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## Heat stress in dairy cows

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This review includes an analysis of the literature on various influencing factors influencing heat stress in lactating dairy cows and the way it affects milk production. Signs and symptoms of heat stress in cows are reduced feed consumption and decreased milk yield, elevated breathing rate, increased body temperature and reduced reproductive overall performance. There are other problems for example, a seasonal growth in bulk tank somatic cell counts. The birth weight is decreased in cows which have been exposed to heat stress throughout the dry length. It is established that the most critical is the heat accumulated via direct radiation from the solar. It was found out that high feed consumption results in raised metabolic heat increment. High metabolic warmness increment requires powerful thermoregulatory mechanisms to maintain body temperature in a thermoneutral area and in physiological homeostasis. It is confirmed that heat stress is complicated because the responses to heat stress have an effect on not best the energy stability, but also water, sodium, potassium and chlorine metabolism. Plasma progesterone degrees may be elevated or reduced depending on whether or not the heat pressure is acute or chronic. Water, sodium, potassium and chlorine are vital constituents of sweat, and sweating is a chief, if not the most important, thermoregulatory mechanism used to burn up extra body heat. Strategies to reduce heat stress must be evolved to enable cows to express their full genetic ability.

**Key words:** dairy cows, heat stress, thermoregulatory mechanism, water, feed consumption, mineral elements.

### Introduction

Heat stress has numerous critical and economically deleterious effects on livestock. The maximum important outcomes of heat stress in dairy cows are decreased feed intake, lessen milk production (Fig. 1) and butterfat percentage, and decreased reproductive overall performance [45]. Hence, cows require extra energy to expend the warmth and altered body temperature. It is vital to apprehend and manipulate heat stress by decreasing the shed temperature by artificial means and dietary heat controlled plan [24].

Thermal environment is a main factor that may negatively have an effect on milk production

of dairy cows particularly in animals of excessive genetic benefit [8]. The system of metabolizing nutrients generates warmth, which contributes to preserving body temperature in a cold surroundings [35].

The warmness and humidity of an ordinary summer combine to make a very uncomfortable environment for lactating dairy cows [28]. During warm summer time climate, milk production can also decrease as much as 50 percent, and reproductive proficiency of lactating dairy cows is significantly diminished. Some records imply that 10 to 20 percentage of inseminations in “heat stressed” cows bring about pregnancies [17].

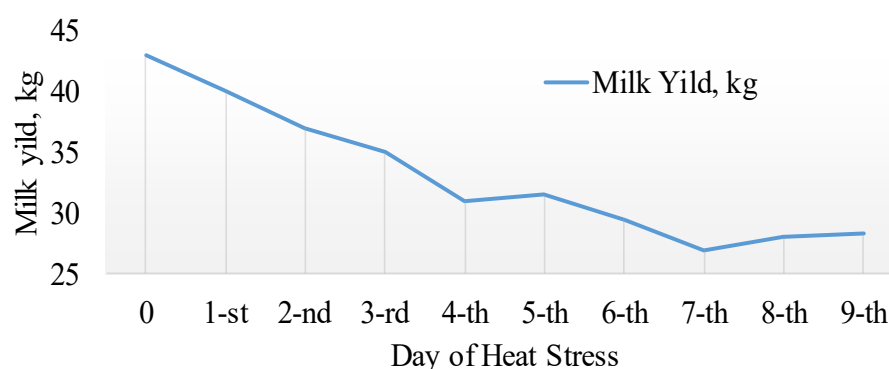


Fig. 1. Effects of heat stress on milk yield in lactating Holstein cows [50].

The purpose of this review is to accumulate knowledge about the causes of heat stress in cows, its course and symptoms, consequences and ways to overcome them to further develop a strategy to reduce heat stress in cows to create the most comfortable conditions and the manifestation of genetic productivity potential.

#### Primary Causes of Heat Stress

There are numerous assets of heat that have an effect on cows and make a contribution to heat stress. The first and in all likelihood most critical is the heat accumulated via direct radiation from the solar. In addition, dark coat animals collect greater radiation warmth than light or white coat livestock [34]. The heat of digestion is an essential source of warmth accumulation in cows. The warmth of digestion of forages is better than that for grains [7]. Animals on a better forage ration are extra inclined to warmth stress than animals on higher grain rations. If given the possibility, cows will try to eat greater grain than forage, by way of sorting greater vigorously or eating less unfastened choice hay. Conduction is also answerable for amassed heat in farm animals [9]. This happens when cattle are crowded collectively. For example, whilst cows try to get into the restricted coloration of a tree, and heat is “trapped” and exceeded by direct touch from animal to animal [14]. During warm days, especially if followed through hot nights, cows collect warmth and cannot safely deplete this frame warmth [36]. This can reason intense warmth strain and manufacturing losses. In extremes deaths from warmth exhaustion have befallen at some point of very warm humid periods [18].

