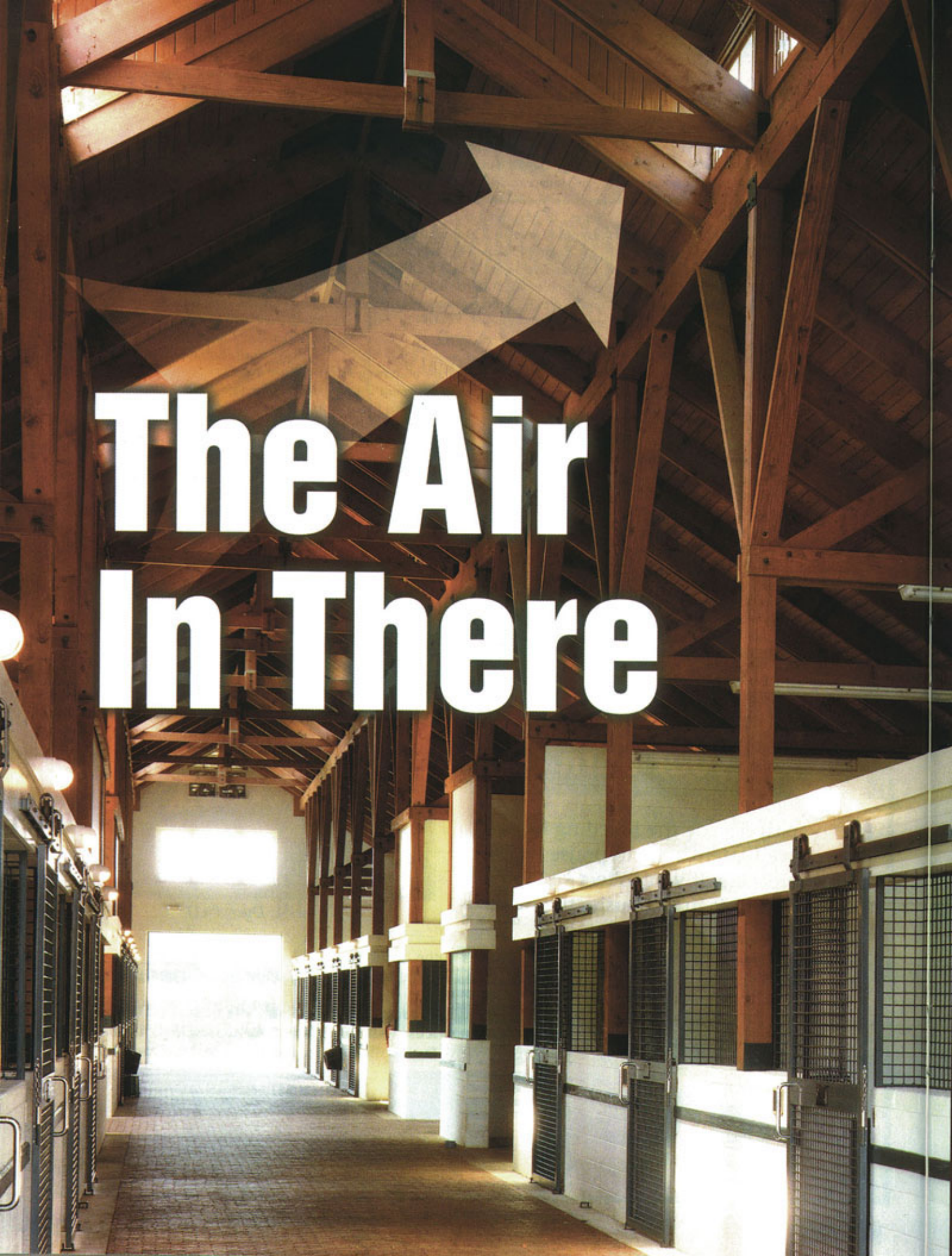
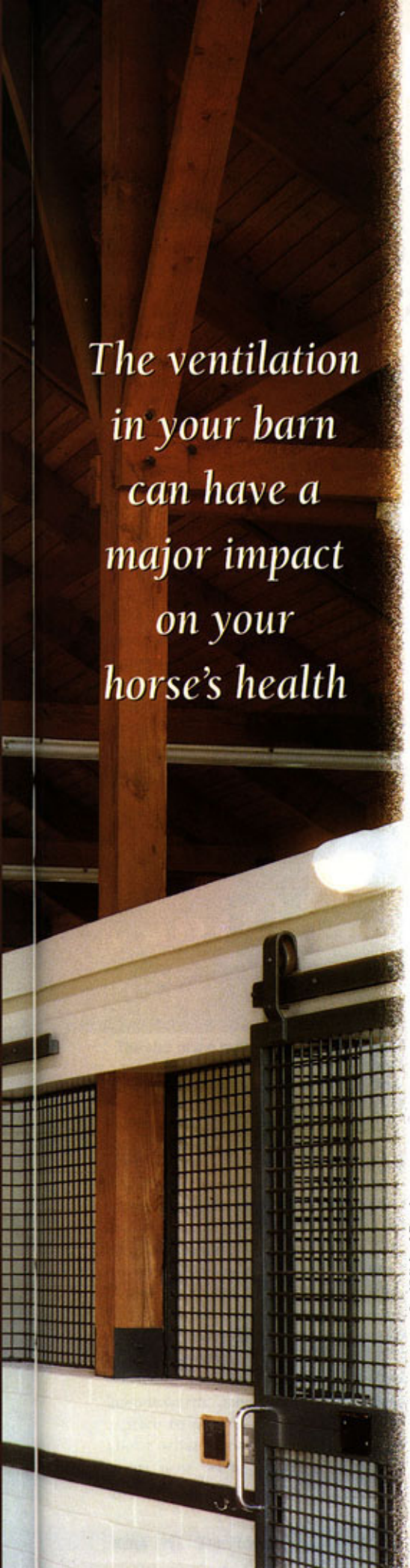


