Florida has its fair share of hot and humid weather. Understanding heat stress and how Livestock Shelter Structures work, is a valuable management tool.

Depending on where the operation is located in Florida, on average, there are 72 days each year that temperatures are 90°F or above, with an average humidity of 86%. Temperature humidity index (THI) is an important indicator of heat stress loading for animals (see Table 1. below). Above 75 THI, heat stress on high-producing cows, such as dairy cows, begins to decrease feed intake and lower milk production. Above 80 THI, severe heat stress may occur for cows on pasture. Anything above an 83-85 THI is in danger of fatal heat stress, where mortality may occur.

Table 1. Temperature Humidity Index (THI)

A Livestock Shelter Structure acts as a shield and reduces solar radiation and thereby heat loads. A Livestock Shelter Structure does not reduce air temperature or humidity. Cattle generate internal heat through normal grazing and feeding. When we have hot weather, cattle regulate body temperature through evaporation, not perspiration like us. So, cattle will tend to breathe or pant more, try to locate surface water so they can totally immerse themselves, and/or decrease the amount feed or forage they consume to try to get cool.

Taken from University of Florida, “Emergency Considerations for Beef Cattle” Publication.
Why is heat stress such a concern for cattle? Hot weather and high humidity can reduce reproduction rates, rate of gain, milk production and feed or forage intake. In extreme cases, heat stress can increase the mortality rate.

**Costs**
Costs include not only materials, labor and installation, but also the cost of operating and maintaining the structure.

**Portable Structure**
**Installation Costs**
**Materials**:
- Galvanized, steel pipe for structure and bracing
- Mesh, shade fabric
- Lacing material, fasteners
- Welding equipment, if applicable

*(Mesh, shade fabric may have grommets for easier lacing to the structure)*

*Refer to NRCS Standards and Specifications for exact requirements.*

**Labor**: Welding galvanized, steel pipe structure and bracing
Lacing mesh, shade fabric to steel pipe structure or
Contract the fabrication (welding) of the frame structure or
Purchase prefabricated structure that does not require welding, just assembly

**Operation and Maintenance**
**Moving Livestock Shade Structures** – This is necessary for two reasons: 1) Pasture grasses can die as a result of trampling and compaction from livestock and the resulting bare ground, which is subject to erosion issues, and 2) Harmful bacteria may also accumulate in the shaded areas.

*Tightening mesh, shade fabric to structure* – The lifespan of the fabric will increase if the fabric is prevented from slamming against the metal structure from wind gusts.

**Permanent Structure**
**Installation Costs**
**Materials**:
- Treated lumber
- Metal Roof
- Concrete (for posts)

*Refer to NRCS Standards and Specifications for exact requirements.*

**Labor**: Building frame
Installing metal roof

**Operation and Maintenance**
**Periodically inspect roof**

*Periodically inspect roof drip line for possible erosion.*
Alternatives

Alternatives to Livestock Shelter Structures would be to use natural shade, such as hardwoods or pine trees. However, natural shade areas will typically become degraded resulting in the loss of trees from compaction and damage to roots and bark if the trees are not fenced. Even if the trees are fenced, the shaded areas are decreased and will eventually become bare through heavy use thus, resulting in pasture loss and increased erosion potential. Because Livestock Shelter Structures are portable, pasture areas can recover.

Considerations

Dairy
The difference between dairy cattle and beef cattle is that heat stress coincides with daily milking schedules. So, the effects of heat stress on dairy cows are immediate and result in reduced milk production on a daily basis. For most Florida dairy operations, concentrate feed is utilized, while most beef cattle operations in the state feed very little concentrate feed (used mostly in the winter months), relying primarily on pastures for their feed source. Due to the higher nutrient density of concentrate feed, it tends to generate more internal heat thereby making the livestock more susceptible to heat stress.

Beef
The body condition or weaning weight lost due to heat stress for beef cattle could be put back on during cooler times of the year or during nighttime cooling. Heat stress may be more of a concern when beef cattle are in closely confined areas such as feedlots and sorting or holding pens as opposed to open pastures where there is adequate air flow to assist in dissipating body heat. In a feedlot situation, there the cattle are feed high protein feeds as well which tend to lower their tolerance to high temperatures.

Economics

Lifespan
The anticipated design lifespan of a portable shade fabric Livestock Shelter Structure is 10 years if properly maintained. During storm events the fabric may have to be removed in order to prevent severe damage. The design lifespan of a permanent metal roof Livestock Shelter Structure is 15 years if properly maintained.

Heat Stress Exposure
Heat stress is not experienced throughout the year. Six months out of the year have the potential to reach Alert, Danger and Emergency THI levels, but only during the daylight hours. During the evening, livestock have the opportunity to cool, thus decreasing the effective hours of the shade. It is estimated that cattle are exposed to heat stress approximately 25% of the time in Florida, based on historic average temperatures and humidity. This percentage is figured into the dairy and beef analysis under the ‘CWT Effected by Total Annual Hours of Exposure’ and ‘Total Weight Gain Effected by Total Annual Hours of Exposure,’ respectively.