#### Signs of heat stress in cows

The confirmation of heat stress in cattle is regularly very subtle. Here are a number of the more not unusual signs and symptoms of heat stress in cows. For example reduced feed consumption and

decreased milk yield (>10 %) and butterfat stage (0.2–0.3 %), elevated breathing rate (>80 breaths / minute), increased body temperature (>39.2 °C) and reduced reproductive overall performance [40]. The key is to monitor the temperature-humidity index (Fig. 2) [47, 49].

Dry matter consumption is decreased through 10–15 % during heat stress. Early lactation and higher yielding cows are affected extra fast and significantly as compared to later lactation cows [29]. As dry matter consumption drops, so does milk production. Milk production drops in addition if water is restraining [42]. Cows divert water from milk manufacturing to facilitate cooling [46].

In a US trial the percentage of inseminated cows that have been showed pregnant dropped from 30 % to 10–15 % in summer days evaluated over three consecutive years [43]. Early embryonic deaths account for large losses in warmth pressured cows [17].

Recent studies shows that heat stressed cows have reduced rate of passage, decreased rumen pH, higher rumen ammonia and exchange in unstable fatty acids [46]. Butterfat declines by as much as 0.3 % gadgets at some stage in summer [6].

A statistically significant effect of THI (temperature–humidity index) on RT (rumination time) was identified, with RT decreasing as THI increased [48].

There are other problems related to overheat during the summer time, for example, a seasonal growth in bulk tank somatic cell counts. Dry cows also are stricken by heat stress [19]. Close-up dry cows are generally stored interior in pens simply prior to calving. Feed intake is decreased, more so because these cows are on excessive forage rations [32]. There is likewise some proof that birth weight is decreased in cows which have been exposed to heat stress throughout the dry length [16].

Temperature, °C	Humidity, %																							
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100			
22.0	64	65	65	65	66	66	67	67	67	68	68	69	69	69	70	70	70	71	71	72	72			
23.0	65	65	66	66	66	67	67	68	68	68	69	69	70	70	71	71	71	72	72	73	73			
24.0	66	66	67	67	68	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	75			
25.0	67	67	68	68	69	69	70	70	71	71	72	72	73	73	74	74	75	76	76	76	77			
26.0	67	68	69	69	70	70	71	71	72	73	73	74	74	75	76	76	77	78	78	78	79			
27.0	69	69	70	70	71	72	72	73	73	74	75	75	76	77	77	78	78	80	80	80	81			
28.0	69	69	70	71	71	72	73	73	74	75	75	76	77	77	78	79	79	80	81	81	82			
29.0	70	70	71	72	73	73	74	75	75	76	77	78	78	79	80	80	81	82	83	83	84			
30.0	71	71	72	73	74	74	75	76	77	78	78	79	80	81	81	82	83	84	84	85	85			
31.0	72	72	73	74	75	76	76	77	78	79	80	81	81	82	83	84	85	85	86	87	88			
32.0	72	73	74	75	76	77	78	79	79	80	81	82	83	84	85	86	86	87	88	89	90			
33.0	73	74	75	76	76	77	78	79	80	81	82	83	85	86	86	86	87	88	89	90	91			
34.0	74	75	76	77	78	79	80	80	81	82	83	85	85	86	87	88	89	90	91	92	93			
35.0	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95			
36.0	76	77	78	79	80	81	82	83	84	85	86	87	88	89	91	92	93	94	95	96	97			
37.0	76	78	79	80	81	82	83	84	85	87	88	89	90	91	92	93	94	95	96	98	99			
38.0	77	78	79	81	82	83	84	85	86	87	88	90	91	92	93	94	95	96	98	99	100			
39.0	78	79	80	82	83	84	85	86	87	89	90	91	92	94	95	96	97	98	100	101	102			
40.0	79	81	81	83	84	85	86	88	89	90	91	93	94	95	96	98	99	100	101	103	104			
41.0	80	81	82	84	85	87	88	89	90	91	93	94	95	97	97	99	101	102	103	104	106			
42.0	81	82	83	85	86	88	89	90	92	93	94	95	97	98	100	101	103	104	105	107	108			
43.0	81	82	84	85	87	89	90	91	92	93	95	96	98	99	101	102	102	105	106	108	109			
44.0	82	83	85	86	88	90	91	92	94	95	96	98	99	101	102	104	105	107	108	110	111			
45.0	83	84	85	87	89	91	92	93	95	96	98	99	101	102	104	105	107	108	110	111	113			
46.0	84	85	87	88	90	92	93	95	96	98	99	101	102	104	106	107	109	110	112	113	115			
47.0	84	85	87	89	90	93	94	95	97	98	100	102	103	105	106	108	110	111	113	114	116			
48.0	85	87	88	90	92	94	95	97	98	100	102	103	105	106	108	110	111	113	115	116	118			
49.0	86	88	89	91	93	95	96	98	100	101	103	105	106	108	110	111	113	115	117	118	120			
	StressThreshold				Midl Stress				Moderate-Severe Stress				Severe Stress											
	Dead cows				No Stress																			

Fig. 2. Temperature-humidity index (THI) of dairy cow.

