# Effect of Heat Stress on Reproduction

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In a southeastern state, such as Kentucky, heat stress is something all dairy farmers must deal with.  It affects how cows perform year-round but has substantial impact during the summer months.  Many herds observe a huge drop in conception rates during the summer, which affects many aspects of the dairy operation.  Therefore, it is imperative we understand how to determine heat stress, identify what changes or stresses the reproductive system, and create changes to alleviate some of the effects of heat stress on cows.

## Determining Heat Stress

Heat stress can be monitored by watching the animal herself or by simply observing the environment.  When monitoring cows, you should take notice of several things.  First, are they cleaning up the feed?  When heat stressed, many cows will decrease their dry matter intake.  Reduced dry matter intake generally results in decreased milk production.  Depressed milk production is something many farmers may notice first.  Though this depression can be indicative of many things, it could be from heat stress.  Second, is the cow's respiration rate high?  Take the time to count out a few cows' breaths per minute.  If it is higher than 75 breaths per minute, this is a good indication of heat stress.  Lastly, if you have a thermometer, take a rectal temperature.  Body temperature is a great way to determine if the cow is stressed.  If her rectal temperature is significantly greater than 102.2°F, she is likely over heated.

The environment can also let you know whether a cow is likely to be heat stressed.  It is important to remember that cows are wearing a thick leather coat so at about 68°F, a temperature that many people are enjoying, a cow is becoming heat stressed.  A simple way to benchmark heat stress is by using the temperature-humidity index (THI).  First, use a thermometer to measure the temperature where the cows are.  This is important because many barns can be warmer or cooler than ambient temperature based on ventilation rates and stocking density.  Next, use a hygrometer to measure humidity.  This is something that many people may not have access to so looking up humidity from the local weather station, or watching the weather on the news can be sufficient.  Next, a formula is used to calculate the THI.  Instead of constantly using the equation, tables can be referenced instead.  Using Figure 1, find the temperature of the barn on the left side and the humidity on the top.  Use your finger to move horizontally right from the temperature and vertically down from the humidity until your fingers meet.  This number is the THI for your barn that day.  The THI at which cows begin to experience heat stress is 68, which can be reached very easily in Kentucky.

