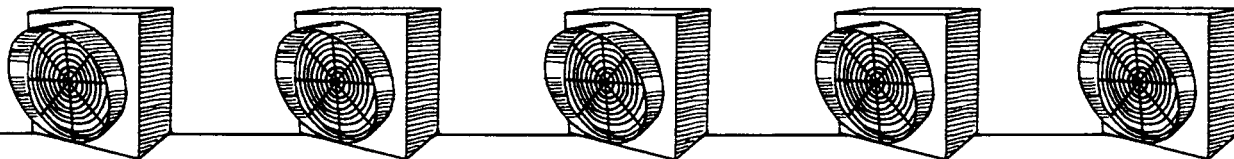


Dairy Barn Ventilation

Exhaust Fan Systems



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Exhaust ventilation systems for successful fall-winter-spring ventilation of dairy stall barns will be discussed in this brieflet. These systems consist primarily of controlled air inlets, fans and thermostatic controls.

A continuous supply of fresh air is necessary whenever animals are closely confined, as in dairy stables, in order to maintain animal health and integrity of the building. Evidence of inadequate ventilation includes condensation or condensation stains on walls, ceilings and structural members, and the presence of foul odors in the barn. Perennial respiration diseases may be another symptom of poor ventilation. Winter barn temperatures should not exceed 50 degrees F. If this temperature is often exceeded, inadequate ventilation may be the reason.

Quantity

Recommended ventilation rates depend primarily upon the total weight of livestock housed in the space to be ventilated. Rates are given in cubic feet per minute

	cfm* per 1000 lbs
Basic cold weather rate:	30-40**
For milder weather, add:	90-120***
Total fan capacity	120-160

* Cubic feet per minute

** Continuous closed barn ventilation

*** Temperature controlled in 2 or 3 stages.

For a 1,400-pound cow, these values become:

Basic closed barn ventilation 45-55 cfm

For mild weather cycling, add 125-170 cfm

Total capacity/1,400-pound cow 170-220 cfm

Table 1. Recommended ventilation rates.

(cfm) per 1,000 pounds of animal weight in *Table 1*. Different rates are required for different weather conditions.

Fans

Select fans that move the required quantity of air at 1/10- or 1/8-inch static pressure, as tested and certified with all accessories in place, such as hoods, protective screens and louvers or shutters. Keep specifications showing delivery vs. static pressure for your fans in a file for reference.

A fan's capacity does not depend upon a single factor, such as diameter. Horsepower, speed and blade shape also have an effect. *Table 2* (Typical fan performance data) can be used as a guide if manufacturer's ratings are unavailable. These figures are given for new, clean fans. *Table 3* (Format for estimating required ventilation rates) can also be used as an aid to fan selection.

Fan location

In barns with tight construction and continuous, baffled slot inlets, fan location has little effect on air distribution. Place fans in groups or banks at a single location, rather than spacing them out singly at different locations. Place each group so air does not move more than 100 feet from intake to exhaust. With perimeter inlets, one group of fans can serve a two-row barn up to 120 feet long. Barns longer than 100 to 120 feet require two or more duplicate fan banks spaced equally to share ventilation. For stables wider than 40-45 feet, usually with three or more rows of stalls, matching fan banks, one for each side of the barn, should be considered. In this case, center air inlets in the ceiling are required, along with outside wall air inlets.

Common mistakes: Moving warm humid air from an area with high animal density to a cooler area. This will