The Air In There



The ventilation in your barn can have a major impact on your horse's health

Courtesy of Blackburn Architects/Morven Stud/Michael Dersin

By Karen Briggs

Brrrrr! It's been another cold and nasty winter for many of us, and it just can't end too quickly. Close those barn doors tight again tonight, folks—there's a bitter wind blowing, and we don't need any drafts getting in through the cracks.

Or do we?

Horse owners often tend to build and manage their barns more for their own comfort than for their horses'—and horses have far greater cold tolerance than we do. What might feel chilly to us often is perfectly comfortable for our hairy friends. More importantly, we might be doing our horses' respiratory systems a grave disservice by shutting the barn up tight.

In some circumstances, horses might spend 24 hours a day in their stalls, especially when the winter weather has made ice skating rinks out of our paddocks, or spring means sticky seas of mud. The air in a barn with inadequate ventilation very quickly can become stagnant and foul. Practically everything in the environment of a barn contributes to poor air quality, from the dusts and molds lurking in hay, grain, and bedding, to the ammonia fumes emanating from urine. Fungal material, bacteria, and viruses, particles of fecal matter, even microscopic bits of plant material and insect parts, all are measurable pollutants in stables. In the middle of it all, with his nose in a flake of hay, is your horse.

Poor air quality is the culprit in a number of performance-limiting allergic responses in older horses (usually lumped under the term COPD, for chronic obstructive pulmonary disease, and more commonly called "heaves" or "broken wind"), as well as a similar response in humans (sometimes called "farmer's lung"). In addition, it recently has been implicated in certain types of non-allergic responses described as "small airway disease," which tend to affect younger horses and can have a major impact on athletic efforts on the racetrack or in the show ring.

There also is a demonstrated correlation between high antibody titres (indicating the horse's body has been fighting infectious agents) and horses who have been stabled rather than living outside.

Fortunately, we're beginning to understand how improving ventilation in barns and stables can improve or protect equine respiratory health—thanks in large part to a series of studies spearheaded by Andrew F. Clarke, BVSc, PhD, MRCVS, CEO of the Equine Research Centre in Guelph, Ontario, Canada.

A Pet Project

Clarke's interest in the effects of ventilation and air quality on equine respiratory health go back to 1984, when he began his PhD studies at the University of Bristol.

"What attracted me," he says, "was that the focus was on preventing disease and maintaining health, rather than putting out fires. The other thing was that it was a very practical area of study, with real-world applications."

As it turned out, his initial thesis work was groundbreaking; very few other researchers had looked at this issue, and Clarke's results were included in several prominent veterinary texts. "It's information that's applicable all over the world," he notes.

