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Introduction

All livestock and poultry buildings require continuous ventilation 365 days of the year to maintain a healthy and productive environment. Since there are so many choices for ventilating a particular building, it is important to carefully consider all the options available. Economics will often play a significant role in this decision-making process. However, cheapest does not always mean most economical.

Figure 1. Automatically controlled, natural ventilation barn with chimneys, vertically-sliding sidewall panels and windbreak skirt.

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Personal Preference

Personal preference has a major influence on the success of any ventilation system. A producer must like the ventilation system if it is going to perform over the years. Buying a ventilation system based strictly on low price is generally not a wise economic decision in the long run. A first-time buyer may be most interested in purchasing a complete ventilation system from a company that will install and service it. Experienced producers or handymen may find more satisfaction in selecting the various components and completing the installation themselves. Some producers like natural ventilation - some do not. If noise is a concern, natural ventilation will have appeal. Less maintenance may also sway some producers to consider natural ventilation. These are just a few of the many personal preferences that can and should

influence the type of ventilation system chosen regardless of economics.

Building Insulation

For warm, environmentally controlled buildings, a well-insulated building is always easier to ventilate than one with too little or poor insulation. A well-insulated building will be easier to heat in the winter and allow a greater exchange of air. Similarly, adequate insulation will prevent excess solar heat gain in the summer months and lower the incidence of animal heat stress. Although insulation can be costly and inconvenient to install, it will provide animal performance benefits over a number of years and allow better ventilation regardless of system choice.

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Building Layout and Surroundings

Although any building layout can be ventilated, some are easier than others. For example, a large, multi-room swine complex may require air ducts to get fresh air in and exhaust air out. This can increase the capital cost, the fan energy cost and maintenance may be more complex and expensive. A building layout giving the pens more outside walls would reduce the duct work required.

Building surroundings that allow free movement of the summer winds give the barn an excellent opportunity to be ventilated naturally with the automatic vent panels now available. If located upwind of the structure to be ventilated, obstructions like other barns, silos and woodlots can all negatively impact natural ventilation.

Equipment Considerations

Most ventilation suppliers offer a wide range of products and options. This is to satisfy the many different barns and ventilation designs employed, as well as address customer preferences and cost considerations.

Durability:

Manure gases and respired moisture from the livestock or poultry readily combine to create a corrosive environment for all metal components. Thus sheet steel used for fan housings and air inlet baffles tends to "rust out" quite quickly. Materials like plastic, cast aluminum and fibreglass will easily last twice as long and therefore may be more economical in the long run. Be sure to purchase totally enclosed motors with sealed ball bearings to keep out dust and moisture. Open motors with sleeve bearings are generally not suited to livestock environments. Insulated curtains for naturally ventilated barns may be less costly than the rigid, insulated panels but are more subject to wind and tear damage which will reduce their useful life. Thermostatic controls are becoming more durable with better dust and moisture seals. Since this component controls the ventilation system, many producers are willing to spend extra money for durability and reliability in this area.

Amount of Maintenance Required:

Generally speaking, the more moving parts there are, the more maintenance there will be. Most people would agree that natural ventilation systems require less maintenance than fan-type systems. Both types of ventilation employ adjustable air inlets and thermostatic controls but mechanical fan ventilation also has all the fan motors, blades and louvres to maintain and keep clean.

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Ventilation Expertise

Consult with a knowledgeable designer and/or supplier. Select one who has experience with the type of ventilation system you are considering and the type of building you wish to ventilate. You might choose to hire an agricultural engineer to design your ventilation system. This would allow you to mix and match various components from different suppliers to obtain a customized ventilation system for your barn. Many ventilation equipment suppliers and some farm building contractors do offer a ventilation design service.

Dealer Service

Due to the requirement for continuous ventilation and the need to minimize repair time, a ventilation supplier with a good parts inventory and reputation for prompt service is an important consideration.

Larger producers will often maintain their own inventory of commonly needed replacement parts such as fan motors, thermostats and inlet cable.

