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UNIVERSITY OF KENTUCKY
College of Agriculture

Kentucky Dairy Notes

May 2013

Dairy Feeding and Management Considerations during Heat Stress

Donna Amaral-Phillips

Heat stress results in decreased milk production, reproductive performance, and immune function in both milking and dry dairy cows. Both environmental temperature and humidity impact the amount of heat stress that dairy cows undergo. Recent research has shown that milking dairy cows start to decrease milk production when the temperature-humidity index exceeds 68 (i.e., temperature of 72°F with 45% relative humidity or 80°F with no humidity) and not 72 as shown in previous research with lower-producing dairy cows. The detrimental effects on the estrus expression, conception rates and early embryo survivability occur before declines in milk production are observed and may occur at a temperature-humidity index as low as 55 to 60. Generally, the maximum declines in milk production as a result of heat stress are not seen until 36 to 48 hours after the initial heat stress event. Older dairy cows seem to be more severely affected compared to younger cows and not all cows respond to heat stress in a similar manner.

Dry cows also are negatively impacted by heat stress. Heat-stressed dry cows produce 1000 to 2000 lb less milk the next lactation. In addition, fetal growth is reduced because of reduced blood flow to the uterus, resulting in a decreased supply of nutrients for the rapidly developing fetus. These effects result in smaller calves being born to dams subjected to heat stress during late pregnancy. Thus, proper management practices, facilities, and to a lesser extent, nutrition, are needed to mitigate the effects of heat stress not only in milking dairy cows, but as importantly for dry cows.

Environmental Management

To maintain normal metabolism, a cow's core body temperature needs to remain relatively constant. In addition, core body temperature must be slightly higher than the ambient temperature to allow heat to be transferred to the external environment. Heat is generated from the digestion of feeds and nutrient metabolism. When dairy cows are subjected to increased environmental temperature and/or humidity outside their thermal neutral zone, the cow's environment must be cooled to allow this heat exchange between the cow and her environment to occur and to prevent, or at least minimize, increases in a cow's core body temperature. By providing dairy cows shade, increased ventilation, and cooling of the surrounding air by fans alone or in combination with sprinklers, dairy cows are better able to minimize the detrimental effects of heat stress on milk production, reproduction and their immune system.

Some key points to remember include:

- Fans over freestalls, housing area, and feedbunks should be automatically programmed to turn on when the temperature and humidity reaches a THI of 68 (i.e., temperature of 72°F with 45% relative humidity or 80°F with no humidity).
- In more humid climates, fans should be used in combination with sprinklers (nozzles need to deliver 0.5 gallon/minute of water, 20 to 40 lb/square inch of pressure (psi)) which will wet the hair coat of cows. Sprinklers should generally be on for 1 to 3 minutes, then off for the remainder of a 15 minute cycle. Fans should run continuously and the amount of time sprinklers run increases with increasing temperature. (Janni, University of Minnesota Engineer)
- Fans and sprinklers (in humid environments) should be used in the holding pen to cool cows waiting to be milked and time in the holding pen should be kept to a minimum.
- Adequate number of fans should be spaced at about 12 ft height along the length of the freestall barn. The recommended distance between fans is 30 feet for 36 inch fans and 40 ft for 48 inch fans (Gay, Virginia Tech Extension Engineer, Pub 442-763).
- Check fans to make sure they are angled correctly (20 degree angle) and are operating properly. Fans also should be cleaned regularly.
- Minimize cow movement and work dairy cows and heifers during the coolest part of the day.

If facilities housing far-off and close-up dry cows do not allow for cooling, an hour in the holding pen with fans and sprinklers operating will help cool dry cows.

Heat Stress Modifies Cow Behavior

Dairy cows experiencing even mild heat stress spend more time standing compared to cows not experiencing heat stress. This change in cow behavior is most likely related to the cow's attempt to increase the amount of surface area needed to dissipate heat and decrease her core body temperature. Although there has not been a research trial looking at the direct impact of heat stress on incidence of lameness, we do know: (1) as cows spend less time lying down and more time standing, the incidence of lameness increases and (2) heat-stressed cows spend more time standing. Thus, one could assume that heat-stressed cows would have a higher incidence of lameness and any practices that reduce heat stress and standing times of dairy cows would likely decrease the proportion of dairy cows becoming lame. Separate studies have shown an increased incidence of lameness during the summer. Besides heat stress, the type of bedding used in freestalls (i.e., sand versus different types of mattresses) and wetness of the feedbunk area as it relates to drainage of water from sprinklers also may affect the incidence of lameness.

