Sheep Facilities and Moisture

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Lambing in barns helps increase lamb survivability; however, for many keeping a barn comfortable and dry is a challenge. Providing dry, draft-free facilities is key to healthy lambs and ewes mitigating respiratory issues. However, extreme cold or transitional periods such as winter turning into spring and dealing with fluctuating temperatures from frigid to warm, may create issues of excessive moisture in barns. The 100-dollar question is "how do I prevent these issues". While moisture issues are barn specific, understanding the basics may help pinpoint an issue.

To really understand the issue, one must look back to middle school science. We are all aware that air holds moisture (humidity), and water is made up of molecules that exist in 3 states solid (ice), liquid, or gas (vapor) depending on the temperature. These states affect how much moisture air can hold with warm air having the greatest moisture capacity. Moisture issues in barns are the result of condensation. Simply put condensation is a change in form from a gas (vapor) to a liquid that often occurs when there is a difference in air temperature (such as warm, moist air hitting a cold steel barn roof). Moisture comes from a variety of sources including the sheep, ambient air (humidity), bedding, and leaky waterers.

Making barns comfortable and dry is a balancing act of air temperature, humidity, and ventilation. In addition, it's helpful to have even air distribution throughout the barn. Periods of extreme cold and/or fluctuating temperatures make moisture issues more of a challenge. For example, in frigid temperatures buttoned up barns stay warmer at the expense of less ventilation trapping moisture, increasing humidity, and creating an unhealthy environment. Ventilation draws in cooler, drier air and expels warm moist air, keeping the barn dry but potentially too cold for lambs. Unfortunately, there is no silver bullet other than to find that balance of temperature and ventilation rates. A couple of options that could help maintain that balance would be to add heat or increase the amount of insulation to the barn.

Adding heat would help maintain a comfortable temperature while allowing for proper ventilation. However, it is a costly option increasing overhead. Furthermore, depending on the type of heater used, it could add moisture to the environment (Table 1). But in general, heaters are an effective way to raise barn temperatures without adding too much moisture, compared to packing more animals in a barn. For lambing barns, an ideal heat source would be a radiant heater.

Table 1. Heat type and moisture expelled

Heat Type	1-lb of Propane burned	1-lb Natural gas burned
Heat released from 1-lb fuel burned	21,564 Btu	19,500-22,500 Btu
Moisture produced from fuel burned[1]	1.64 lb	2.25 lb
Daily heat equivalent of 175-lb ewe[2]	2.3 hd	2.1-2.4 hd
Daily moisture equivalent of 175-lb ewe[2]	0.62 hd	0.85 hd
Daily heat equivalent of 22-lb lamb[2]	8.8 hd	7.9-9.2 hd
Daily moisture equivalent of 22-lb lamb[2]	2.48 hd	3.40 hd

[1]This is moisture generated from direct venting into the barn
[2]Heat and moisture generation data were acquired from House (2001).

The second option to help maintain a comfortable temperature would be to increase the insulation of the barn. When done properly insulation can potentially decrease the formation of condensation on walls and roofs of barns making it drier by simply keeping the barn warmer and increasing the air moisture holding capacity. To get an idea of how insulation can help let's model a 30' (W) x 52'(L) x 10' (H) steel barn in a few different scenarios. We will assume the barn meets a minimum ventilation requirement of 25 cfm per 1000 lb or 0.63 air changes per hour (H. H., ed. 1994). and that this barn is designed to house 40, 165-pound ewes. We will consider the following scenarios.

Scenario

A: Steel structure has no insulation resulting in considerable heat loss through the walls and ceiling

B: Steel structure has an R2 value insulation in the walls and ceiling (current MWPS plan recommendation)

C: Steel structure has an R6 value insulation in the walls and ceiling

D: Steel structure has a 1-inch spray foam (R6 value) on ceiling only

E: Steel structure has a 1-inch spray foam (R6 value) on the ceiling with basic R2 value insulation on the walls.

The amount of heat produced by a sheep is affected by many factors, e.g., nutrition, body fat, fleece, and by the environmental temperature. After estimating this heat produced from a 40-head flock an uninsulated barn (Scenario A) could only keep the temperature slightly above outside air temperature (Figure 1). This is due to the large surface of uninsulated walls and ceiling. Adding an R2 (Scenario B) insulation to the walls and ceiling would greatly improve the ability of the building to hold heat. A further improvement would be made by adding an R6 (Scenario C) to the ceilings and walls but would increase the price to insulate. The current MWPS plan recommends having a minimum R2 value insulation on the walls and ceiling. However, we need to remember that warm air rises and condensation forms when there is a difference in building surface temperature and air temperature. In a Midwest climate warm moisture air hitting a cold, steel roof can cause condensation that will fall back into the barn creating damp conditions. Therefore, the ceiling should be an area of concentration for insulation. Insulating the ceiling with a spray foam (R6 value) and a basic R2 insulation on the walls (Scenario E) creates a tight, warmer barn that would be slightly cheaper than insulating the entire building with an R6 insulation. The last scenario would be Scenario D, this demonstrates a ceiling only R6 insulation. This barn would only be slightly warmer than Scenario A without insulation. This is simply due to the large amount of heat being lost through the walls. However, even though the barn temperature would not be that different from an uninsulated barn it would help minimize condensation forming on the ceiling and moisture from raining in the barn.

