Design and Ventilation Considerations for Dairy Goat Housing

Overview
- Facility options
- Remodeling buildings for goats
- Pen design criteria
- Feed and water space requirements

Permanent shelter options
- Hoop barns/greenhouses
- Post frame buildings

Acknowledgements:
Thanks to Dr. David Kammel (Ret) University of Wisconsin, Madison for providing information, photos, and supporting materials.
Permanent shelter options

Remodeled barns

Semi-permanent/portable shelter options

Carports

Portable shelter options

Porta huts

Portable shelter options

Portable buildings
Facility design criteria

✓ Fits management plan
✓ Provides clean, dry environment for all management groups
✓ Plenty of fresh air, feed, and water
✓ Labor efficient
✓ Economical
✓ Safe for workers and goats
✓ Environmentally friendly

Develop a management plan

1. Define management group and number in group.
2. Determine animal needs.
   - Comfort and ventilation
   - Nutrition and feeding strategy
   - Health care and treatment
   - Movement between groups
   - Manure Handling
3. List needs (and wants) of the owner and employees.
4. Determine features that meet these needs and wants.
5. Prioritize the list of features.

Is renovating worth it?

Will remodeled buildings:
• Fit with the management plan?
• Provide animal comfort?
• Improve labor efficiency?
• Allow for expansion?
• Be cost effective?

Think critically about your resources

Do you have adequate:
- Land?
- Feed?
- Labor?
- Manure storage?

Photo credit: Dr. David Kammel, UW-Madison
Possible limitations

• Structural issues
• Bad location
• Low ceiling height
• Stuff in the way
  – Posts, walls, gutters
• Water
  – Access, corroded pipes
• Old/undersized wiring
• Poor/no ventilation

Pen design criteria

Provide a safe, comfortable, and healthy environment

• Space to rest and exercise
• Clean and dry resting space
• Adequate feed and water
• Draft free fresh air
• Manage temperature extremes
  • 50 - 60°F adults (0 - 55°F no production affects)
  • 54 - 65°F kids

Fencing and dividers

• 4 to 5 ft high for does, 6 ft for bucks
• Wood ok but will need maintenance
• Woven wire/wire mesh panels
  ▪ 4” x 4” for young goats
  ▪ 6” x 6” for adult goats
  ▪ Avoid with horned goats

Feeder design criteria

• Place feed platforms above floor
  ▪ Reduces parasites
  ▪ Keeps feed clean
• Use toe boards if needed
• Throat height 18” for does
• Slant bar feeder openings
  ▪ 4” young goats
  ▪ 6” adult goats
  ▪ 7” bucks
## Resting area recommendations

<table>
<thead>
<tr>
<th>Housing type</th>
<th>Resting area</th>
<th>Doe</th>
<th>Buck</th>
<th>Young kid</th>
<th>Growing kid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedded pen with lot</td>
<td></td>
<td>12 – 18 ft²</td>
<td>30 – 40 ft²</td>
<td>3 – 5.5 ft²</td>
<td>8 – 10 ft²</td>
</tr>
<tr>
<td>Dirt lot</td>
<td></td>
<td>25 – 40 ft²</td>
<td>100 ft²</td>
<td>15 – 20 ft²</td>
<td>20 – 30 ft²</td>
</tr>
<tr>
<td>Paved lot</td>
<td></td>
<td>16 ft²</td>
<td>50 ft²</td>
<td>5 ft²</td>
<td>10 ft²</td>
</tr>
<tr>
<td>Bedded pen total confinement</td>
<td></td>
<td>20 – 25 ft²</td>
<td>50 ft²</td>
<td>8 – 10 ft²</td>
<td>8 – 10 ft²</td>
</tr>
<tr>
<td>Individual pen</td>
<td></td>
<td>6’ x 6’</td>
<td>6’ x 6’</td>
<td>4’ x 4’</td>
<td>4’ x 4’</td>
</tr>
<tr>
<td>Kidding pen (1 per 10 does)</td>
<td></td>
<td>5’ x 5’</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Adapted from Dairy Goat Production Handbook (2016) American Institute for Goat Research and Langston University

## Feed and water space recommendations

<table>
<thead>
<tr>
<th>Feeding system type</th>
<th>Doe</th>
<th>Buck</th>
<th>Young kid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited feeding – grains or pellet feed</td>
<td>16 – 20”/head</td>
<td>12”/head</td>
<td>9 – 12”/head</td>
</tr>
<tr>
<td>(all animals require equal access)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed always available – forages such as</td>
<td>6 – 8”/head</td>
<td>6”/head</td>
<td>2 – 4”/head</td>
</tr>
<tr>
<td>dry hay, silage, or mixed ration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic water bowl/nipple</td>
<td>40 – 50 head/bowl</td>
<td>10 head/bowl</td>
<td>50 – 75 head/bowl</td>
</tr>
<tr>
<td>Water tank perimeter</td>
<td>15 – 20 head/ft</td>
<td>No info</td>
<td>25 – 40 head/ft</td>
</tr>
</tbody>
</table>

Adapted from Dairy Goat Production Handbook (2016) American Institute for Goat Research and Langston University

## Summary

- Many facility options can work if they meet design criteria.
- Assess resources and limitations before remodeling.
- Adequate dry bedded resting area will help keep goats clean and healthy.
- Follow feeding and water space recommendations to maximize production.
Pneumonia

Environmental causes
- Pasteurella multocida
- Mannheimia haemolytica
- Histophilus somni

Contagious causes
- Salmonella
- Mycoplasmas
- Viruses: BRSV, BVD, IBR

Improve ventilation

Evaluate:
- Colostrum management
- Calorie intake
- Bedding
- Vaccination program
- Sanitation

What is ventilation?
Ventilation = the provision of fresh air into a building space.