Dairy
In a University of Florida, Institute of Food and Agricultural Sciences (IFAS) study, reducing solar radiation through artificial shade from permanent structures, resulted in a 10-19% increase in milk production. The same study reported that protection from portable shades, such as Livestock Shelter Structures, were less
effective at reducing solar radiation than permanent structures, but that proportional benefits would be expected. This means that if the Livestock Shelter Structure provided only 80% shade as compared to a permanent structure with a metal roof, we could expect only 80% of the potential increase in milk production shown in IFAS Studies. If we assume only a potential of a 10% increase in milk production (the lower estimated percentage of increase in milk production found in the study) and the Livestock Shelter Structure provided 80% shade, you could expect an 8% increase in milk production due to portable fabric shade structures. So, 10% increase in milk production × 80% shade = 8% increase in milk production as a result of fabric shade structures. The table below breaks down of benefits and costs of Livestock Shelter Structures for dairies (see Table 2. below).

Table 2. Benefit and Costs of Livestock Shelter Structures for Dairies

### BENEFITS

<table>
<thead>
<tr>
<th>DAIRY</th>
<th>Portable Shade Fabric Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Cows Served Under Shade Structure*</td>
<td>Average Milk Production Annually (lbs./cow)</td>
</tr>
<tr>
<td>45</td>
<td>18,100</td>
</tr>
</tbody>
</table>

| Number of Cows Served Under Shade Structure* | Average Milk Production Annually (lbs./cow) | Increase in Milk Production Annually with Shade | Increase in Milk Production Annually with Shade (lbs) | CWT of Milk Production (lbs) | CWT Effected by Total Annual Hours of Exposure (lbs) | Average Price Received per CWT** | Average Annual Benefit |
| 45 | 18,100 | 10% | 81,450 | 815 | 204 | $19.56 | $3,990.24 |

### COSTS

<table>
<thead>
<tr>
<th>Portable Shade Fabric Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Per Unit Cost</td>
</tr>
<tr>
<td>$2.60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Permanent Metal Roof Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Per Unit Cost</td>
</tr>
<tr>
<td>$5.50</td>
</tr>
</tbody>
</table>

### Fabric Shade Structure Analysis

- Average Annual Benefit: $3,188.28
- Average Annual Cost: $326.56
- Average Annual Net Benefit: $2,861.72

### Permanent Metal Roof Structure Analysis

- Average Annual Benefit: $3,990.24
- Average Annual Cost: $546.00
- Average Annual Net Benefit: $3,444.24

*Based on typical 20' x 40' dimensions. (20' x 40' = 800 Sq. Ft.) (800 Sq. Ft. ÷ 45 Sq. Ft./Head = 17.77 Head per Shade Structure (20 rounded))

**5 Year Average of Milk Prices Received (CWT)
For dairies a portable fabric shade Livestock Shelter Structure has an estimated Average Annual Benefit of $3,188 and an Average Annual Cost of $326 resulting in a Net Average Annual Benefit of $2,861.

In a permanent metal roof Livestock Shelter Structure situation, the structure has an estimated Average Annual Benefit of $3,990 and an Average Annual Cost of $546 resulting in a Net Average Annual Benefit of $3,444.

Most dairies in Florida have a partial or total confinement barns, which would leave smaller permanent metal roof Livestock Shelter Structure obsolete. These partial or total confinement barns usually have misters as well, assisting further to decreasing temperatures. Typically, portable fabric Livestock Shelter Structures in dairy situations are used and are located in the grazing pastures.

**Beef**

Texas Tech University reported an increase of 25 lbs. increase in weight of shaded heifers than those unshaded in a feedlot situation using permanent metal roof structures. The table below breaks down of benefits and costs Livestock Shelter Structures for beef cattle feedlots (see Table 3. below). The same principals were used to estimate weight gain with proportional shade percentages for portable shade fabric structures (8% weight gain). There was no percentage used for the permanent structure scenario since the study, mentioned previously, indicated a total increase of weight gain.

For beef cattle, a portable fabric shade Livestock Shelter Structure has an estimated Average Annual Benefit of approximately $17 and an Average Annual Cost of $326 resulting in a Net Average Annual Loss of -$309. In a permanent metal roof Livestock Shelter Structure situation, the structure has an estimated Average Annual Benefit of $223 and an Average Annual Cost of $546 resulting in a Net Average Annual Loss of -$323.

It is expected that the benefit of Livestock Shelter Structures for beef cattle on pastures would be less than a feedlot situation because the air movement in open pastures is less restricted. A beef cattle feedlot situation, however, is different from a cow/calf operation in that livestock in a feedlot situation are only staged there for a short time, so efficiency in weight gain is crucial to the bottom line. Feedlot operations also house beef cattle in confined areas, where airflow is more restricted resulting in additional stress. Pasture areas, in a cow/calf operation, have the advantage because there is more open space for cattle allowing summer breezes to move over and around the herd assisting with cow comfort.