| Temperature | | % Relative Humidity | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| °F | °C | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | 55 | 60 | 65 | 70 | 75 | 80 | 85 | 90 | 95 | 100 |
| 72 | 22.0 | 64 | 65 | 65 | 65 | 66 | 66 | 67 | 67 | 67 | 68 | 68 | 69 | 69 | 69 | 70 | 70 | 70 | 71 | 71 | 72 | 72 |
| 73 | 23.0 | 65 | 65 | 66 | 66 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 71 | 72 | 72 | 73 | 73 |
| 74 | 23.5 | 65 | 66 | 66 | 67 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 |
| 75 | 24.0 | 66 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 |
| 76 | 24.5 | 66 | 67 | 67 | 68 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 |
| 77 | 25.0 | 67 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 |
| 78 | 25.5 | 67 | 68 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 74 | 75 | 75 | 76 | 76 | 77 | 77 | 78 |
| 79 | 26.0 | 67 | 68 | 69 | 69 | 70 | 70 | 71 | 71 | 72 | 72 | 73 | 73 | 74 | 74 | 75 | 76 | 76 | 77 | 77 | 78 | 79 |
| 80 | 26.5 | 68 | 69 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 76 | 77 | 78 | 78 | 79 | 79 | 80 |
| 81 | 27.0 | 68 | 69 | 70 | 70 | 71 | 72 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 77 | 78 | 78 | 79 | 80 | 80 | 81 |
| 82 | 28.0 | 69 | 69 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 77 | 78 | 79 | 79 | 80 | 81 | 81 | 82 |
| 83 | 28.5 | 69 | 70 | 71 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 80 | 81 | 82 | 82 | 83 |
| 84 | 29.0 | 70 | 70 | 71 | 72 | 73 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 80 | 81 | 82 | 83 | 83 | 84 |
| 85 | 29.5 | 70 | 71 | 72 | 72 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 84 | 85 |
| 86 | 30.0 | 71 | 71 | 72 | 73 | 74 | 74 | 75 | 76 | 77 | 78 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 84 | 85 | 86 |
| 87 | 30.5 | 71 | 72 | 73 | 73 | 74 | 75 | 76 | 77 | 77 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 85 | 86 | 87 |
| 88 | 31.0 | 72 | 72 | 73 | 74 | 75 | 76 | 76 | 77 | 78 | 79 | 80 | 81 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 |
| 89 | 31.5 | 72 | 73 | 74 | 75 | 75 | 76 | 77 | 78 | 79 | 80 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 |
| 90 | 32.0 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 | 90 |
| 91 | 33.0 | 73 | 74 | 75 | 76 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 86 | 87 | 88 | 89 | 90 | 91 |
| 92 | 33.5 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 |
| 93 | 34.0 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 80 | 81 | 82 | 83 | 85 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 |
| 94 | 34.5 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 86 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 |
| 95 | 35.0 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 |
| 96 | 35.5 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 |
| 97 | 36.0 | 76 | 77 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 94 | 95 | 96 | 97 |
| 98 | 36.5 | 76 | 77 | 78 | 80 | 80 | 82 | 83 | 83 | 85 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 98 |
| 99 | 37.0 | 76 | 78 | 79 | 80 | 81 | 82 | 83 | 84 | 85 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 98 | 99 |
| 100 | 38.0 | 77 | 78 | 79 | 81 | 82 | 83 | 84 | 85 | 86 | 87 | 88 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 98 | 99 | 100 |
| 101 | 38.5 | 77 | 79 | 80 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 90 | 92 | 93 | 94 | 95 | 96 | 98 | 99 | 100 | 101 |
| 102 | 39.0 | 78 | 79 | 80 | 82 | 83 | 84 | 85 | 86 | 87 | 89 | 90 | 91 | 92 | 94 | 95 | 96 | 97 | 98 | 100 | 101 | 102 |
| 103 | 39.5 | 78 | 79 | 81 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 94 | 96 | 97 | 98 | 99 | 101 | 102 | 103 |
| 104 | 40.0 | 79 | 80 | 81 | 83 | 84 | 85 | 86 | 88 | 89 | 90 | 91 | 93 | 94 | 95 | 96 | 98 | 99 | 100 | 101 | 103 | 104 |
| 105 | 40.5 | 79 | 80 | 82 | 83 | 84 | 86 | 87 | 88 | 89 | 91 | 92 | 93 | 95 | 96 | 97 | 99 | 100 | 101 | 102 | 103 | 105 |
| 106 | 41.0 | 80 | 81 | 82 | 84 | 85 | 87 | 88 | 89 | 90 | 91 | 93 | 94 | 95 | 97 | 98 | 99 | 101 | 102 | 103 | 104 | 106 |
| 107 | 41.5 | 80 | 81 | 83 | 84 | 85 | 87 | 88 | 89 | 91 | 92 | 94 | 95 | 96 | 98 | 99 | 100 | 102 | 103 | 104 | 106 | 107 |
| 108 | 42.0 | 81 | 82 | 83 | 85 | 86 | 88 | 89 | 90 | 92 | 93 | 94 | 96 | 97 | 98 | 100 | 101 | 103 | 104 | 105 | 107 | 108 |
| 109 | 43.0 | 81 | 82 | 84 | 85 | 87 | 89 | 89 | 91 | 92 | 94 | 95 | 96 | 98 | 99 | 101 | 102 | 103 | 105 | 106 | 108 | 109 |
| 110 | 43.5 | 81 | 83 | 84 | 86 | 87 | 89 | 90 | 91 | 93 | 94 | 96 | 97 | 99 | 100 | 101 | 103 | 104 | 106 | 107 | 109 | 110 |
| 111 | 44.0 | 82 | 83 | 85 | 86 | 88 | 90 | 91 | 92 | 94 | 95 | 96 | 98 | 99 | 101 | 102 | 104 | 105 | 107 | 108 | 110 | 111 |
| 112 | 44.5 | 82 | 84 | 85 | 87 | 88 | 90 | 91 | 93 | 94 | 96 | 97 | 99 | 100 | 102 | 103 | 105 | 106 | 108 | 109 | 111 | 112 |
| 113 | 45.0 | 83 | 84 | 86 | 87 | 89 | 91 | 92 | 93 | 95 | 96 | 98 | 99 | 101 | 102 | 104 | 105 | 107 | 108 | 110 | 111 | 113 |
| 114 | 45.5 | 83 | 85 | 86 | 88 | 89 | 92 | 92 | 94 | 96 | 97 | 99 | 100 | 102 | 103 | 105 | 106 | 108 | 109 | 111 | 112 | 114 |
| 115 | 46.0 | 84 | 85 | 87 | 88 | 90 | 92 | 93 | 95 | 96 | 98 | 99 | 101 | 102 | 104 | 106 | 107 | 109 | 110 | 112 | 113 | 115 |
| 116 | 46.5 | 84 | 86 | 87 | 89 | 90 | 93 | 94 | 95 | 97 | 98 | 100 | 102 | 103 | 105 | 106 | 108 | 110 | 111 | 113 | 114 | 116 |
| 117 | 47.0 | 85 | 86 | 88 | 89 | 91 | 93 | 94 | 96 | 98 | 99 | 101 | 102 | 104 | 106 | 107 | 109 | 111 | 112 | 114 | 115 | 117 |
| 118 | 48.0 | 85 | 87 | 88 | 90 | 92 | 94 | 95 | 97 | 98 | 100 | 102 | 103 | 105 | 106 | 108 | 110 | 111 | 113 | 115 | 116 | 118 |
| 119 | 48.5 | 85 | 87 | 89 | 90 | 92 | 94 | 96 | 87 | 99 | 101 | 102 | 104 | 106 | 107 | 109 | 111 | 112 | 114 | 116 | 117 | 119 |
| 120 | 49.0 | 86 | 88 | 89 | 91 | 93 | 95 | 96 | 98 | 100 | 101 | 103 | 105 | 106 | 108 | 110 | 111 | 113 | 115 | 117 | 118 | 120 |