Respiratory health and air quality in stables have remained a pet project for Clarke ever since, and several studies stemming from that original research now are ongoing at the Equine Research Centre (with funding assistance from the Ontario Ministry of Agriculture, Food, and Rural Affairs, the Ontario racing industry, the Animal Health Trust of Canada, the J.B.W. Carmichael Respiratory Initiative Fund, and the R. Howard Webster Foundation, among others). The information that has been uncovered in these studies is having an impact on both the design of stables, and in management choices, like the selection of bedding and feed.

Air Quality

Ventilation might be one of the most overlooked requirements of horse housing around the world, partly because most other types of livestock are not maintained with either longevity or athletic performance in mind. Studies have demonstrated the detrimental effects of poor ventilation on beef cattle, for example, but such results are of little consequence because those animals generally are slaughtered in their prime. Although horses are housed in low-density situations compared to cattle or pigs, they still are subject to many of the same ventilation problems that exist in most livestock buildings—problems that are only now beginning to be understood and addressed.

The ideal barn ventilation system, says Clarke, distributes fresh air uniformly throughout the building, helps minimize your horse's exposure to environmental irritants, and provides fresh air without drafts at all times of the year. Ventilation can be achieved either naturally or, if need be, artificially (with the use of fans or duct systems). In either case, it's helpful to understand just how air tends to move in a building.

First of all, air movement (as we all know from watching the Weather Channel) is driven by differences in temperature. Cooler air tends to enter a barn through openings close to the ground. Once inside, it mixes with warmer air (which has been heated by the horses themselves or by activity within the barn). The warm air rises and tries to exit the barn through openings higher in the walls or ceilings. As it is displaced, more cool air is drawn in to replace it. This overall cycle of thermal buoyancy is sometimes called "the stack effect."

There also are two other ways in which air moves in and out of a barn—aspiration, in which air is moved by the action of the wind blowing across the roof (drawing air out through any available opening), and perflatation, a fancy name which just describes the way wind blows from side to side or end to end of a barn when openings allow it. The size of the building, the height and placement of vents or openings, and the distance between inlets (where cool air enters) and outlets (where warmer air escapes) all can have an effect on how well a ventilation system works. Other considerations include local geography and weather conditions—particularly topographical features like hillsides, hedgerows, trees, and the direction from which wind and driving rains usually come.

Air movement within a barn is beneficial because it tends to sweep away the dust and mold particles, as well as airborne viruses and bacteria, which are so much a part of the everyday environment of a horse operation. Unfortunately, our tendency to close up any gaps or openings in a barn can interfere with

normal air circulation and trap those particles inside. In addition, it might trap moisture and noxious gases. Most of us have been in a barn in which condensation has collected on the ceiling, sometimes even dripping on our heads as we walk down the aisle. Water stains and drips are classic signs of a poorly ventilated barn (and, of course, a damp environment encourages the growth of fungal spores).

"Whenever you close up a building to keep it warm," says Clarke, "the lungs have a price to pay. We understand a lot now about what happens when ventilation is poor; now we're looking at the consequences."

Courtesy Lucas Equine Equipment

Inside The Lungs

We need to understand the normal equine respiratory function. With each breath a horse takes, air enters the nostrils and is warmed and humidified prior to entering the trachea (windpipe). Here at this early stage, large dust or mold particles are prevented from going farther into the respiratory system when they are trapped by the turbinates (blood-rich scrolls of bone at the entrance to the trachea).

From the trachea, the air travels down to the lungs, through an ever-decreasing series of passageways that branch off like broccoli florets. Larger airways are called bronchi; smaller ones are bronchioles, which eventually lead to the alveoli or alveolar sacs, where gas exchange (the process by which oxygen passes through membranes and into the blood, for circulation throughout the body, while carbon dioxide is passed back into the lungs for disposal) occurs.

The lung's passageways are lined with cilia, microscopic hairs that function to trap smaller irritant particles and to move mucus up from the depths of the lungs. There also are groups of lymphoid cells that help launch immune responses to infectious agents. The final line of defense lies in the alveoli, where macrophages wait to clean up microscopic dust and mold particles as well as bacteria and viruses that make it that far.

