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NDS Dynamics

Welcome to the NDS Dynamics newsletter!

Dear readers,

Welcome to our last issue before the summer break. In this number Dr. Giulia Esposito (R&D at RUM&N) gives an overview on how to use the “environment tab” in NDS professional to predict the possible level of heat stress and the consequent changes in requirements and intake related to the different temperature and humidity index that the model calculates. Following, for the NDS UPDATES column, Ermanno Melli (CEO and R&D at RUM&N) will discuss about the feed inventory.

We take the opportunity to remind our users about the NDS North America series of online seminars, dedicated to the users in the Americas; the next one, scheduled for the 27th of August, will be on Rumen Health and Component Feeding Systems .

Please continue to follow us on our channels to receive updates on what is new and what is happening at RUM&N and NDS North America.

The Editor
Ermanno Melli

Heat stress: a challenge for dairy cows and dairy farmers

*By G. Esposito**
**R&D RUM&N*

Elevated temperature and humidity have always been a source of stress for dairy cows. As well explained in the recent reviews by Polsky and von Keyserlingk (2017) and by Becker et al., (2020), lactating dairy cows, normally have elevated internal heat loads, generated through metabolism (maintenance, exercise, growth, lactation, gestation, feed intake), because of the high milk production (Chebel et al., 2004). Therefore, to regulate their thermal energy balance, they dissipate the heat generated through metabolism into the environment (Fournel et al., 2017). To reach thermal balance, the heat generated must equal the heat lost to the environment. Thus, when the animal is unable to dissipate enough metabolically produced or absorbed heat, thermal balance cannot be maintained (Bernabucci et al., 2014). The effects of accumulating incremental heat are exacerbated when temperature and humidity values increase in the surrounding environment (West, 2003). Based on several factors, such has level of adaptation to elevated temperature and humidity, duration and intensity of the heat stress, physiological status of the animal etc, the animals can alter their response to the stress both physiologically and behaviorally (Ratnakaran et al., 2017) showing, for instance, increased respiration rate, panting, and reduced milk yield and reproductive performance. Furthermore, also their drinking and eating behaviour might change preferring the coolest hours of the day for these activities and spending more time standing and seeking shade and decreasing any activity and movement (De Rensis and Scaramuzzi, 2003; Schütz et al., 2008).

Usually, when dairy cows experience short bursts of heat stress, production is adversely affected for about a 5-d recovery period following the heat stress conditions (Ominski et al., 2002). On contrary, long-term exposure to high ambient temperatures and humidity can lead to carryover effects even after experiencing it (Wolfenson et al., 1997; De Rensis and Scaramuzzi, 2003). Therefore, it is not surprising, that for regions such as southwestern United States and Brazil, where there is a constant presence of the sun and high humidity, challenges are greatest than for geographical regions such as central Europe, northern United

States and Canada, where the summer season is relatively short. However, in these temperate regions, cows may not be physiologically adapted to heat stress conditions, making episodic thermal stress difficult for the animals to handle (Ominski et al., 2002). These animals experience production losses even at lower thresholds compared to animals adapted to conditions of thermal stress (Hammami et al., 2013; Schüller et al., 2014).

To better manage possible heat stress and the challenge of ensuring dairy cows' welfare (and productivity) it has become necessary to implement a temperature-humidity index (THI). This index, first introduced to describe the effect of ambient temperature on humans (Thom 1959), has been adapted to describe thermal conditions that drive heat stress in dairy cattle (De Rensis et al.,2015). It is a dimensionless index with the objective of quantifying the risk of heat stress in dairy cows. A concept similar to the THI has been implemented by the CNCPS which describes a current temperature index (CETI), computed from current temperature and relative humidity. The CETI (expressed in Celsius or Fahrenheit degrees)is used to make adjustments for cold or heat stress, and to adjust predicted intake for temperature effects. The concept of CETI and THI have been adopted and implemented within the NDS Professional, to modulate the animals' response to it.

As seen in Figure 1, NDS Professional has a dedicated section, within the Animal inputs tab, for the environment. When inputting the information in this section, it is important to remember that with "temperature, relative humidity, minimum night temperature, wind speed, and hours in sun" it is intended "the current average" (temperature, relative humidity, minimum night temperature, hours in sun, and wind speed) the animals are exposed to during the period being evaluated (e.g. the average of the last 5 to 7 days).