Fan		Fan capacity, cfm		Motor h.p.	Type drive
Speed rpm	Size in.	Free air	½" W.G.		
Single-speed					
1100	10	560	380	½ ₂₀	Direct
1725	10	910	840	⅙	"
1150	12	1240	780	⅙	"
1725	12	1640	1520	⅙	"
1750	12	1760	1575	⅙	"
1050	14	1250	1020	½ ₂₀	"
1725	14	2100	2005	⅙	"
1140	16	1950	1780	⅙	"
1150	16	2630	2190	⅙	"
1725	16	2800	2680	¼	"
1750	16	3000	2770	¼	"
1140	18	2700	2380	⅙	"
1150	18	3110	2620	⅙	"
1725	18	2845	2680	¼	"
1725	18	4000	3860	⅓	"
1750	18	4130	3720	½	"
1150	20	3620	3240	¼	"
1725	20	2920	2485	¼	"
1150	20	4430	3850	⅓	"
1725	20	4200	4120	⅓	"
860	24	4800	3770	¼	"
860	24	5630	4950	⅓	"
1140	24	4400	4100	¼	"
1140	24	6500	6200	½	"
1725	24	3975	3725	⅓	"
690	30	8800	7780	½	"
690	30	9250	8280	¾	"
860	30	11000	10150	1	"
650	30	8570	7520	⅙	Belt
545	30	9950	8200	½	"
615	30	11200	9700	¾	"
650	30	8570	7520	½	"
670	30	12100	10700	1	"
816	30	10850	10000	1	"
476	36	10900	9550	½	"
545	36	12450	11400	¾	"
505	36	14200	11900	¾	"
367	42	13400	10830	½	"
420	42	15300	13330	¾	"
462	42	16800	15200	1	"
Two-speed					
1725	16	2534	2353	⅓	Direct
1140		1675	1374		
1140	18	2686	2395	⅙	"
855		2015	1573		
1725	18	4065	3880	⅝	"
1140		2686	2395		
1100	20	2920	2760	¼	"
800		1930	1630		
855	24	4691	4180	⅓	"
570		3127	2105		
1100	24	5520	4800	⅓	"
800		4010	2800		

Table 2. Typical fan performance data.

increase condensation and worsen conditions in the colder area. It is a mistake to try to heat that part of the barn housing young stock by moving air from the warmer part of the cow stable. Exhausting ventilation fans into cold sheds leads to rot and structural failures. In colder regions, radiant heaters directed at tractors and manure spreaders make winter operations easier.

Positive pressure fan systems with plastic tubes or wooden ducts may be necessary for hard-to-ventilate situations.

Air Inlets

Rule of thumb for inlet location: Inlets should be located so that if straight lines were traced from all inlet points to the exhaust fan, no portion of the space would be without a trace passing through it.

Rule of thumb for inlet area: Provide 200 square inches of total inlet opening for each 1,000 cfm (cubic feet per minute) of air moved by the fans in operation.

Air inlet design and location is more important to good ventilation than the fans themselves. Properly designed inlets are required for complete fresh air distribution throughout the barn space.

Uncontrolled air inlets

There are controlled, or planned, air inlets and uncontrolled, or unplanned, air inlets. Cracks around doors and windows, open doors to hay lofts and hay chutes, and wall cracks due to weather and age are uncontrolled air inlets. It is almost impossible to design a good ventilation system around unplanned cracks for air inlet.

Uncontrolled inlet area should be less than 25% of the total inlet area. This is possible with tight construction and a well-designed ventilation system. On the other hand, in many older barns more than 50% of the air will enter uncontrolled openings. Ventilation systems with more than 50% uncontrolled air entry will work only on a hit-and-miss basis.

Continuous slot inlets

Continuous and adjustable slot inlets are best for controlled air inlets. They are best for good air distribution and for mixing. These slot inlets are located in the center of the ceiling and/or on the perimeter of the ceiling at the top of the walls. (See *Figure 1*.)

Inlets should not be placed closer than within 10 to 12 feet of any fan. Center inlets are needed in barns that have three, four, or more rows of cows and may be needed in two-row barns in windy locations with variable wind directions.

animals multiplied by the average body wt = total wt

$$\frac{\text{(# large animals)}}{\text{}} \times \frac{\text{(average weight)}}{\text{}} = \text{_____ lbs.}$$

$$\frac{\text{(# medium)}}{\text{}} \times \frac{\text{(average weight)}}{\text{}} = \text{_____ lbs.}$$

$$\frac{\text{(# small)}}{\text{}} \times \frac{\text{(average weight)}}{\text{}} = \text{_____ lbs.}$$

Grand total weight = _____ lbs.

divide grand total by 1,000 = _____ AU
(total animal units)

40 X AU = _____ cfm basic capacity (upper limit)

120 X AU = _____ cfm cycling capacity (upper limit)

Example

50 cows at 1,400 lbs each	= 70,000 lbs.
20 young stock, average 500 lbs each	= 10,000 lbs.
Total weight	= 80,000 lbs.

80,000 divided by 1,000 = 80 animal units (AU)

80 x 40 cfm = 3,200 cfm, basic rate
80 x 120 cfm = 9,600 cfm, cycling rate

Total capacity = 12,800 cfm

Suggested fan selection:

for basic ventilation — one - 3,000 cfm single-speed fan
for moisture control — one - 3,000 cfm single-speed fan,
and one - 6,000 cfm single-speed fan, each thermostatically
controlled

or:

for basic ventilation — one - 3,000 cfm single-speed fan
and one - 3,000 (min) /9,000 (max) cfm dual-speed fan,
thermostatically controlled.