☐ **Stress Threshold** Respiration rate exceeds 60 BPM. Milk yield losses begin. Repro losses detectable. Rectal temperature exceeds 38.5 °C (101.3°F)

☐ **Mild-Moderate Stress** Respiration rate exceeds 75 BPM. Rectal temperature exceeds 38°C (102.2°F)

☐ **Moderate-Severe Stress** Respiration rate exceeds 85 BPM. Rectal temperature exceeds 40 °C (104°F)

■ **Severe Stress** Respiration rate 120-140 BPM. Rectal temperature exceeds 41 °C (106°F)
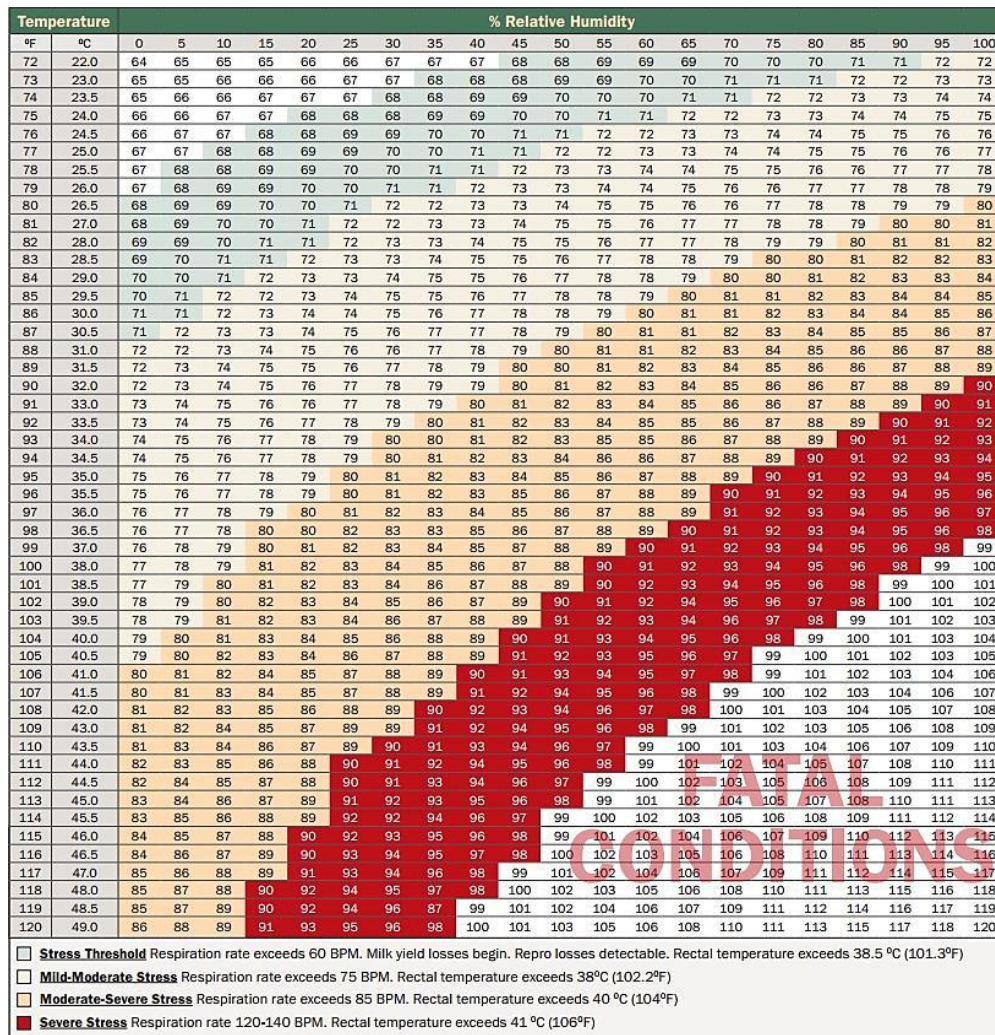
Figure 1. Heat Index Chart. R. B. Zimbleman and R. J. Collier. Hoard's Dairyman.