In comparison to dairy cattle, beef cattle can recuperate during the night when it is cooler, and are not as stressed as dairy cattle because they are not being ‘harvested’ or milked everyday like dairy cows. High and humid temperatures effect the dairy operation’s profits because they are milked every day, while beef cattle go to livestock market only once. Beef cattle operations can usually “catch-up” during cooler months – they have a longer planning horizon. Heat stress in beef cattle will affect those cows that are comprised prior to higher temperatures occurring. Sick cows will not be able to tolerate the high and humid temperatures as well as healthier cattle.
### Table 3. Benefit and Costs of Livestock Shade Structures for Beef Cattle in Feedlot

#### BEEF CATTLE

**BENEFITS**

<table>
<thead>
<tr>
<th>Number of Cows Served Under Shade Structure*</th>
<th>Portable Shade Fabric Structure</th>
<th>Permanent Metal Roof Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Weight Gain Annually (lbs./cow)</td>
<td>Average Weight Gain Annually (lbs./cow)</td>
<td>Average Weight Gain Annually (lbs./cow)</td>
</tr>
<tr>
<td>Increase in Weight Gain with Shade</td>
<td>Total Weight Gain with Shade (lbs)</td>
<td>Total Weight Gain with Shade (lbs)</td>
</tr>
<tr>
<td>Number of Cows Served Under Shade Structure*</td>
<td>22 25 8% 44</td>
<td>22 25 550 137.50</td>
</tr>
<tr>
<td>Total Weight Gain Effected by Total Annual Hours of Exposure (lbs)</td>
<td>11</td>
<td>4% 0.1170 $326.56</td>
</tr>
<tr>
<td>Average Price Received (per lb.)**</td>
<td>$1.62</td>
<td>$1.62</td>
</tr>
<tr>
<td>Average Annual Benefit</td>
<td>$17.82</td>
<td>$222.75</td>
</tr>
</tbody>
</table>

#### COSTS

<table>
<thead>
<tr>
<th>Average Per Unit Cost</th>
<th>Unit (sq. ft.)</th>
<th>Quantity</th>
<th>Total Estimated Installation Cost</th>
<th>Operation &amp; Maintenance Cost</th>
<th>Amortization Rate***</th>
<th>Average Annual Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portable Shade Fabric Structure</td>
<td>$2.60</td>
<td>Sq. Ft.</td>
<td>800</td>
<td>$2,080.00</td>
<td>4%</td>
<td>0.1170</td>
</tr>
<tr>
<td>Permanent Metal Roof Structure</td>
<td>$5.50</td>
<td>Sq. Ft.</td>
<td>800</td>
<td>$4,400.00</td>
<td>4%</td>
<td>0.0840</td>
</tr>
</tbody>
</table>

**Fabric Shade Structure Analysis**

| Average Annual Benefit | $17.82 |
| Average Annual Cost | $326.56 |
| Average Annual Net Benefit | -$308.74 |

**Permanent Metal Roof Structure Analysis**

| Average Annual Benefit | $223.00 |
| Average Annual Cost | $546.00 |
| Average Annual Net Benefit | -$323.00 |

*Based on typical 20' x 40' dimensions. (20' x 40' = 800 Sq. Ft.) (800 Sq. Ft. ÷ 35 Sq. Ft./Head = 22 Head per Shade Structure)

**5 Year Average of Milk Prices Received (CWT)

***Based on 3% Interest Rate and 10 and 15 Year Design Lifespan for Portable Shade Fabric and Permanent Metal Roof, respectively.

**Management Summary**

Stress experienced by animals during periods of high and humid temperatures may result in reduced feed intake and reduced body weight gain and in extreme cases, an increase in mortality, which may have been a result of other health issues and exaggerated by heat stress. Not only THI, but high protein feeds contribute to heat loads on dairy and beef cattle. The use of high protein feeds typically occur in dairy operations where feed management is a critical component for high milk fat content. High protein feeds
for show animals can also result in higher internal temperatures and Livestock Shade Structures may assist in relief.

Essentially, the decision to use Livestock Shelter Structures depends on your management level and the type of livestock operation (e.g. dairy, cow/calf, feedlot, show steers/heifers). If shade structures are placed in a pasture setting, livestock will naturally gravitate to the shade to find comfort, just like we would. Your management style may determine that a Livestock Shade Structure is needed because you do not want to see your herd health decline in the summer months, but instead remain steady until cooler temperatures arrive.

REFERENCES:

Chase, Larry, "Climate Change Impacts on Dairy Cattle", Department of Animal Science, Cornell University.
Conversations with several North Central Florida dairymen, March and April, 2006.
Mader, Terry Dr., “Benefits of Shade for Feedlot Cattle”, University of Nebraska.
NASS, Milk Prices Received.
National Oceanic & Atmospheric Administration; “Mean Number of Days with Maximum Temperature 90 Degrees F or More” and “Average Relative Humidity,” Data Tables; [www.noaa.gov], 2004.
UGA, “Beef Cattle Requirements.”