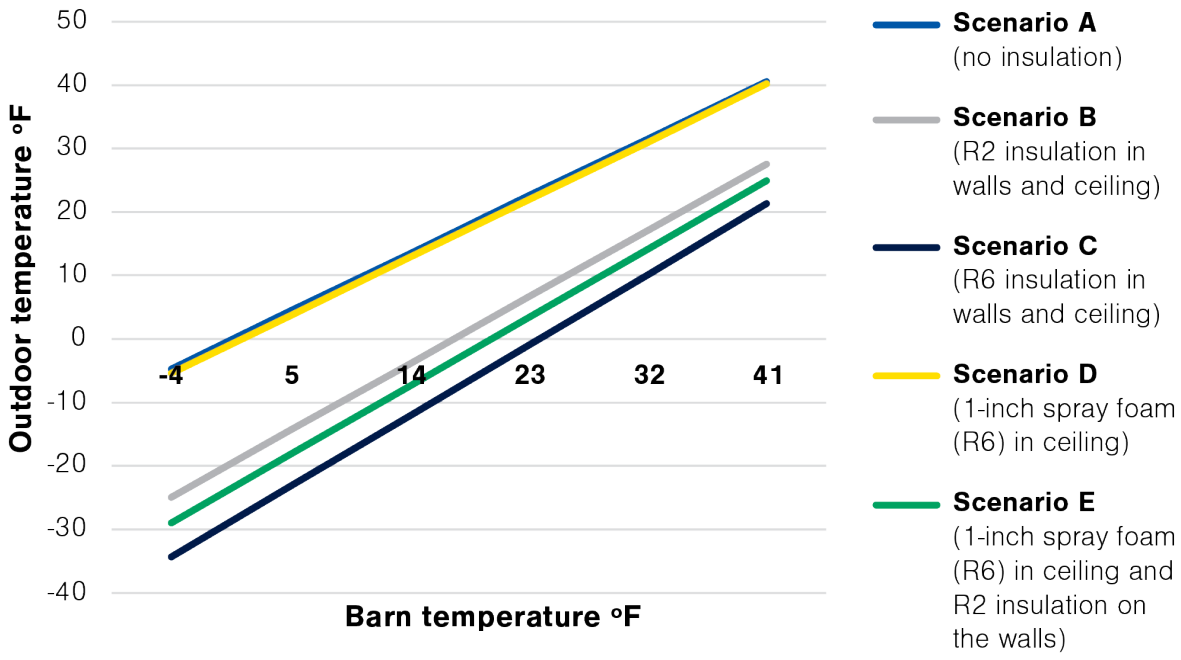

Figure 1. Estimated barn heat balance with various insulation.

It is important to understand the basics of condensation and moisture holding capacity of air based on temperature. Besides adding heat or insulation to help maintain the balance between temperature and moisture, producers can consider a few control tips. These include:

- Shearing ewes prior to housing indoors for the winter. Wool can hold up to 30% of its weight in moisture, meaning a sheep with 7 pounds of wool can potentially also hold up to 2.1 pounds of water.
- Fix any source of dripping or leaky waterlines/ water fountains as this can add more humidity and moisture.
- Consider grinding bedding materials such as straw. As moisture enters through the cut ends, larger straw stems take more time to absorb moisture and longer to dry out.
- As winter moves into the spring period of freeze/ thaw and the days heat up, use it to your advantage to increase barn ventilation drawing out moisture laden warm air during the day. Unheated barns can be cooler inside than outside during day temperatures leading to more condensation.
- Lastly, note any drainage issues or potential barn environmental issues experienced that can be addressed later.

Whether you are considering building a new or renovating an old barn, make sure to consider the balance of temperature and moisture to ensure the barn will provide an environment ideal for the type of animals being housed. Thoughtful planning can mean a healthier barn, healthier animals, and increased profits.

Definitions

Ambient air humidity or relative humidity: concentration of water vapor present in the air

Condensation: When warm, moist air hits a cold surface (with temperature lower than the air's dew point).

R-Value: The R value of insulation defines how well heat can be kept from entering or leaving a building. The higher the R value the better the insulation properties are, and typically the greater the expensive of the insulation.

References

Simão, B. R., Maia, A. S. C., Castro, P. A., Moura, G. A. B., & de França Carvalho Fonsêca, V. (2017). Estimation of the body surface area and its impact on the heat transfer by convection in sheep: a computational way.

Leso, L., P. F. P. Ferraz, G. A. S. Ferraz, G. Rossi, and M. Barbari. 2021. Factors affecting evaporation of water from cattle bedding materials. Biosystems Engineering 205:164-173.

H. H., ed. 1994. Sheep Housing and Equipment Handbook. MidWest Plan Service, Agricultural and Biosystems Engineering Dept., Iowa State University, Ames, IA.

House, H. K. (2001). Ventilation of sheep structures. Accessed at http://ablamb.ca/producer_mgmt/Setting-It-Up-Sheep-Infrastructure/4-Utilities/4-2-Ventilation-of-Sheep-Structures.pdf

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