With this information, the platform is able to calculate the current THI and, through the CETI, adjust the prediction for maintenance requirements and intake.

With "previous temperature, previous relative humidity, previous wind speed, previous hours in sun", it is intended the average (temperature, relative humidity, minimum night temperature, hours in sun, and wind speed) the animals are exposed for the previous month. This information is used by the model to compute adjustment factors (considering that cows not used to high THI my suffer of heat stress at lower THI thresholds) for maintenance requirements. It is important to note that the environment information to be inputted refer to the environment within the pen.

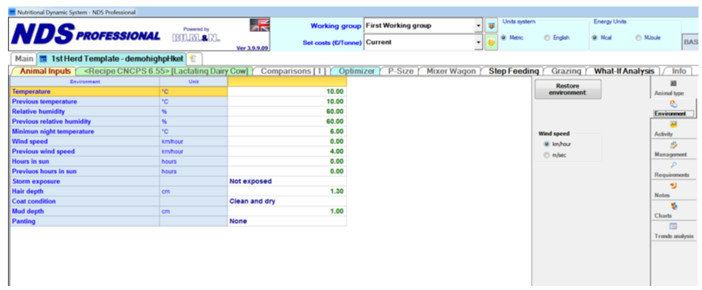

Figure 1. Environment section within the Animal Input tab

In the example reported in Table 1, we show the changes in prediction of intake, satisfaction of ME% requirements and, consequently, prediction of ME allowable milk for cows at 125DIM, with a production of 36.74 Kg at a different THI.

Other factors affecting the maintenance requirement and the intake of the cows are "hair dept, coat condition, mud depth and panting". Hair depth, in fact, affects the ability of the cow to maintain or dissipate heat when needed. Average suggested values are 0.5 inches (1.27cm) in winter and 0.25 inches (0.64 cm) in summer for clean and dry hair coat.

Coat condition, intended as level of cleanness will not affect the model unless the animal is near lower critical temperature.

Information regarding the lot mud depth is used to adjust the DMI predicted because animals become increasingly reluctant to go to the feedbunk as mud depth increases. Instead, the panting index code reflects the energy cost of getting rid of excess heat.

It is important to remember that, although the environment tab allows the model to better predict maintenance requirements and intake, its prediction may be able to indicate a trend for the group, but it may not be as accurate because the behavioral changes adopted by the cows to cope with the heat stress (standing, seeking shade, etc), often further affects intake and maintenance requirements.

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Table1: Changes in intake, requirements and allowable milk based on different THI indexes

THI		REQUIREMENTS		ALLOWABLE MILK	
	Intake	ME (%)	MP (%)	ME (Kg)	MP (Kg)
64	23.82±1.4 Kg	99.2	100	36.30	36.73
72-74	21.25±1.9 Kg	96.7	100	34.88	36.73
79-89	19.35±2.4Kg	92.5	100	32.32	36.73

Based on the information inputted, and by calculating the THI, the model will graphically show the risk of heat stress the group is currently facing (Figure 2).

The THI odometer is divided into categories that potentially indicate the level of heat stress, but definitions vary between researchers and conditions.

NDS professional implemented the definition adopted by De Rensis et al. (2015) and Armstrong (1994). According to them, a THI <68 is outside the thermal danger zone for cows. Very mild signs of heat stress can be observed at THI of 68 to 72, whereases at THI 72 to 79 the cows are experiencing mild heat stress; at THI of 80 to 89 the animals are considered to be in moderate heat stress, and to reach a severe heat stress at THI >90. According to De Rensis et al. (2015), a THI ≥75 will cause drastic decreases in production performance (De Rensis et al., 2015). The THI odometer is a valid tool for management decisions related to heat stress.

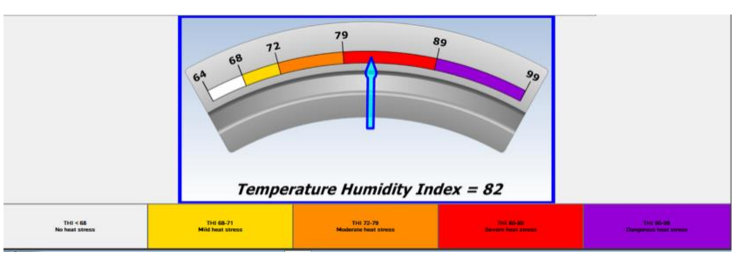

Figure 2. THI index prediction in NDS Professional. The index is calculated based on the input inserted by the user in the environment section.

