85	-99	-112
20	32	18	3	-9	-24	-40	-52	-68	-81	-96	-110	-129
25	30	16	0	-15	-29	-45	-58	-75	-89	-104	-118	-133
30	28	13	-2	-18	-33	-49	-63	-78	-94	-109	-125	-140
35	27	11	-4	-20	-35	-52	-67	-83	-98	-113	-129	-145
40	26	10	-4	-22	-36	-54	-69	-87	-101	-116	-132	-148

Little danger for mature animals if shelter or windbreak is available.

Increasing danger-will freeze flesh such as teats and scrotums. Will stress animals causing latent diseases to appear.

Great danger - death in young animals

From: John Herrick, Iowa State University Extension Veterinarian

Critical attention must be given to the placement of windbreaks for improving milk production. Improper placement can result in lack of use, improper use, lack of feeding, improper feeding, and/or creation of muddy feeding and holding areas. All of these factors can directly or indirectly have some effect on milk production and the benefits which could be attributed to windbreaks. Adequate preplanning is necessary to assure that the windbreaks will grow and function properly. Artificial windbreaks (constructed of boards, mounds of earth) are significantly different from windbreaks composed of trees and shrubs and should not be used where extended zones of protection are needed or where blowing and drifting snow can be a serious problem.

Another potential benefit from windbreaks to dairy cattle is the protection of the udder. Cows entering cold, windy environments after leaving the milking parlor with warm, moist udders can suffer significant udder damage. Cold stress is know to trigger mastitis which can also significantly reduce milk production.

Effect of Windbreaks in Reducing Stress, Injury, and Death of Livestock

Beef Animals and Dairy Animals

In areas subject to periods of cool-wet, cold-dry, or cold-wet weather, livestock and feedlot windbreaks can be valuable for reducing stress on animals. Reduced stress results in better animal health and lower mortalities. Table 7 is accredited to John Herrick, Iowa State University extension specialist. This table illustrates the effect of temperatures and wind velocities on animals. For instance, if the outside temperature is 0° F and the average wind velocity is 20 mi/h the equivalent temperature (windchill) is -40. This combination of temperature and wind would place the animal into the zone where bare flesh, such as teats and scrotums, will freeze. Also, the combination will stress the animals causing latent diseases to appear.

As a guide, you can use the following guidelines to assess the effect of temperature and wind on livestock (Adapted from John Herrick, Iowa State University extension specialist).

When the actual or equivalent temperatures fall within 50° to -24° F (windchill index):

There is little danger to mature animals when ample energy and food is available.

When the actual or equivalent (windchill index) temperatures are 0° F or below:

1. More energy and food will be needed by the animals to maintain their body heat.
2. A very stressful situation will exist for young animals.
3. For newborn claves the situation will be extremely stressful.

When the actual or equivalent temperatures read -30° to -70° F:

1. There is danger that unprotected flesh, such as teats and scrotums, may freeze.

2. There will be increased stress on the animals causing such diseases as pneumonia, thrombo, coccidissis, etc.

3. There will be a need for more energy and food for maintenance of body heat.

When the actual or equivalent temperatures are -70° F or below:

1. Efforts should be made to provide shelter for animals.

2. Extra feed should be provided.

3. Intensive care should be provided immediately to minimize problems.

Since windbreaks reduce wind velocities, they can be very valuable to livestock owners for reducing stress. For instance, if the outside temperature is 0° F and the average wind speed is 25 mi/h the equivalent (windchill index) is -45° F. Without a windbreak there would be danger of bare flesh freezing. Assuming that a windbreak will reduce wind velocities by 70 percent, the equivalent or windchill index in the protected zone of a tree and shrub windbreak would be approximately -13° F. With this equivalent temperature, there would be little danger to mature animals. Some danger would still exist for young animals and newborn calves and they should be moved to the most protected zone behind the windbreak (2-5H zone) or provided with some other form of protection.

Windbreaks would be extremely valuable during calving periods because temperatures and wind velocities can commonly provide equivalent temperatures (windchill indexes) below 0° F. Equivalent temperatures near or below this reading can cause serious problems for young animals and newborn calves. These problems can result in significantly higher mortality rates.

Adequate research on the effect of windbreaks on mortality rates is seriously lacking. However, testimonials on the effect of windbreaks on livestock mortalities are readily available from farmers and ranchers. There seems to be little doubt that windbreaks are valuable for reducing stress and mortality rates during periods of cool-wet, cold-wet or cold-dry weather.

<u>Swine</u>

Hogs raised in open confinement in the northern and midsections of the United States must endure temperature substantially below their comfort zone which appears to be in the vicinity of 60° to 70° F. Table 4 readily shows that hogs start utilizing significantly more feed when actual temperatures or temperature equivalents (windchill indexes) reach 50° F or below. This would indicate that stress factors could be more serious at significantly higher temperatures then for beef or dairy cattle. As stated earlier hogs are poorly adapted to cope with extreme cold or heat. They have very little comfortable at 80° to 90° F, they will shiver when standing by themselves at 70° F and appear to be cold at temperatures of 60° F and below.

Livestock and feedlot windbreaks should benefit open confinement hogs in a manner similar to beef and dairy animals. Essentially they would reduce wind velocities during periods of cool and cold weather which would reduce windchill indexes. Lower windchill indexes should minimize problems related to stress. This should result in lower disease problems and lower mortality rates.

Research on the effect of tree and shrub windbreaks on hogs is seriously lacking.

Sheep

Sheep are naturally adapted to cool and cold climates. Range flocks of sheep appear to generally obtain the protection needed during severe weather in natural features on the landscape. However, in situations where natural features for protection are not available, thousands have been known to die during severe blizzards. Therefore, a case can be made for some form of protection during periods of severe weather where natural features for protection are not available. Sheep are also vulnerable to significantly higher mortality rates during the lambing season and would benefit from some form of wind protection. One study in Australia during a cold and windy period of their year indicated a 50 percent reduction in mortality rates for lambs protected by grass hedges versus lambs without protection.

Research on the value of tree and shrub windbreaks on the general health and mortality rates of sheep is lacking. However, there appears to be few doubts that tree and shrub windbreaks could be beneficial during the lambing season in areas subject to severe winter or early spring storms.

General Comments

This technical note was developed to provide some information and methods for determining or estimating the benefits to be derived from livestock and feedlot windbreaks. As with most things associated with agriculture, we do not have all the answers that are needed to determine all the actual benefits of livestock and feedlot windbreaks. In all likelihood, perfect answers will not be available for years. The lack of perfect answers should not deter us from using the best information and methods available to us at this time. This technical note offers you something to present to farmers and ranchers now.

As new research information becomes available, it will be forwarded to allow for the updating and improvement in the information and methods presented here.

The need for additional kinds of research was noted throughout the technical note to draw attention to the needs. Whenever and wherever possible researchers should be encouraged to investigate these needs.

It is important to note that in evaluating research studies or promoting designed tree and shrub windbreaks. Board fences, sheds, and the like may not function or provide the same benefits as tree and shrub windbreaks.

In the design of new or in the evaluation of existing livestock windbreaks, careful attention must be given to drainage within the windbreaks and within the feedlots. Areas of poor drainage or wet areas due to drifted snow within the feedlot can cancel any feeding, lowering of stress, or lowering of mortality rate benefits associated with windbreaks. All windbreaks must be designed to keep drifted snow out of feedlots and all water originating from snow drifts or other sources within windbreaks must be diverted away from feedlots.

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