**Critical steps in controlling heat accumulation in cows**

The most critical degree is to lessen warmth load or increment in cows. This means dealing effectively with the three principal assets of warmth accumulation in cows [11].

Genomic selection has good impact on controlling heat stress [23]. Keep cows out of the sun from eight to nine am to as a minimum four to five within the afternoon! This is a vital step for controlling heat stress in particular dark coloured cows. Keep cows in the barn [2] and make sure the cows have fresh feed and water. Remember that high humidity exaggerates the impact of high temperature [1].

Reformulate the ration to encompass much less, better best forage but do not compromise the minimal ranges for acid detergent fiber (17 %) and forage neutral detergent fiber (22 %). Feed more high excellent, relatively digestible forage in summer time. Include fat inside the ration to

assist more consumption when feed consumption declines [39].

It is even extra crucial no longer to crowd cows during hot weather. This can occur whilst inadequate bunk area is supplied or cows are crowded inside the vicinity [37]. These are vital measures to help lessen heat accumulation in cows. However, despite our excellent efforts and intentions, cows do still go through some distress from heat stress in the course of the new summer time months [15].

Water requirements parallel the growth in ambient temperature. As the temperature rises from 30 to 35 °C, water intake might also boom from 80 to 12 l. If cows go out of the doors lot, it's far very critical that the water be near shade and the feed bunk [25].

Higher producing cows are extra liable to suffer from heat stress because they generate extra heat because of their higher feed intake and hence, will require more consuming water [31].

The water have to be clean, clean, and free of contaminants. Try to hold cows that are on outdoor lots or pasture far from ponds [22]. Ponds pose a chance to farm animal's health: They frequently have poor high-quality water, and that they can also increase the prevalence of mastitis and higher somatic cellular counts on your herd [10].

Sprinkling the cows lightly, without also presenting ok air flow, can get worse the state of affairs via developing a warm and humid environment with a view to not permit heat to use up [12]. Increasing airflow by way of the addition of fans is a partial approach to this hassle [20].

Permanent sun shades can now and again be a trouble as they are able to concentrate moisture and manure and can growth the occurrence of mastitis. Portable shade structures can be constructed with both timber or welded pipes. Shade material that gives at least 80% cooler is to be had [27].

Heat is produced due to microbial fermentation inside the reticulo-rumen. Low pleasant, stems containing forages generate greater heat of fermentation within the animal, contributing to the animal's total heat load [21].

Heat is used to maintain body temperature when ambient temperatures are low (under 4.5 °C). But while ambient temperatures are high the cow wishes to maintain its body temperature within organic limits well matched with lifestyles [4].

Increase water availability to cows. Normal water supply guidelines are inadequate inside the summer time. Water intake will increase by way of as much as 50% as the Temperature Humidity Index is 80. Place extra water points close to where the cows spend maximum of the time. Make positive the water is easy, cool and sparkling. Clean troughs more often in the summer time [26].

Change the feeding habitual of the cow. The maximum vital modifications are blend and feed extra often and feed a more share of feed at night time, 60 to 70% of feed. Watch for feed heating within the bunk – clean bunks out greater regularly [41].

Increase the airflow / ventilation. Open up the sides of the barn to maximize the natural air flow. Install lovers in the barn. The most essential areas to increase ventilation are the holding region, along the inner of the feed bunk and over the stalls [38].

Add fats to the ration, boom potassium to 1.5–1.7 %, increase sodium to 0.45–0.5 %, boom magnesium to 0.3–0.4 %. This requires a cautious selection of mineral sources to make certain that chloride tiers are stored low [3]. Feed a total mixed ration. Add water to the total mixed ration, first off to increase water consumption and secondly to assist save you sorting by means of the cows [13].

Add fat to the ration to maintain adequate dry mater intake – Cows will consume less feed for the duration of heat stress [30]. Decreased dry matter intake will bring about bad milk yield and duplicate. To keep dry matter consumption all through the summer season months, increase the percentage of fats in the ration [5]. However, fat must not exceed 7% of the full ration on a dry matter basis. Avoid using excessive quantities of vegetable oils [33].