Dairy cows seek out areas that have a lower ambient temperature. This behavior seems very intuitive but may readily explain why certain areas of a housing facility are better utilized during the summer and/or hottest part of the day. Sometimes incorrect fan placement and/or operation, lack of natural ventilation, or north-south orientation of a barn (allowing sun to enter) creates sections of the barn that are not as cool as other areas, thus limiting their use.

Feeding Behavior Modifications with Heat Stress

Water intake: Water intake increases dramatically in dairy cows under heat stress as a means to dissipate heat to the environment. When environmental temperatures increased from 64 to 86°F, water consumption was shown to increase by 29%. Thus, providing plenty of cool, clean water is critical upon return from milking and within their respective housing. Routinely, waterers should be emptied and scrubbed with a brush and chlorine solution. Providing shade for waterers for heifers and dry cows is also critical in maintaining water intake.

Dry matter intake: Dry matter intake drops under heat stress with a corresponding drop in milk production. However, only 50% of the drop in milk production can be explained by decreases seen in dry matter intake. The remaining drop in milk production is associated with changes in metabolism and the responsiveness of various tissues and organs to normally-produced hormones. This does not mean that instituting practices to maintain feed intake are not important (for more information, http://www.extension.org/pages/65108/checklist-for-the-top-5-priorities-for-fallwinter-dairy-feeding-programs), they are and will help maintain or attempt to optimize nutrient intakes at a critical time. Feed should be mixed more often in the summer or an additive (i.e. buffered propionic acid products) incorporated into the TMR mix to extend bunk life and prevent feed from excessively heating in the feedbunk. Dairy cows generally consume more feed over the nighttime hours when environmental temperatures are lower.

Increased maintenance requirement for energy: With the increase seen in respiration rates and panting with heat stress, energy needed for maintenance increases by 7 to 25% or 0.7 to 2.4 Mcal NEL/day. This increase in energy requirement equals the amount of energy needed to produce 2.2 to 7.5 lbs of milk (3.7% butterfat). Thus, helping dairy cows thermal regulate is very important when trying to maintain production.

Modifying Diets for Heat-Stressed Dairy Cows

Maintain effective fiber intake: Adequate effective fiber is necessary for maintaining rumination, buffering of the rumen contents, and an efficient digestion of forages and grain components of the diet. Heat stress increases the rate of respiration and panting, decreases rumination time, and results in a decrease in the amount of saliva and bicarbonate in the blood. These changes result in a decreased buffering of the rumen and blood. Thus, decreasing the fiber content and increasing the amount of starch of a diet is the last change you want to make in an attempt to increase the energy of the diet because ruminal acidosis could result. On the flip side of the coin, feeding excessive amounts of neutral detergent fiber (NDF) to dairy cows under heat stress is detrimental. High NDF forages are generally lower in forage quality, result in more heat of fermentation when digested in the rumen, and thus the dairy cow needs to dissipate more heat compared adequate amounts of fiber.

Feed highly digestible forages: Feeding higher quality forages increases the energy content of the diet, helps maintain adequate rumination, and decreases the heat of fermentation associated with feeding lower quality forages. Brown midrib forages, i.e., corn silage or forage sorghum, may be more beneficial in diets of heat-stressed dairy cows to improve digestibility of the fiber and, therefore, amount of energy derived from the consumed diet.

Adding fat to the diet: Adding fat to the diet is expected to decrease heat produced during the digestion of feeds while increasing the amount of energy available. Studies where fats have been fed to heat-stressed cows have shown inconsistent responses in improving milk production, some have improved milk production and others have shown no response.