Why do we need good ventilation?

Fresh air displaces heat, moisture, noxious gases, dust, and airborne pathogens
- Healthier, more productive animals
- Helps keep bedding dry
- Odor and fly control
- Reduced condensation
- Need draft protection

Air quality targets
- Ammonia levels < 10 ppm
- Relative humidity 50-75%
  (± 15% of outside RH)
Choosing a ventilation system

- Barn has ceiling?
  - Yes
    - Ceiling can be removed?
      - Yes
        - Mechanical Ventilation – Positive Pressure
      - No
        - No
          - Natural Ventilation
    - No
      - Barn obstructed from wind?
        - Yes
          - Mechanical Ventilation – Negative Pressure
        - No
          - Yes
            - Tight construction?
              - Yes
                - Mechanical Ventilation – Negative Pressure
              - No
                - No

Adapted from Ventilation Design for Goat Comfort by Dr. David Kammel (ret), UW Wisconsin.

Natural ventilation

Reasons to consider a natural ventilation system:
- Location maximizes wind access.
- Barn does not have a ceiling and/or is not insulated.
- Low operating cost.
- Low maintenance.

Natural ventilation

- Open ridge and eaves.
- Adequate interior roof slope (4:12 pitch or greater).
- Potential to open > 50% of total sidewall area.
- Free from wind shadows.
- East - West orientation protects from sun and catches more wind during summer.

Open ridge and eaves

- Important for ventilation from both wind and thermal buoyancy.
- Ridge: 2 inches per 10 ft of building width.
- Eaves: 1 inch per 10 ft of building width each side.
- Elevated ridge cap with upstands, or cupolas, preferred.
- Net cupola opening should equal minimum ridge opening.
Natural ventilation drawbacks - summer

Sometimes the wind doesn’t blow

Wind predominantly from South and SW

Natural ventilation drawbacks - winter

Sometimes it’s colder inside the barn than outside

Positive pressure tube ventilation systems

- Designed to **SUPPLEMENT** properly designed natural ventilation.
- Provide ~4 ACH through tube **NON-STOP**, year-around basis.
- **Uniform** air discharge down the length of the tube.
- Increasing ventilation rates as weather warms are provided by opening sidewalls.

Positive pressure tube ventilation systems

- Air jets from tube reach “still” air (~60 ft/min) just above the animal (**NO DRAFTS**).
- Need proper fan size and tube diameter to fit barn.
- Throw distance is determined by internal static pressure and hole diameter/location.
This is the WRONG way to install a tube

- Oversized holes will create drafts
- Tube not sized properly for even air distribution
- Fan will recirculate every pathogen in the barn

This is the RIGHT way to install a tube

- Fan with oversized hood forcing fresh air into barn
- Multiple rows of properly sized and spaced holes

Mechanical ventilation

Reasons to consider a fully mechanized ventilation system:

- Poor location/orientation does not maximize wind access.
- Barn has ceiling and/or tight construction.
- More control over the barn environment.
- More comfort for workers.

Mechanical ventilation design

Negative pressure system

- Fans in sidewall
  - Creates negative pressure
- Designed inlets
  - Distribute air without drafts
- Controls
  - Temperature & humidity
Mechanical ventilation design

Positive pressure system

• Fans in sidewall
  – Creates positive pressure
  – Distribute air without drafts
• Outlets
  – Open windows
  – Doors for animal access
• Controls
  – Temperature & humidity

Mechanical ventilation rates

<table>
<thead>
<tr>
<th>Ventilation rate</th>
<th>Adult goats</th>
<th>Young goats</th>
<th>Air exchange rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold weather</td>
<td>20 cfm</td>
<td>3 cfm</td>
<td>4 ACH</td>
</tr>
<tr>
<td>Mild weather</td>
<td>60 cfm</td>
<td>10 cfm</td>
<td>15 ACH</td>
</tr>
<tr>
<td>Hot weather</td>
<td>150 – 200 cfm</td>
<td>30 cfm</td>
<td>60 ACH</td>
</tr>
<tr>
<td>Draft free</td>
<td>&lt; 100 fpm</td>
<td>&lt; 50 fpm</td>
<td></td>
</tr>
</tbody>
</table>

Draft free is defined as < 100 fpm for air movement and < 50 fpm for air velocity.

cfm = cubic feet per minute
fpm = feet per minute
ACH = air changes per hour

Summary

• Work with your vet to determine the cause of diseases – ventilation is not a magical fix.
• Choose the right ventilation system for your barn location and construction type.
• Natural ventilation is a low-cost option but has drawbacks.
• Properly designed positive pressure tube systems have been shown to improve health in most barn systems.
• Fully mechanical systems can work but require fine-tuning and careful management.

Resources & contact information

https://www.extension.iastate.edu/dairyteam/dairy-goats-and-sheep

Brian Dougherty
Field Agricultural Engineer
ISU Extension and Outreach
brian1@iastate.edu
563-583-6496 ext. 125
@IAFieldAgEngrs @NEIowaAgEng