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Operating Costs

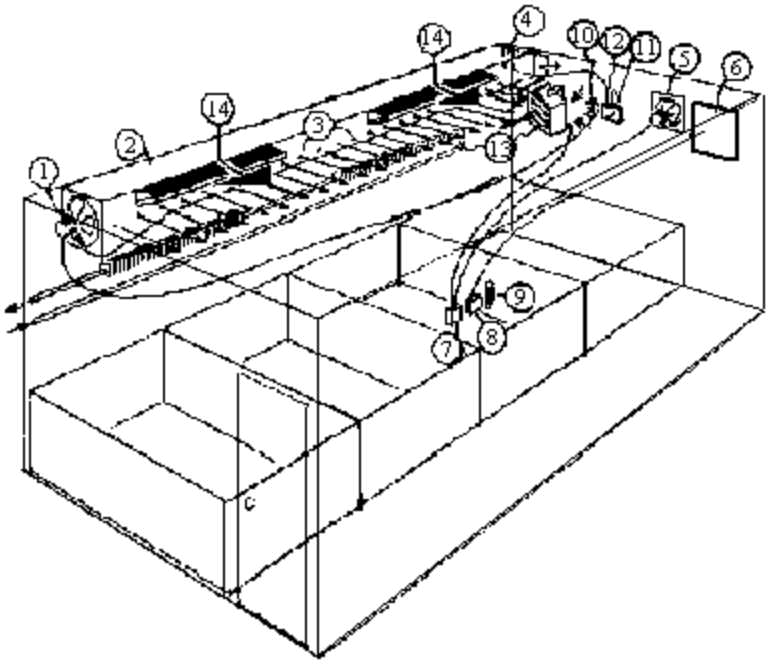
Proper Equipment Sizing and Control

Excessive ventilation in the winter months expels extra heat and can drastically increase heating costs. This can occur because of over-sized fans or poor control of the fans or natural ventilation openings. Under ventilating a barn in the winter yields poor air quality with high humidity and odours which can lead to sick animals and a building deterioration problem. Under ventilating a barn during warm weather can result in a hot barn with heat stressed animals that in turn do not produce for you. All of these outcomes can be extremely costly and should be charged to the ventilation system - natural or fan ventilated.

Type of Ventilation System

Table A indicates that very little electrical energy is required to monitor the building temperature regardless of which ventilation system is chosen. However, the electrical energy demand to operate the air inlets and the exhaust fans can vary significantly between the various types of ventilation systems. On-farm metering has shown that only 2 to 5 kWh per year is consumed by each actuator operating a sidewall vent panel or chimney in a naturally ventilated barn. A similar quantity of energy will operate a sidewall baffle type air inlet in a fan ventilation system. On the other hand, self adjusting air inlet baffles do not require any electrical energy.

Figure 2. A complete cross-flow fan ventilation system for a small livestock room showing the air inlets, exhaust fans, controls, internal air circulation and supplemental heat.



1. Recirculation + step 1 fan
2. Recirculation duct, sized
3. Recirculation air holes
4. Step 1 exhaust air slide valve
5. Step 2/step 3 exhaust fan
6. Step 4/step 5 summer exhaust (shown covered and sealed for winter)
7. Heat/cool interlocking thermostat
8. Two-state thermostat for fan (6)
9. Max/min thermometer
10. Manual speed control for recirculation fan (1)
11. Manometer
12. Manometer tube from attic
13. Various heating options
14. Self-adjusting fresh air inlets

Table A. Ventilation Functions Requiring Electrical Energy

Ventilation Function	Natural Ventilation	Cross-Flow Fan Ventilation	Fan Powered Intake and Exhaust Ventilation (*1 & 2*)
Monitor Building Temperature	Negligible	Negligible	Negligible
Operate Inlet Openings	2-5 kWh/yr/actuator	2-5 kWh/yr/controller	3,000-4,000 kWh/yr/ventilator
Operate Exhaust Fans (*2 & 3*)	Nil	(small) 1,000-2,000 kWh/yr/fan (med.) 3,000-4,000 kWh/yr/fan (large) 5,000-10,000 kWh/yr/fan	3,000-4,000 kWh/yr/ventilator
Operate Internal Air Circulation Fans (*2 & 4*)	3,000-4,000 kWh/yr/fan	3,000-4,000 kWh/yr/fan	Included above

1. *A typical 18" fan powered intake and exhaust ventilator with recirculation was considered. Other units are available*
2. *Due to wide range of energy consumption for various fans, should consult manufacturer for specific data*
3. *Small fans less than 2,000 cfm; med. fans 2,000-5,000 cfm; large fans over 5,000 cfm. Energy consumption stated for continuously running fan 24 hrs/day, 365 days/yr*
4. *Typical 3,000-4,000 cfm basket fans assumed for internal air circulation*

Conversely, every exhaust fan, depending on it's size and efficiency, will consume between 1,000 and 10,000 kWh in a year if it operates continuously (24 hours a day, 365 days of the year). Although not as common, fan-powered air intake and exhaust ventilators use an additional fan to blow air into the building and distribute it as well as recirculate room air. For this reason, these units will consume additional energy. Sometimes this type of system will be used to maintain consistent air quality during the autumn, winter and spring periods of low ventilation rather than operate internal air circulation fans. If internal circulation fans and/or ducts are utilized, they can consume a similar quantity of electrical energy as do the exhaust fans.