Addition of yeast cultures to diets: Yeast culture has been shown to improve fiber digestion and stabilize the rumen environment. In heat-stressed dairy cows supplemented with yeast, lower rectal temperatures and respiration rates were observed in several but not all studies. Several studies, but not all, have shown an increase in milk production of heat-stressed cows supplemented with yeast. In 1994, Dr. Huber and others summarized 14 lactation comparisons with 823 heat-stressed cows where yeast was or was not added to the diet. Overall, this comparison showed a 2.2 lb/day increase in milk production with yeast supplementation with 6 comparisons showing significantly higher milk production with supplementation, 3 slightly higher, and the remaining 5 comparisons with no or slightly lower milk production. Two recent studies have shown no improvements in milk production with yeast supplementation, but one indicated feed efficiency was improved. Early lactation cows fed a higher proportion of concentrate may respond more favorably to yeast supplementation than mid to late lactation cows.

Modify mineral content of the diet: Heat-stressed dairy cows sweat and their sweat contain high amounts of potassium and sodium, thus increasing their needs for these minerals in summer rations. To achieve these increased concentrations of potassium and sodium and maintain adequate dietary cation-anion difference (DCAD), additional amounts of sodium bicarbonate and/or potassium carbonate need to be added to the diet. Additions of salt and/or potassium chloride will not achieve the desired changes needed. In addition, higher amounts of potassium reduce the absorption of magnesium, thus increasing the requirements for magnesium.
Heat-stressed dairy cows should be fed adequate amounts of trace minerals and vitamins. At this time, research trials, where additional trace minerals or vitamins have been added to diets of cows under heat stress, have not consistently shown a benefit. More research is needed before additional amounts and sources of trace minerals are recommended to be added to diets of heat-stressed dairy cows.
Rations for dairy cows should be formulated for dairy cows before heat stress occurs and should contain:

1.4 to 1.6% potassium
0.35 to 0.45% sodium
0.22 to 0.35% magnesium (readily available source)
+ 25 to 30 or greater DCAD balance

Environmental and dietary modifications can help mitigate the effects of heat stress on dairy cows and should be implemented ***before the effects of heat stress are noticed***. These modifications are needed not only for the milking herd, but as importantly for the far-off and close-up dry cows. When making these modifications, one must realize that changes in the environmental temperature are the most important, with dietary modifications serving a supportive role. By helping dairy cows dissipate the extra heat load, milk production, reproduction and health can be maintained or at least the negative effects minimized and potential profitability realized during the spring, summer and early fall months.

Should I Process My Own Milk?

Jeffrey Bewley, Brianna Goodnow, and Elizabeth Chaney

With fluctuating milk prices, many dairy producers desire a more reliable, less cyclical income stream. At the same time, the local food movement has increased demand for locally produced foods. Throughout the country, dairy producers are considering on-farm processing to add value to the milk produced on their farms. Dairy producers may bottle milk or process their milk into cheese, ice cream, butter, yogurt, or cream. Generally, adding value to a product consists of transforming a product from its original form to an alternative form that will allow it to bring more value and income to the business. Through this process, consumers receive a high-value product and dairy producers may receive a new revenue stream for their business. These products often have a distinguishing marketing feature (i.e. organic, grass-fed, or natural) in addition to being locally produced. As an individual farm enters an on-farm processing venture, non-monetary benefits come from new connections with consumers and local families. On-farm processing increases interactions between farmers and consumers and consumer education.

The decision to enter this venture should not be taken lightly. Like many small businesses, the failure rate for dairy on-farm processing enterprises is high. Additional food safety and liability risks must be considered. While many producers are attracted to the potential for increased value for their milk, to realize this value, consumers have to actually purchase the product. Moreover, successful operation of a dairy on-farm processing venture requires a completely different skill set than the skills needed to manage a herd of dairy cows.

How do I know whether I should start a business?

A business plan is one of the most difficult but most important parts of starting an on-farm processing enterprise. When dreaming up a new business, especially an on-farm dairy processing enterprise, excitement takes over, and it is easy to become overly optimistic and blind to potential pitfalls. A business plan helps organize the overwhelming amount of information and ideas into one document.
Why is a business plan important?