Ordinarily, the respiratory system's natural defenses work very well to protect your horse from disease. But in a sufficiently polluted environment, these defenses can be overwhelmed. For example, heavy burdens of dust can decrease the ability of the macrophages to fight infectious agents and leave the animal prone to respiratory diseases, such as influenza, strangles, or equine herpesvirus.

Nuclear medicine studies at the Equine Research Centre have shown that following a bout of influenza, equine lungs can take up to a month to recover fully. The cilia lining the airways are compromised long after the horse appears healthy again. During this invisible recovery period, horses are extremely sensitive to the inhalation of airborne pollutants—and no wonder, with the average horse taking in approximately five liters of air in a single breath, or about 60 liters per minute.

Sensitivities to dusts, molds, and other inhalants vary a great deal, as most horse people know. There is little we can do to predict which horses, exposed to the same environment, will develop signs of allergies or COPD, and which will not. Likewise, it can be difficult to assess an individual horse's natural resistance to airborne viruses and bacteria—until he catches a respiratory bug. As a result, there is no one "threshold" level that will tell us whether a barn's ventilation is adequate or not. Even less well understood, at this point, is what factors might be behind the development of non-allergic small airway disease (also known as lower respiratory tract inflammation, or LRTI), which often appears in young racehorses. But by identifying some of the common culprits, we are well on our way to making improvements in our horses' environments.

Sources Of Contamination

According to the Equine Research Centre's studies, hay is the single most common source of dust and mold spores in the stable. Susan Raymond, research associate with the Respiratory Health and Air Quality project at the ERC, explains that in one study, Clarke's team compared the relative dust levels of five different types of forages: dry hay, water-soaked hay, haylage, hay cubes, and a complete feed pellet. Particles of two sizes were measured—those between one and two microns in diameter (a size at which particles can potentially lodge in the alveoli), and those between two and five microns in diameter (a size which allows particles to reach into the deep airways of the lungs, but probably not the alveoli). Dry hay, even that which by visual inspection looked to be of very high quality, consistently demonstrated dust levels dozens of times higher than hay cubes or pellets, both in terms of small diam-

eter particles and large ones. All of the other forage types generated significantly less dust. Interestingly, hay that had been soaked (a traditional horseman's treatment for dusty hay) did show a major reduction in particulates, although, of course, soaking a poor-quality, moldy hay in water will not make it any less moldy. Haylage (hay fermented and packaged in airtight plastic) also is low in dusts and molds if properly preserved, but it must be carefully managed—any haylage that smells of ammonia, contains dirt, or comes from a punctured or damaged bag should not be fed, and opened bags of haylage should be fed within a couple of days; otherwise, the risk of botulism is unacceptably high.

Bedding is another major source of inhalant particles in the equine environment. The worst offender, according to the ERC studies, is straw. Even the cleanest of wheat straw, it has been found, contains significantly smaller, respirable fungal spores than most other beddings, such as shavings, peat moss, or shredded newspaper. Deep litter bedding systems, whether done with straw or shavings, are another major mold-producer; they allow molded bedding and fecal material to accumulate, and have the added disadvantage of allowing the buildup of noxious gases (such as ammonia), not to mention more infectious bacteria and larvae of internal parasites.

"One of the worst things you can do," adds Clarke, "is to put your shavings pile, or the chute that brings the shavings down from the loft, right next to your horse's stall."

Kelly Counsell; Susan Raymond inset

Dust sampling device on a horse's halter (above). (Below) Dust from a hay sample being examined for mold spores (shown in inset).

Kelly Counsell

Such a setup may mean your horse is inhaling irritant particles for hours every day.

One type of bedding that the ERC demonstrated to be unusually low in dust was paper bedding made from shredded telephone books (safer than shredded newspaper because it did not contain any glossy advertisements, which sometimes are printed with inks containing heavy metals). It proved not only low in dust, but was also easy to work with (largely because it was shredded in small squares roughly the same size as cedar shavings) and very absorbent. The amount of airborne particles generated during mucking-out with this bedding, according to Raymond, was consistently much lower than with straw bedding in a direct comparison, both in poorly ventilated and well-ventilated barns.

Grain can be another source of airborne pollutants in the barn, especially when stored in bulk and under less-than-ideal conditions, which can allow the growth of fungi and molds. Needless to say, any grain that shows the slightest indication of being moldy should not be fed—quite apart from the internal upset, the number of spores a horse would inhale at the first bite represents a serious health threat to his respiratory tract.