Sprinkling cows with water is an extraordinary manner to increase evaporation. However, its miles important that fans should be in the vicinity [44].

#### Acidosis risks

The probability of acidosis increases during the period of heat stress. The development of rumen acidosis can be promoted by:

- decrease of dry matter intake and increase of sorting;
- decrease of rumination;
- decrease in the amount of saliva entering the rumen (a source of buffer);
- increase of CO<sub>2</sub> emissions.

Fibrolytic bacteria are most sensitive to lower pH in the rumen. When the pH value is below 6, the digestibility of the fibers by these bacteria is significantly reduced

Reducing dry matter intake, decreasing rumination, reducing saliva and suppressing the activity of rumen bacteria leads to a decrease of milk production and fat content in milk, diarrhea, reproductive disorder, can lead to death [49].

**Conclusions.** Heat stress adversely affects the health and productivity of cows. They reduce feed consumption, milk secretion, and its quality deteriorates. At the same time, the reproductive qualities of cows and the quality of newborn calves deteriorate. To prevent losses, it is necessary to develop a strategy to protect cows from excessive heat and manage heat stress.

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#### Тепловий стрес у дійних корів

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В огляді міститься аналіз літературних джерел щодо чинників, які зумовлюють тепловий стрес у дійних корів у період лактації та наслідки їх впливу на виробництво молока. Ознаками та симптомами теплового стресу у корів є зменшення споживання корму та зниження надів молока, підвищення частоти дихання та температури тіла, а також погіршення репродуктивної функції. Є також інші проблеми, наприклад, сезонне зростання кіль-

кості соматичних клітин у загальному молоці, зібраному з корів. Вага під час народження зменшується у корів, які зазнали впливу теплового стресу впродовж сухостійного періоду. Встановлено, що найбільш критичним є тепло, накопичене від дії прямого сонячного випромінювання. З'ясовано, що високе споживання корму призводить до збільшення накопичення метаболічного тепла. Це, зі свого боку, вимагає потужних механізмів терморегуляції для підтримання температури тіла в термонейтральній зоні та фізіологічному гомеостазі. Доведено, що тепловий стрес ускладнений тим, що негативно впливає на енергетичну стабільність, а також на обмін води, Натрію, Калію та Хлору. Ступінь плазмового прогестерону може бути підвищеним або зниженим залежно від того, є тепловий стрес гострим чи хронічним. Вода, Натрій, Калій та Хлор є життєво важливими складниками поту, а потовиділення є основним, якщо не найважливішим, механізмом терморегуляції, який використовується для видалення зайвого тепла з тіла. Отже, необхідно розробити стратегії зменшення теплового стресу, щоб дати коровам змогу проявити на повну силу свій генетичний потенціал продуктивності.

**Ключові слова:** дійні корови, тепловий стрес, механізм терморегуляції, вода, споживання корму, мінеральні елементи.

#### Тепловой стресс у дойных коров

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Обзор включает анализ литературных источников относительно факторов, обуславливающих тепловой стресс у дойных коров в период лактации и последствия

их воздействия на производство молока. Признаками и симптомами теплового стресса у коров являются уменьшение потребления корма и снижение надоев молока, повышение частоты дыхания и температуры тела, а также ухудшение репродуктивной функции. Есть и другие проблемы, например, сезонный рост количества соматических клеток в общем молоке, собранном от коров. Вес при рождении уменьшается у коров, подвергшихся воздействию теплового стресса в течение сухостойного периода. Установлено, что наиболее критичным является тепло, накопленное от действия прямых солнечных лучей. Изучено, что высокое потребление корма приводит к увеличению накопления метаболического тепла. Это, в свою очередь, требует мощных механизмов терморегуляции для поддержания температуры тела в термонейтральной зоне и физиологическом гомеостазе. Подтверждено, что тепловой стресс осложнен тем, что негативно влияет на энергетическую стабильность, а также на обмен воды, Натрия, Калия и Хлора. Степень плазменного прогестерона может быть повышенной или пониженной в зависимости от того, является тепловой стресс острым или хроническим. Вода, Натрий, Калий и Хлор являются жизненно важными составляющими пота, а потоотделение является основным, если не важнейшим, механизмом терморегуляции, который используется для удаления лишнего тепла из тела. Поэтому необходимо разработать стратегии уменьшения теплового стресса, чтобы дать коровам возможность проявить в полную силу свой генетический потенциал продуктивности.

**Ключевые слова:** дойные коровы, тепловой стресс, механизм терморегуляции, вода, потребление корма, минеральные элементы.



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