- Lays out plans into a written form

- Helps to set a timeline of practicality and priorities
- Documents goals and purposes
- Forces inclusion of details often overlooked
- Helps managers to consider parts of an operation that may not have been considered without a business plan

What should be included in a business plan?

- Market and product research
- Cash flow and profitability projections
- Location plans
- Financial plans
- Extra insurance
- Business structure
- Product manufactured
- Future short- and long-term plans and goals

Multiple websites and organizations are available to assist in the writing or outlining of a business plan. The Small Business Administration website (http://www.sba.gov/smallbusinessplanner/plan/writeabusinessplan/index.html) outlines everything from how to write it, how to find a niche, workshops offered, and much more. The Agricultural Marketing Resource Center (http://www.agmrc.org/business_development/starting_a_business/) provides sample plans, free online worksheets, and a host of business assessment, planning, and management links from across the nation.

How will I fund the new business?

Funding an on-farm processing enterprise can be challenging. This reality check can prove to be a major obstacle for many. First, each business owner must realize that some internal financing is needed. Without your own equity, lending institutions will not be able to help. It is extremely important that estimations are made ahead of time for costs related to installation, management, and maintenance. While developing these estimates, professionals familiar with these enterprises, should be contacted. For equipment and consulting fees, be sure to obtain multiple competing estimates. Once estimates are established, a true understanding of the cost requirements can be in place. Bank loans, agricultural based loans, and grants may be available to start your new business. Lending or granting agencies will want to see business plans, cash flow projections, break-even points, advertising, distribution, labor, and packaging costs, fees for permits, and expected sales before providing funding.

What regulations will I need to consider?

Before beginning an on-farm dairy processing enterprise, many regulations, and restrictions for producing a specific product must be considered. The Dairy Practices Council's "Guideline for on-farm and small-scale dairy products processing" (GL-90) (http://www.dairypc.org/catalog/guidelines/haccp/on-farm-and-small-scale-dairy-products-processing) is an excellent resource for all phases of establishing this business including regulatory requirements. Regulations in production can include anything at the national, state, or local levels, including health requirements. Different products require different methods of production, and regulations are directed at safe and healthy production for consumers. Along with safety requirements, labeling requirements must also be considered. All dairy processing plants must adhere to state and national regulatory requirements depending on what product you choose to create and these regulations are important to consider when making a business plan. For example, the time, buildings, and equipment needed to bottle your own milk are not the same requirements to make aged cheese. Considering the items needed to efficiently produce your product is essential. In addition, consulting with other farmers who have produced the same product is very helpful in beginning an on-farm processing venture. Regulations vary by state and when deciding to start an on-farm dairy processing enterprise, the producer must consider all the regulations and determine whether they are willing and able to oblige to all the regulations. For more information on regulations in Kentucky, contact the Kentucky Milk Program at the following address, or visit their website.

Kentucky Milk Program Milk Safety Branch, 275 East Main Street, HS1C-B, Frankfort, Ky. 40621
(502) 564-3340 Fax: (502) 564-8787 http://chfs.ky.gov/dph/phps/On-Farm.htm

In future articles, we will discuss choosing a product to produce, manufacturing, and marketing.

2013 National Dairy Challenge Academy Team
By: Donna Amaral-Phillips

2013 University of Kentucky National Dairy Challenge Academy Team Members (from left to right): Bailey Smith (Senior from Frankfort, KY), Emily Morabito (Senior from Long Island, New York), Alexis Thompson (Sophomore from Phoenix, Arizona), and Taylor Reiter (Senior from Boston, Massachusetts). All students are majoring in Animal Science at UK. They were coached by Barbara Wadsworth and Dr. Donna Amaral-Phillips.

Undergraduate students from the University of Kentucky participated in the inaugural North American Intercollegiate Dairy Challenge Academy held in Fort Wayne, IN on April 4-6.

On the first morning of this educational event, students learned about careers in the dairy industry as well as how the global economy affects the profitability of dairy farms. In the afternoon, students toured the Kuehnert family dairy in small groups. Each of the groups rotated through each of the 8 educational stations on this family farm. At each station, dairy industry sponsors focused on explaining specific aspects of the operation, such as feeding, calf raising, and manure handling and explained how each aspect was handled in Indiana.