NDS UPDATES

Another Great Tool: The Feed Inventory management module

By E.Melli[1]; D. Weber[2] and K. Cotanch[2]
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After balancing the perfect ration and getting the nutrients in digestive harmony for maximum performance, the nutritionist will then look at the next set of constraints. These may be just as or even more important to the animal operation for success and profitability: the availability of the feed, the Income over Purchased Feed Cost (IOpurFC), and the opportunity cost of the feeds in the rations. The Feed Inventory Module assists the user in achieving these goals by looking at the entire operation around the feeds presently owned by the farm, and those available to purchase at any given time during the feeding periods.

The main goal when managing feeds is to always use first the farm's forages and to manage those making sure that as much of the feed inventory as possible is used without running short until the next forage is ready to replace it. Many farms look at making sure the new crop corn silage has 60- 90 days ensiling before feeding and even some farms desire to have one year inventory on hand at any time.

IOpurFC is another big driver to make sure that profit is maximized on the operation and many farms will look at both Income Over Feed Cost (IOFC) and IOpurFC. Either parameter will help to maximize using already owned or purchased feeds like forages and home-grown proteins before adding monthly expenses into rations.

Another profit driver to consider is the “Opportunity cost” of feeds. Opportunity cost is a little more complex than IOFC and IOpurFC. It can help determine if there is a more profitable approach to feeding the current feeds available. Recently on a farm when looking at previous protein contracts that the farm had done, without a joint discussion for the ration needs, two contracts for proteins were “long” or the farm had purchased more tons per month than needed for this contract period. Looking at both feeds and investigating with the contract buyer it was discovered that for a nominal per ton fee one of the contracts could be “forwarded” or moved to the next contract period. This will save almost 60 dollars a ton on that feed compared to the next contract price. The other protein feed, #2, has a less

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desirable contract for that protein for moving it ahead. Finding out we have purchased two excess contracts and one can be forwarded we now are using the second protein, #2 as much as possible and allowing the first to be moved to the next contract period. This will be a tremendous advantage in the next quarter as replacement or "spot" prices for all proteins look greatly increasing in price. The animal performance will be maintained, and profit will be maximized.

In summary, the Feed Inventory Tool is now available to become such a big part of helping harvest profit on farms!

On-farm Feed Inventory

We have pointed out above that for a profitable dairy operation, it is of paramount importance to plan for the amount and quality of forage needed. Planning minimizes the risk of running out of forage and having to buy at inopportune times. For instance, many times hay prices climb in the late winter and spring due, in part, to an increase in demand caused by livestock producers not anticipating their forage needs.

A good way to reduce the risk of purchasing hay at high prices is to determine forage requirements and supplies periodically throughout the year. This allows for the anticipation of shortages and gives the producer time to plan.

In addition to determining amounts of forage and hay supplies, segregating forages by quality (especially in a year when forage is expensive) may help increase farm profitability. For instance, if only high-quality hay is available and an inventory indicates a shortage of total forage exists, lower-quality hay for feeding to pregnant heifers can be purchased. This may prevent running out of forage and needing to purchase high hay, sometimes difficult to find, for lactating cows.

A forage inventory should be done on a regular basis, at least every three months. This will help avoid dramatic ration changes caused by the poor allocation of forage, i.e. running out of hay and having to switch to an all corn silage ration, or running out of corn silage to replace it completely with triticale silage. Since cows do not adjust well to dramatic ration changes, planning to anticipate change is the best way to avoid drops in production and cattle health issues.

Developing a Feed Inventory

When developing a forage inventory there are three key questions that need to be answered:

1. How much feed is required for all animals?
2. What is the total feed supply available?
3. How can a feeding program be developed based on the forage and commodities supply available and the needs of the different feeds?

The purpose of the **Feed Inventory Planner** included in NDS Professional as an add-on, is to determine the quantities of feeds available on the farm, giving several options to avoid running out of forage too early.

By matching the inventory with animal numbers, decisions regarding an adequate use or supply of forage for the intended feeding period can be made.

Because there can be a large amount of variation in forage density and dry matter intake, it is a good management practice to update the inventories frequently (at least every three months).

The module is designed to calculate feed surpluses or deficiencies in each farm. It is structured to manage all components of a proper feed inventory:

- ***Part I - Feed requirement***

Feeds requirements are calculated for the whole herd.