Table 3. Format for estimating required ventilation rates.

Adjustable Baffle

Each inlet should have an adjustable baffle to direct the air-mixing jet and control inlet air velocity. A design rule of thumb is to provide 200 square inches of inlet opening for each 1,000 cfm of fan capacity in operation. If this rule is used, an average inlet velocity of 700 feet/minute will be maintained, which is sufficient for mixing. Greater inlet areas result in lower velocities and less mixing. Smaller inlet areas result in too much restriction and loss of fan capacity. You should be able to faintly feel the air movement on the back of your hand 12 to 18 inches

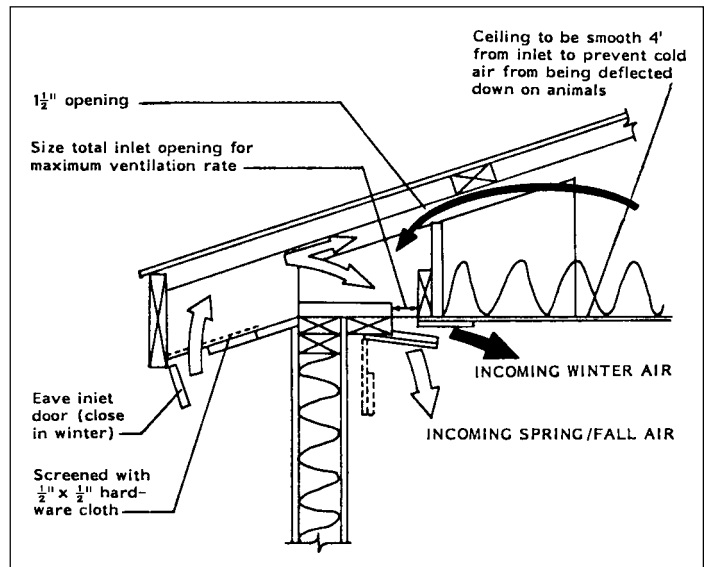


Figure 1. Slot inlet.

in front of any inlet that is being used as part of the air inlet system.

In a system with approximately 2 to 3 feet of continuous slot inlet for each cow, an opening with adjustments ranging from a minimum of 3/8-inch or less to a maximum of about 2 inches is satisfactory.

Inlet Control

Many inlets are adjusted manually, once in the fall and again in the spring, to match inlet openings for typical cold weather operation, and then again for more typical spring/fall operation. Automatic inlets that have pressure sensors are available; self-adjusting baffles maintain the pressure difference within a preset range. Other designs include floating gravity baffles with flaps that nearly close with low level ventilation and open wider with greater air flows of higher level ventilation rates. Floating flaps do not work well where wind can affect them. Some adjustment and maintenance will be necessary with any of these inlets. *Table 4* contains some ideal opening widths relative to given lengths.

Slot Inlet Opening Width

	Slot length per cow		
	2 ft	3 ft	4 ft
50 cfm/cow	3/8"	1/4"	3/16"
75 cfm/cow	5/8"	7/16"	5/16"
100 cfm/cow	7/8"	1/2"	3/8"
150 cfm/cow	1-1/4"	7/8"	5/8"

Table 4. Ideal slot inlet opening widths.

Retrofit Inlets

Inlets for barns that have been built without adequate consideration for controlled mechanical ventilation are difficult to design. Windows, although not recommended as winter ventilation inlets if other options are available, are better than no inlets at all. Adjustment of opening is often difficult, and the distribution of air into the barn is usually poor and drafty. *Figure 2* shows a type of box

