# Ventilation of Pre-Weaned Calf Barns

*Part 2: Overview of Methods*

## Methods of Ventilation

Air exchange can be achieved through the use of natural ventilation, mechanical ventilation, or a combination of both commonly known as natural assist. All three types of ventilation systems require carefully designed air inlets and outlets to reach recommended levels of air exchange. Natural systems rely on wind and thermal buoyancy to achieve air exchange while mechanical systems use fans. Individual barn conditions and management determine the best method of ventilation to be applied.

## Natural Ventilation

Natural ventilation can be an economical and successful method of ventilation for a pre-weaned calf barn when employed correctly. Natural ventilation relies on the availability of natural air movement, key barn characteristics that harness air movement, and proper management of air inlets and outlets to achieve air exchange. Factors that will determine the success of a naturally ventilated facility include site selection, building orientation, side wall height and opening capacity, end wall openings, eaves, roof slope, ridge opening, and insulation.

Barn site location and orientation are important considerations that affect the performance of natural ventilation systems. A site should have a natural breeze, be located on high ground, have minimal natural or man-made obstructions, and provide an adequate distance between structures.

A properly designed naturally ventilated calf barn ideally should have the barn oriented with ridge line running perpendicular to prevailing summer winds, a minimum 10-foot eave height, a continuous open ridge sized for 2 inches per 10 feet of building width (or a 12" minimum), continuous eave openings (on both sides) of 1 inch per 10 feet of building width, and both sidewalls fully openable for summer to at least 8 feet [1].

## Mechanical Ventilation

Mechanical systems incorporate the use of fans and planned air inlets/outlets to achieve air exchange through forcing air into or out of a barn. These systems are reliable, maintaining appropriate air exchange in all seasons and weather patterns, provided reliable back up power is available. Negative pressure, positive pressure, and neutral pressure are all types of mechanical ventilation systems named to describe the in-barn pressure produced based on fan location and air flow. Each should be professionally designed to provide the recommended amount of air exchange during each season based on either the number of animals housed or a standard number of room volume air exchanges per minute.

Negative Pressure Systems create air exchange through the use of fans to draw in-barn air out of the facility, creating a vacuum to pull fresh air in through planned inlets. Negative pressure systems rely on the control of air streams through the barn, and are disrupted by air entering through unplanned openings. The barn must be sealed for the fans to develop the desired negative pressure required for ventilation to occur. Tunnel ventilation in cow barns is the most widely known example of negative pressure ventilation in the dairy industry. However, much more appropriate for pre-weaned calf barns is a slatted ceiling mounted air inlet system because they don't result in drafts and can be used year-round. Other common examples of negative ventilation are cross-ventilation, where exhaust fans are placed on one barn side-wall to draw air across the width of the barn.

Positive Pressure Systems create air exchange by pushing fresh air into a barn and displacing the slightly contaminated air. Fresh air is introduced through controlled air inlets, and discharged through planned outlets to ventilate the barn. Similar to the negative pressure systems, positive pressure systems rely on controlled air streams to ensure air is exchanged in key locations within the barn. This type of system is not seen frequently in practice due to the constant positive pressure created within the barn. This pressurized environment can push moisture into a barn's structural components, requiring a well-constructed airtight building envelope to combat this common result[2].

Neutral Pressure Systems exchange air through the concurrent operation of positive pressure and negative pressure ventilation systems. The positive pressure and negative pressure systems are designed to be of equal capacity, which in turn creates a controlled air exchange system for the facility. Neutral pressure systems, when utilized require closed barns with no natural, free air flow due to the goal to control air streams between air inlets and outlets. Given the airstream control the neutral pressure system provides, it is generally applied in cold and transition seasons when the barn is closed off from natural air flow. Control of air streams provided by this system is also beneficial to providing predictable and adequate air exchange through the calf pen microenvironment.

### Natural Assist

Natural assist ventilation is when a barns predominant natural ventilation system is supplemented by a mechanical ventilation system (fans). Natural ventilation is typically supplemented to mitigate environmental stress in warm/hot seasons, or to provide a minimum air exchange during colder seasons when barns are closed off to natural air flow. Natural assist also solves the problems faced with natural ventilation when required wind speed is lower than needed for a prolonged period or difficult to capture in any given season. Assisting natural ventilation also provides the ability to control air streams to ventilate the calf microenvironment more than would be addressed by natural ventilation alone.

Fans can be used to augment natural ventilation in two ways. First, fans can be used to exhaust air from the barn, typically exhausting air upwards through chimneys or cupulas along the barn's ridge to increase air inlet through sidewalls and eave openings. Second, fans can be used to force air into the barn, displacing stale air and forcing it out of the barn. A common example of this method are positive pressure air plenums. These positive pressure tubes are typically used when forcing air into the barn to allow an even distribution of air to all areas of the barn.

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**AUTHORS**
***Jennifer Bockhahn*** jsb466@cornell.edu
***Curt Gooch***, PE cag26@cornell.edu

**REFERENCES**

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