This section, selecting the recipes fed to all pens, and depending on the number of animals in each of those, determines the total amount required for each feed in a given feeding period.

The figure below (Figure 1.) shows the Summary tab with an overview of all feeds supplied in terms of amount per day and required over the entire feeding period for the whole herd. Details of the amounts of the feeds required during a given feeding period (default from today to 3 months forward) are available and calculated for each pen, that is for each animal type, according to the diets fed during the period.

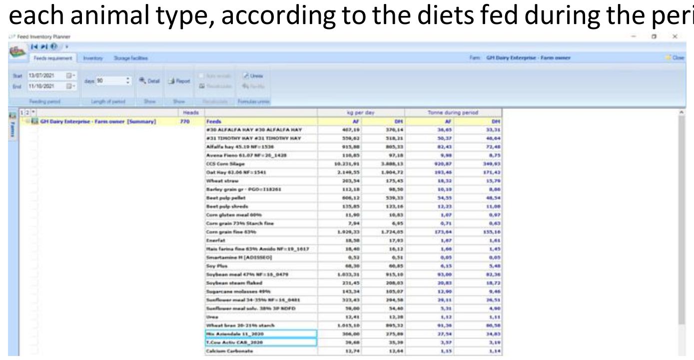

Figure 1: Summary of the feeds currently used in the farm

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- ***<u>Part II - Inventory</u>***

The **Inventory** tab, shown in Figure 2, allows the user to access the second part of the Feed Inventory Planner, where the current amount of feeds are compared with the amount required, calculating the feed's Balance of Availability. In this tab the model will report the following information:

  - **current quantity**: determines the amount currently stored and available for each feed. The initial amount can be entered or modified directly or can be calculated considering the volume and density of the silos (bunker, piles, bag, etc.) or the number of bales of hay.
  - **quantity required**: determines the amount of forage available to meet animal needs during the feeding period. For forages, the feeding period should be at least until the next harvesting and it will be different according to the forage type (corn silage, winter cereals silages, hay, etc.).
  - **feed balance availability**: determines the feed's surplus or deficit for each feed. It provides the number of days of availability and the date by which that feed will run out, in addition to daily amounts available, in order to use the feed for the feeding period desired. It provides information on whether to implement a new strategy for the proper management of availability and/or for the possible purchase of feeds. The farmer will then be able to make the final decision.

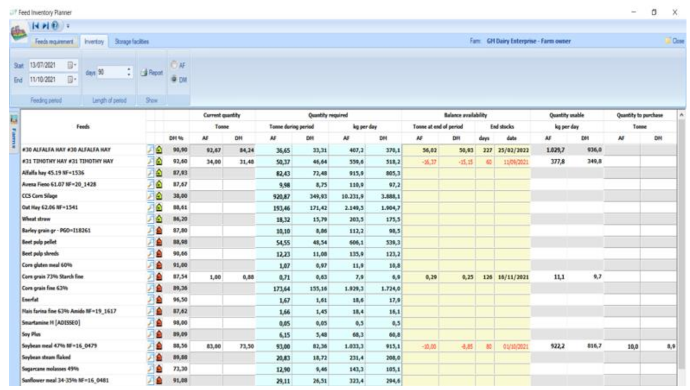

Figure 2: Inventory tab showing the current quantity, the quantity required, the balance availability, the quantity usable, and the quantity to purchase for each feed ingredient

The inventory tab only lists the ingredients used in the recipes (therefore, the ingredients present in a recipe with an amount of zero are not listed). However, feeds not currently included in the recipes or listed with no feeding rate can be still managed in an additional list located just below the list of "regular" feeds. Their required quantities need to be manually entered since there is no way to automatically calculate them from available data. This feature is very useful for simulating the use of feeds that may become available in the future.

Send us your comments on this topic! Emiliano Raffrenato is at emiliano.raffrenato@rumen.it; Giulia Esposito is at giulia.esposito@rumen.it; Dave Weber is at rumendvm@gmail.com

Note that the features and utilities developed by the NDS team are not components of the underlying CNCPS model. None of the original CNCPS structures or equations have been changed in the NDS platform. NDS does provide sub-models and utilities to provide enhanced predictions based on the original CNCPS model. *<u>Questions about the use of these features should be directed to the NDS support team, and not to the CNCPS group at Cornell.</u>*

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