On days 2 and 3, the students were placed on teams with members representing various universities across the United States. Together they evaluated a dairy operation and presented their recommendations regarding the strengths, opportunities for improvement, and a prioritized plan for their host farm based on the farmer's goals, performance records, and observations on-farm. Each team had 2 academy advisors from the dairy industry to help them through this process.

With this educational event, they can apply concepts they have learned in the classroom to real farm situations and then defend their recommendations. Before attending this event, the students visited dairy farms in Kentucky. The team would like to thank the Kentucky dairy practice farms for allowing them to visit and learn from these operations. In addition to participating in this educational event, students wrote an article for Kentucky dairy producers about an aspect of dairy production. These articles will appear in upcoming issues of Kentucky Dairy Notes.

Phosphorus's Role in a Dairy Operation
Alexis Thompson, UK Dairy Challenge Student, Barbara Wadsworth, and Donna Amaral-Phillips

Phosphorus (P) is a macronutrient required in large quantities by plants for growth. It is also required by dairy cattle for growth, milk production, and reproduction. Plants obtain their required phosphorus from the soil and in turn, livestock are fed the plants for energy and protein as well as the phosphorus they require. More often than not, phosphorous will need to be supplemented, through other feedstuff in the diet, to dairy cows because the forages they consume do not contain adequate amounts. The cows in turn excrete the phosphorus through their milk and manure. The manure is then returned to the soil in a form of nutrients that plants can utilize and so the cycle continues. The main characteristic of the cycle is balance. The phosphorus that cows consume, and therefore excrete, needs to balance the amount of phosphorus required by the crops on the surrounding acreage in addition to the phosphorus already in the soil (Mullins).

What Dairy Cows Need

Cows need phosphorus for growth, milk production, and reproduction. Growing heifers require about 0.3 % P. Heifers deficient in phosphorus will not display estrus and therefore take longer to become a productive member of the lactating herd. Dairy NRC recommends a lactating cow to consume 0.35 % P with slight variation to account for differing production levels. Having sufficient phosphorus in the diet is vital for reproduction but providing it in excess will not increase the reproductive performance of the herd. During their dry period, dairy cows need about 30 to 40 grams of phosphorus. On average, dietary rations contain about 8 % more phosphorus than required (Weiss). Overfeeding phosphorus can increase the acreage needed for manure application depending on the soil phosphorus content and can be a direct result of feeding byproduct feeds high in phosphorus.

Table 1: Amount of additional phosphorus excreted by a dairy cow fed over the recommended concentration and the amount of additional acreage required for removal by the harvested corn silage. Assumptions are that cows consume 50 lbs of dry matter and that each ton of corn silage removes 3.5 lbs P_2O_5 with an estimated yield of 20 tons of corn silage as fed.

% Phosphorus over recommendation	Additional Amount Excreted (P_2O_5) per year	Additional number of acres of corn silage need to apply manure
0.05	9.125	0.3
0.10	18.25	0.6

Once the threshold for phosphorus absorption needed for maintenance and production has been reached, additional phosphorus passes directly into the manure. High levels of phosphorus in the manure require additional acreage to spread the manure.

As feed prices rise, by-products are becoming more common in rations. These by-products contain higher concentrations of phosphorous per pound of feed than forages. If rations are high in by-products then the phosphorous levels in the ration will be high. To decrease phosphorous, the amount of by-products should be decreased in rations. The lower price of by-products should be weighed against the additional land needed for manure spreading or for movement of manure to a secondary location.

What Plants Need

Phosphorus is found in two different states, organic and inorganic. Organic phosphorus is found in manures, plant residues, soil organic matter, microbial biomass, etc. and must be mineralized to orthophosphate (HPO_4^{2-}, $H_2PO_4^-$) in order to be available for plant use. Inorganic phosphorus can be found in applied fertilizer, bound by minerals in the soil, or in secondary mineral compounds and must also be in the orthophosphate form for the plant to utilize. Manure from cattle contains 45 to 70 % inorganic phosphorus. The crops in the fields can immediately use the inorganic phosphorus, whereas the organic portion of phosphorus must be mineralized prior to plant uptake. Applying manure before planting maximizes the utilization of the phosphorus and minimizes soil fixation. When the manure is initially applied to the fields, the inorganic portion of P is available for plants to absorb. The more time that passes after the manure has been applied, the greater amount of P that is adsorbed onto the surface of minerals and/or precipitated as secondary mineral compounds (collectively termed “fixed”). This is because the minerals in the soil become “fixed” to the phosphorus and over time convert it to unavailable forms of phosphorus. Soils that are slightly acidic (pH 6 to 7) slow this process down and increase its availability for plant uptake (Mullins).