Energy Efficiency

With ventilation systems, energy efficiency can be expressed as the amount of air flow achieved per unit of electrical power consumed. For natural ventilation systems, the actual quantity of air flow is hard to establish but since the quantity of electrical energy consumed is so negligible, the system is considered extremely energy efficient - much more so than any fan ventilated barn could achieve.

However, energy efficiency is a very important consideration in all fan-powered systems. **Table B** which lists some typical 18 inch diameter fans, shows the tremendous range of both air-flow capacity (CFM) and energy efficiency amongst fans.

Comparing the operating cost of Fan B and Fan C, if both fans operate 50% of the year, one finds that the more efficient Fan C will save $21 in hydro costs per year.

Fan B: 0.402 kWh x 12 hr./day x 365 days/yr. x $0.08/kWh = $140.86

Fan C: 0.342 kWh x 12 hr./day x 365 days/yr. x $0.08/kWh = $119.84

Providing Fan C does not cost considerably more than Fan B, it is a very wise choice over Fan B for an air flow rate of 3100 CFM. If more air flow is desired, then Fan D is a better choice yet. Please remember that energy efficiency will pay back much slower if the fans in question are only used a small quantity of time per year e.g. larger summer fans. Conversely, continuous running fans will give a very quick payback for increased energy efficiency.

Table B

Fan Model	Air Flow Capacity CFM	Power Consumption KWh	Energy Efficiency CFM/Watt
A	2100	0.229	902
B	3080	0.402	7.7

C	3150	0.342	9.2
D	3580	0.328	10.9

Source: PAM1 Ventilation Fan Test Reports (*Prairie Agricultural Machinery Institute, Humboldt, Saskatchewan*)

Also, one should be aware that dirty fan blades and louvres can reduce fan output by up to 30%. Not only does this drastically change the energy efficiency rating but can also severely impact the effectiveness of the total ventilation system. All ventilation equipment and controls must be kept clean to function properly.

Yearly Energy Consumption

Table C provides an estimate of the yearly energy consumption per animal space for both exhaust fans and internal air circulation systems. Not only does the quantity of internal air circulation vary greatly, but also room size and animal type has a large influence on the amount of energy consumed. The internal circulation system is assumed to be operating continuously, 365 days of the year. In practice, this system may only operate through the cooler months or in some naturally ventilated barns may only be used to enhance summer air movement.

This table can be used to help estimate the operating cost of fan ventilated barns when multiplied by the current cost of electrical energy.

Table C. Yearly Ventilation Energy Consumption Per Animal Space in Barn (kWh)

Animal Type		Exhaust Fan Energy	Circulation Fan Energy*
Dairy Cow	Year round housing	226	85-110
	Fall/winter/spring housing	142	55-75
Dairy Calves		102	70-110
Swine	Gestating Sows	59	20-30
	Farrowing Sows	180	100-130
	Weaning Pigs (7-25 kg)	25	8-17
	G-F Pigs (> 25 kg)	32	6-10
Horses	Fall/winter/spring housing	120	100-145
Caged Laying Hens		4.3	0.8-1.0
Broiler Chickens		0.5	0.3-0.45
Turkey	Brooding	1.0	0.5-0.6
	Growing	3.4	2-3
Sheep - Goats		20	5-7
Rabbits (per doe)		23	7-10

* Circulation Fans running 365 days per year.

Example Calculation:

To determine the yearly energy consumption and cost for a 500 grow-finish swine barn (36' x 120') with fan ventilation, one would proceed as follows: 500 pigs x 32 kWh/pig space x $0.08 kWh current energy cost = $1,280 per year. If the barn has an internal air circulation system running for 8 months of the year, the additional operating cost could be 500 pigs x 10 kWh/pig space x 240 days/365 days per year x $0.08 current energy cost = $267.

For an equivalent barn using natural ventilation, the annual energy cost could be the following:

2 actuators per side = 4 actuators x 5 kWh/yr/actuator x $0.08 kWh =$1.60. This assumes the chimneys

are manually controlled. If the barn uses internal air circulation during warm weather to enhance air movement, the additional energy will be 500 pigs x 10 kWh/pig space x 60 days/365 days per year x $0.08 kWh = $65.75.

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Additional Information

A number of Canada Plan Service leaflets covering ventilation theory, equipment and troubleshooting are available at the Ontario Ministry of Agriculture and Food.

Decision Making Time

Make a list of all the ventilation system choices that are suitable for the barn to be ventilated. Include a full description of each system noting its strengths and weaknesses. Now apply the selection criteria outlined in this Fact sheet to help select the system that best meets your requirements. Visiting other barns with similar ventilation, and discussing its operation with the owner , and also be very helpful in making your ventilation system choice.

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