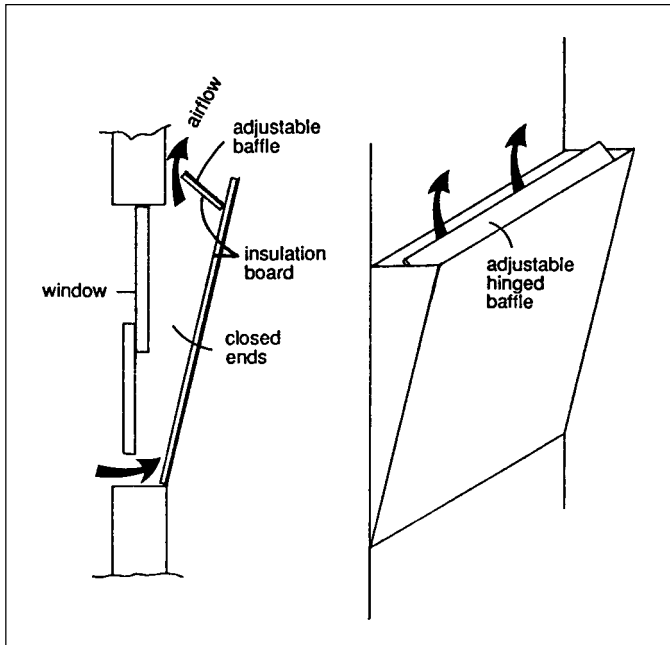


Figure 2. Window box inlets.

that may be used over a window to give better control of air inlet and distribution, at the same time reducing drafts.

Holes drilled through the ceiling into the haymow for fresh air are not the answer. They are quickly plugged with chaff, even if some method of protecting the holes is attempted. It is also seldom possible to get enough holes drilled to allow the passage of the amount of air required.

Ducting air from a large opening, such as an open hay chute or an opening through the barn wall, is a better alternative for air distribution if there is sufficient headroom in the stable. Normal duct dimensions are 12" x 24" with intakes every 20 feet. However, ducts as narrow as 6 inches can be used with more frequent intakes. *Figure 3* shows a cross-section of a typical duct inlet.

Cold Barns

For those barns with more than 25% uncontrolled air inlets that tend to be cold in winter, a box inlet around the primary exhaust fan to draw cooler air of the floor may help keep the barn warmer. (See *Figure 4*.)

Controls and Motor Protection

Ventilating rates are commonly controlled by thermostats at different temperature set points which operate fans, dampers or louvers. Timer controls to cycle motors on and off in order to obtain recommended ventilation rates are not recommended. They create larger temperature fluctuations and use more electric power because of high starting currents of motors. Moisture sensors and humidistats perform poorly in most barns.

Thermostats

Fans should be controlled by thermostats located to sense the average temperature in the barn. They should be located at least 10 feet from the fan, at least 1 foot below the ceiling, not directly over the cows and away from abnormal conditions, such as sunlight, air intake drafts, and heating devices. All controls for each group of fans should be placed at the same location. Keep controls clean and check for accuracy against a mercury thermometer yearly.

Control should be in the 38- to 48-degree range in the winter, with the higher temperatures in this range used to

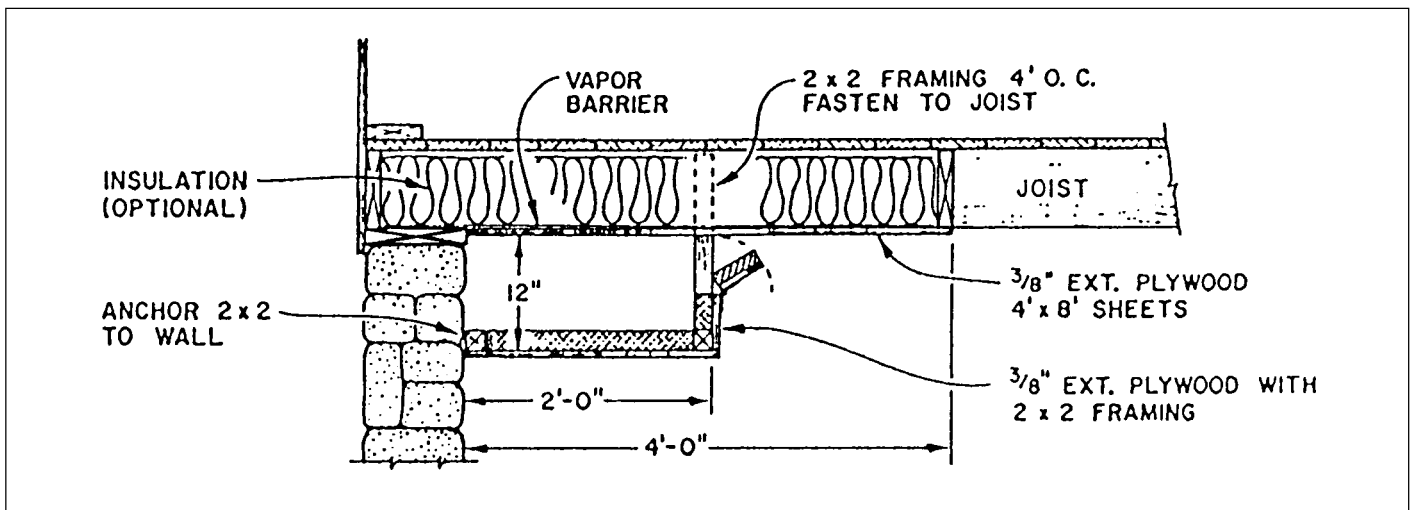


Figure 3. Duct inlets.

control fans producing the higher ventilation levels. Separate fans are normally staged to come on in 2-4 degree increments. Most thermostats have an on-off range of 3 to 5 degrees to minimize rapid on-off cycling.