Phosphorus and Water Quality

High concentrations of phosphorus could be detrimental to ponds, lakes, and streams. Phosphorus is required for growth in all plants and is often limiting in aquatic environments. When P is introduced into a P limited aquatic environment, algae and other aquatic plants flourish. This is commonly referred to as eutrophication. This flush of plant growth can deplete the amount of available oxygen to aquatic animals causing them to die off. When the algae begin to die and rot because of the low oxygen concentration, insect activity and odor increase (Mullins). Typically there has to be a disturbance in the soil (i.e. tilling or plowing) for soil applied phosphorus to reach water reservoirs. Two exceptions are: leaching of P at very high levels of soil test P levels, and direct surface runoff into surrounding waters (more typical with manures than fertilizers). In general, since phosphorus is bound to the soil, the phosphorus goes where the soil goes.

Crops that Remove Phosphorus from the Soil

All plants require phosphorus for growth but some crops will remove more P than others. This is helpful in places that have high phosphorus concentrations. The crop that removes phosphorus in the greatest quantity is corn silage, which removes 70 lbs/acre. Common feedstuffs and the amount of phosphorus they remove per acre are listed below (AGR-1- *Lime and Nutrient Recommendations, University of Kentucky Publication*).

Crop	Yield per acre	Total Phosphorus (P_2O_5) Removed
Fescue Hay	3 ton	42 lbs
Corn silage	20 ton	70 lbs
Soybeans	50 bushels	35 lbs
Corn	150 bushels	60 lbs
Wheat silage	7 ton	28 lbs

A soil sample should be collected and analyzed to determine the amount of phosphorus in the soil and if additional phosphorus is needed. Government regulations should be considered before the application of manure.

Government Standards

Government regulations, specifically NRCS Code 590, control the amount of phosphorus which can be applied and to what soil types. Each state differs slightly in their regulations but they all depend on the current concentration of phosphorus in the soil. Before manure is applied, state regulations should be consulted to ensure the proper amount of phosphorus is being applied.

Conclusion

Phosphorus is vital in dairy operations for milk production and growth of plants and animals. Balancing intake and therefore excretion helps manage how much fertilizer is applied to surrounding fields without causing a residual effect. The benefit of this fertilizer is embodied in the crops of the next season.

Check Out the Following

UK Dairy Extension has just released two new extension factsheets. We hope you find this information useful.

Using DHIA Records for Somatic Cell Count Management
By Jeffrey Bewley, Michelle Arnold, and Donna Amaral-Phillips
http://www.ca.uky.edu/agc/pubs/ID/ID212/ID212.pdf

The Kentucky Compost Bedded Pack Barn Project
By Randi Black, Jeffrey Bewley, Joe Taraba, Flavio Damasceno, and George Day
http://www.ca.uky.edu/agc/pubs/ID/ID213/ID213.pdf

Jack McAllister Retirement Reception

When: Wednesday, May 22, 2013 from 3:30 - 5:30 p.m.

Where: E.S. Good Barn, Weldon Suite, University of Kentucky

Parking is available in the gated lot west of the Good Barn.

For additional information contact: George Heersche, gheersch@uky.edu

Save the Date

October 26, 2013
Dare to Dairy
UK Coldstream Dairy

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Jack McAllister's Retirement Reception
E. S. Good Barn, Lexington, KY

June 1st
Ownership Deadline for Kentucky & youth dairy animals, and 4-H Livestock Educational hours deadline

June 25
State 4-H Dairy Judging Contest
UK Coldstream Dairy
Registration Deadline: June 14th

July 30-31
Kentuckiana Dairy Exchange Trip