Another factor that can influence air quality is whether your barn has hay stored in a loft above the stalls. Old bank barns, in particular, might have rotted floorboards, which allow chaff and dust from hay stored above to sift through. The risk is particularly high when old hay and bedding from many years past form a layer on the loft floor, providing an ideal environment for fungal and mold growth, as well as a hiding place for rodents, sparrows, and other uninvited residents. Consider, too, how the dust levels in your barn can increase if you have an attached indoor arena. If you and your horse come in from working in that arena coughing and coated with dust, it's a safe bet those particles are floating in the atmosphere and irritating the respiratory passages of every horse in residence.

Courtesy of Blackburn Architects/ Morven Stud/Michael Dersin

Making It Work

How can you improve the air quality in your barn? Often, a combination of simple solutions is enough to do the job, says Clarke. He and his team often are called upon to assess existing horse operations and make suggestions for change, and to assist in the design of ventilation systems for new barns.

A simple walk through the barn is a good start, according to Clarke. Look for the obvious—is the shavings pile, or a large hay shed, right next to the barn, for example? Even

worse, is the manure pile positioned right next to a window?

Is there an obvious smell of ammonia as you enter? (To get a better idea of the fumes your horse is likely to be inhaling, try sitting on the floor of the stall for 15 minutes or so. Horses spend a good part of their time with their heads lowered, eating hay, lying down, or sorting through their bedding. Getting your nose at their level can be quite an eye-waterer.) Do you see signs of mold in the hay or bedding? Is there a history of lung problems in the horses who live there? Do any of them have chronic coughs? Do you start to sneeze after a few minutes?

In order for the ventilation "stack effect" to function as we'd like it, barns should have inlets (vents) placed under the eaves, with outlets higher up in the roof (a cupola, or series of cupolas, along the roofline, is one popular arrangement). Just how big these vents should be, and how far apart they should be spaced, depends on how large the barn is, its location, the local climate, and a number of other factors discussed earlier. In a mild climate, they might take the form of open windows; in a colder one, screened vents or louvers that can be adjusted to open or close, and prevent drafts, might be a better option. (It's important to note that young foals are much more vulnerable to chilling from cold drafts than are adult horses. Foaling stalls, therefore, should be positioned toward the center of the barn, well away from doors. It's a good idea to consider installing quartz-halogen heat lamps, particularly if you expect to have foals born in the winter months.)

One dramatic way to demonstrate whether the ventilation in a barn is adequate is to use a "smoke puffer," a small device that fills the barn with (harmless) smoke and allows you to watch how fast it dissipates—and where it goes.

"It's very graphic to the barn owner," says Clarke, "because you can see which areas of the barn may have stagnant air, and how fast the atmosphere clears. We look for an 'air change rate' of about six to eight air changes per hour, as a minimum—one air change being the time it takes for the smoke to completely disappear from the barn."

Another method used by the ERC research team is a small monitor attached to the halter next to the horse's nostrils. Borrowing technology used to assess air quality in underground mines, these monitors often are used in human health and safety studies. In the case of barn ventilation research, they can provide a picture of how many, and what types, of particulates a horse inhales in the course of an average hour or day. A battery-powered pump attached to a girth or surcingle provides the power as the monitor samples a consistent volume of air per minute; a small filter traps particles, making the pump work measurably harder as it becomes clogged with pollutants. The filter yields even more information—not only can it be examined microscopically to identify the type, shape, and quantity of the particles trapped on it, but it can also be cultured to discover which bacterial or viral agents are present.

Gases in the environment can be measured in a similar way. Ammonia is the main concern in horse stables. An inhalable, toxic gas, it can inhibit movement of the cilia in the horse's respiratory passages, affecting their ability to remove dust. It also irritates the eyes and mucous membranes of both horses and humans. When stalls are not mucked frequently or thoroughly, ammonia can build up very quickly in an airtight barn. While its distinctive sharp odor is always a tip-off, its levels also can be measured by use of color-changing crystals, housed in a small test tube and safely clipped to a horse's halter.