## Effects of Heat on the Reproductive System

Recognizing heat stressed cows is the first step to appreciating and understanding the resulting decrease in reproductive performance. The cow can be affected at all stages starting at the follicular stage (the follicle contains the egg/ovum) all the way to post-calving. That is why continued management of heat stress at all times is important.

### *Estrus Expression*

Heat stress has a huge impact on the cow's expression of estrus. This is due to heat stress causing a decrease in the cow's production of luteinizing hormone and estradiol. Estradiol is the hormones responsible for estrus expression. Therefore, a cow may be in estrus, but will not express it due to her body's response to overheating. A study in Florida reported an estimate of 76 to 82% of undetected estrus events in summer months compared to 44 to 65% from October to May. Heat stress can also cause a decrease in physical activity, which further decreases estrus behavior.

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### *Influence on Ova and Embryos*

Ovarian follicles, the ova/eggs they contain and young embryos can all be compromised by heat stress.  Heat stress does not decrease the rate of fertilization after cows are inseminated.  However, heat stress has a negative impact on quality of ova, which may influence the viability of young embryos. In addition, if a cow is heat stressed soon after fertilization, development of the embryo can be compromised.  An increase of a mere 0.9 degree F in the cows uterine temperature can decrease her conception rate by 6.9%.  For an animal that already has a low conception rate in perfect conditions, 6.9% is a huge reduction.  This is why fertility decreases immediately after it gets hot.  There also is a latent influence of heat stress on fertility.  This may be due to the aforementioned negative impact of heat stress on developing ova.  It takes 40-60 days after heat stress before undamaged ova are ovulated and fertility returns to normal.

### *Dry Cows*

Heat stress can also have an effect during the dry period of the cow.  Many dry cows are put out to pasture with little to no shade or heat abatement.  This can have serious implications to how the cow and calf perform postpartum.  When heat stressed during the last 2 – 3 months of pregnancy, there are clear reductions in placental function, calf birth weight, and milk production.  Research has suggested that cooling dry cows can result in increased birth weight, improved quality of colostrum, reduced transitional health disorders, and increased milk production.

### *Bulls*

Natural service is still utilized on many dairy farms.  Therefore, the importance of maintaining fertility in bulls is important.  Bulls can be heat stressed when exposed to temperatures of 80°F for merely 6 hours a day and the effects can last 9 weeks or more after the heat stress.  Studies have shown sperm motility is reduced by 10%, abnormal sperm count is increased by 20% and total sperm concentration is reduced by 61%.  The overall result is fewer opportunities for normal, healthy sperm to reach the ovum and produce a pregnancy.

### **Conclusion**

Understanding all the signs and symptoms of heat stress is an important part of dealing with the repercussions it has on the cow's reproduction.  An important tool in defeating any problem is the knowledge of why it's occurring.  Having these tools allows for better management and action to overcome the obstacle of summer heat.