Complete shutdown of all fans in a ventilation system should not happen in well-designed barns and ventilation systems unless the temperature drops below zero for several hours and then, preferably, only for a few hours at a time.

Each fan motor should have a delayed-action fuse or circuit breaker correctly sized for the motor. Hoods on the outside of the building are recommended for weather protection. All fans should have anti-backdraft shutters. Fans used primarily for higher ventilation rates can be manually switched off during cold weather and covered with insulation to reduce heat loss and cold air bleeding to adjacent operating fans.

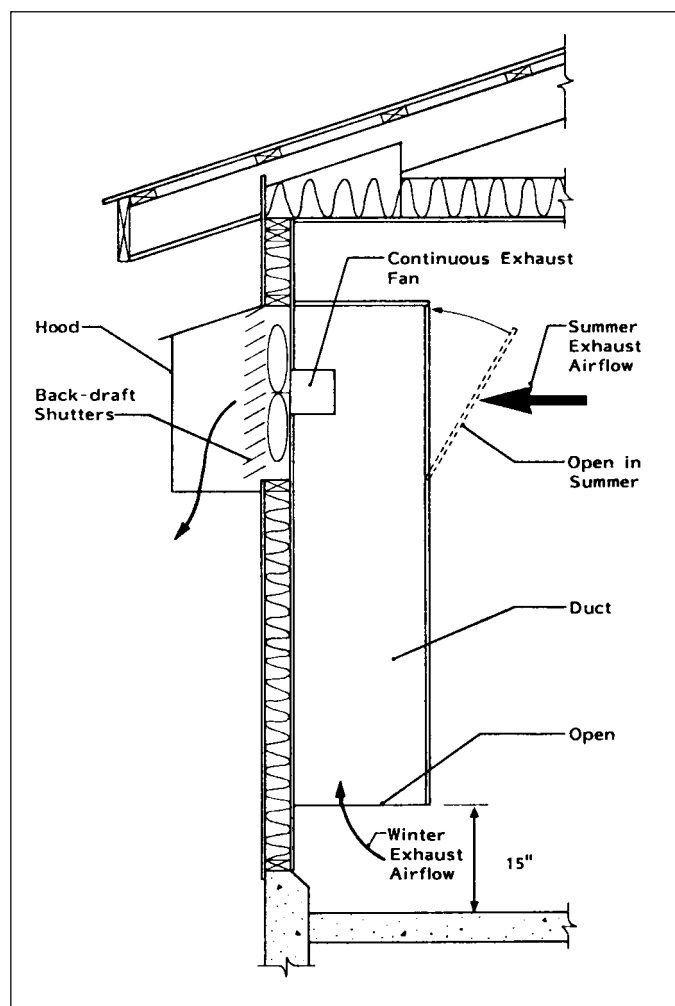


Figure 4. Heat conservation duct for continuously operated exhaust fan.

Design Assistance

Before building a new barn, make sure that the design used includes adequate provisions for ventilation. Make sure the builder follows these plans. Commercial and home architects and builders often don't understand the unique problems in dairy barn ventilation. If there is some question, contact your local Extension office.

Correcting problems in existing buildings can be frustrating. Before spending lots of money on fans and construction changes consult with livestock ventilation experts.

Reasons to Ventilate a Dairy Barn

1. *Healthier cows and young stock.* You maintain a healthier atmosphere for your livestock. Sudden temperature changes and high humidity lower your milk production.
2. *Better milk quality.* You produce better quality milk. There are no off-flavors from foul air.
3. *Comfortable barn.* You get a more comfortable environment in the barn for yourself and your hired help.
4. *Sounder barn.* The barn will last longer. Excess humidity causes rot, mildew, electrical problems, etc.
5. *Healthier lungs.* Spores, mold, dust and other irritants that could cause farmers' lung and other lung problems will be under better control (although ventilation systems as described here do not guarantee that these problems will not occur).

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