Particle counters, which use light-scattering techniques to identify the size and number of airborne particles, are another tool in the air quality arsenal. They can be set up practically anywhere in a barn for sampling at pre-set intervals and volumes of air, and have yielded much of the information on dust levels in feeds and bedding in the ERC research.

Finally, examining the symptoms of horses with respiratory distress can tell you a great deal about the source of the irritation. The outward signs of a horse suffering from a respiratory virus, and one suffering an allergic response to airborne pollutants, might be very similar, for example, but Clarke notes that a culture of the mucus from the respiratory tract should always be taken to determine whether there is an infectious bacterium or virus at work. This is particularly important because different respiratory diseases respond to different treatments—and some of the treatments for allergic responses (particularly those which involve cortisone or other steroidal drugs) can suppress the immune response, a potentially disastrous effect for a horse battling a disease!

With all of these options at our disposal, it's not difficult to assess the air quality of a barn. Even so, it's impossible to nail down one threshold "safety" level for all horses. Clarke explains, "It's like trying to determine a 'safe' level of cigarette smoke. Sensitivities differ…so the best approach is just to minimize all the potentially damaging effects as much as possible."

Simple Solutions

How to do that? Take heart—it's frequently a matter of small changes, rather than rebuilding your whole barn. Making sure you only use the best-quality hay and bedding is a good start. Consider a switch to a less-dusty program, including hay cubes or pellets. Just about any bedding other than straw or sawdust might be something to consider, particularly if you already have horses with chronic respiratory problems. There is much benefit to soaking any hay you feed indoors, even if it's of very high quality. Move that manure pile farther from the barn, store the bedding and hay in a separate building, and resist the temptation to close every crack and cranny of the barn up tight when the weather gets chilly—instead, try blanketing your horse and allowing a little breeze to come through.

"Natural ventilation is cheapest and best," says Clarke. "We've consulted on the building of very large barns equipped only with natural ventilation, and it works very well."

Natural ventilation is mostly about making sure there are inlets and outlets. If your barn isn't equipped with vents, consider adding some. A builder or architect can help make recommendations as to how many you'll need, and where you should place them for maximum air flow without drafts. There also are software programs that can help you make these design decisions yourself.

If natural ventilation alone won't do the job (as it might not if your barn is sheltered by a hill, for example), you might need to look at some mechanical assistance. Ceiling fans are one solution; or you might want to install a duct system complete with particle filters that can help trap atmospheric particulates before they reach your horse's nostrils. Duct systems are most applicable for very large barns, where air might not circulate from one end to the other very efficiently without help.

Insulation can be a boon in a horse barn; the extra couple of degrees of heat it helps conserve inside the building encourages thermal buoyancy and can increase the number of air changes per hour. If your barn is not insulated, consider adding some insulation; It will also help keep your water pipes from freezing in the winter, reduce condensation on the walls and ceilings, and keep the barn cooler in summer.

Here's one we rarely think of in terms of barn construction: sunlight. Ultraviolet light from the sun is a potent killer of a wide range of airborne viruses, bacteria, and even parasite eggs and larvae. Windows and skylights, used liberally throughout the barn, can be real contributors to a healthy environment (not to mention saving you electricity). If you decide to install skylights, use plastic or U/V light translucent glass, rather than normal glass. Both allow more of the useful U/V rays to come through.

Works In Progress

There is still much to explore in the field of air quality and respiratory health. The latest research focus at the ERC is a project entitled, "An investigation of the levels of selected mycotoxins found in the diet of performance horses," due to begin in the summer of 1998, with funding from the E. P. Taylor Equine Research Fund and collaboration from the University of Kuopio in Finland. Mycotoxins, poisonous compounds produced by some molds present in hay, might contribute to immunological, reproductive, digestive, and respiratory disorders in horses which inhale or ingest them. They can increase to dangerous levels when hay is grown in extreme environmental conditions (such as drought or rain followed by cold weather). The upcoming ERC study hopes to identify the impact of new production methods on the nutrition of the resulting forages, and the risk factors for the growth of mycotoxins. The effect of typical storage periods will also be examined. Researcher Susan Raymond notes that the ERC currently is looking for Ontario farmers who wish to participate in the study. If you are interested, please contact the ERC at 519/837-0061.

The Respiratory Health research team is happy to address your questions or concerns about air quality and barn construction. Please feel free to call the ERC, or visit its Website at http://www.erc.on.ca.