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# NDS Dynamics

## *Welcome to the NDS Dynamics newsletter!*

Dear readers,
Finally the so expected 2021 has began and the teams at RUM&N and at NDS North America want to wish everyone a year back to normality.
In this first issue, professor Trevor de Vries illustrates how feeding behavior affects rumen health and production in dairy cattle.
Furthermore, in the column "NDS UPDATES", we will discuss about the management and environment model and its recent updates.
While we hope to start travelling again soon to offer training and support to our users in person, this year we will continue offering also virtual training and support.
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

## *Interaction of feeding behavior with rumen health and production in dairy cattle*

*By Trevor DeVries*
*University of Guelph*

Milk production of dairy cows is inherently linked to the amount of nutrients consumed; consumption is essentially the function of a cow's eating behavior. That is, the total DMI (kg/d) of a cow is the result of the frequency of meals consumed daily (#/d) and their size (kg/meal) (Nielsen, 1999). DMI can also be expressed as a function of the total feeding time of a cow per day (min/d) multiplied by the rate (kg DM/min) at which she consumes that feed. Thus, for a cow to consume greater DMI, she needs to adjust some aspect of her feeding behavior. For example, by increasing the frequency of daily meals or the average meal size, or some combination of those two, the cow can increase her daily DMI. The same concept applies to the length of eating time per day and the rate at which that feed is consumed. In recent research we (Johnston and DeVries, 2018) demonstrated, using data from multiple studies of high production cows, that both meal frequency and feeding time were stronger predictors of daily DMI, and subsequently milk yield, than the size of meals consumed or the speed at which they were consumed. Thus, these data suggest that increases in DMI may be achieved more consistently by getting cows to have more frequent meals, spread over a longer periods of time at the feed bunk.

Dairy cattle fed a TMR typically consume their daily DMI in 3 to 5 h/d, spread between 7 to 12 meals per day (DeVries et al., 2003). The size and distribution of those meals, not only may impact DMI, but may also influence rumen function. Following a meal, and initial digestion of highly-fermentable carbohydrates, volatile fatty acids (VFA) accumulate and ruminal pH declines. The rate of pH decline will increase as meal size increases (Allen, 1997). Further, with increased rate of feed consumption, daily salivary secretion is reduced (Beauchemin et al., 2008), decreasing the buffering capacity of the rumen and further reducing rumen pH. This results in a much more variable fermentation pattern, resulting in within-day depressions in rumen pH characteristic of subacute ruminal acidosis (SARA). As such, it has been suggested that management practices that cause adult dairy cattle to eat fewer and larger meals more quickly have been associated with a greater incidence of SARA (Krause and Oetzel, 2006). It is, thus, not surprising that consumption of smaller meals, at a slower rate, has also been associated with greater overall efficiency of production in lactating dairy cows (Ben Meir et al., 2018). Therefore, maximizing rumen health, efficiency and productivity involves providing dairy cows with rations, as well as a feeding environment and management of feed therein to promote the frequent, slow consumption of feed in small meals throughout the day.

In addition to the time course of eating, what cows actually consume from the diets provided to them may be equally important. When provided feed as a TMR, dairy cattle have been shown to preferentially select (sort) for the grain component of a TMR and discriminate against the longer forage components (Leonardi and Armentano, 2003; DeVries et al., 2007), increasing the risk of depressed rumen pH (DeVries et al., 2008). Related to this, we have observed that such sorting of a TMR is associated with cows producing milk with lower fat percentage (milk fat decreased by 0.15% for every 10% refusal of long forage particles in the ration; DeVries et al., 2011a; Fish and DeVries, 2012). In Miller-Cushon and DeVries (2017) we also demonstrated that same association, finding that milk fat decreased by 0.10 percentage points for every 10% refusal of long particles. In that work, we also demonstrated that milk protein content decreased by 0.04 percentage points for every 10% refusal of long particles (Miller-Cushon and DeVries, 2017). This finding suggests that sorting also disrupts the balance of nutrients required to optimize microbial protein growth. Imbalanced nutrient intake, as a result of sorting, may also impact the digestion efficiency and production; Sova et al. (2013) demonstrated that efficiency of milk production decreased by 3% for every 1% of group-level selective over-consumption (sorting) of fine ration particles. Sorting of a TMR may also reduce the nutritive value of the TMR remaining in the feed bunk, particularly in the later hours past the time of feed delivery (DeVries et al., 2005; Hosseinkhani et al., 2008), and thus impact production at a herd-level. Sova et al. (2013) showed that every two-percentage point increase in selective refusal (i.e., sorting against) of long ration particles on a group level was associated with a per cow reduction of 0.9 kg/d of 4% fat-corrected milk.

After feed is consumed, there is another behavior that may influence rumen health and efficiency: rumination. Rumination contributes to the breakdown of feed into smaller particles, which then increases feed surface area and decreases the amount of time it takes feed to be fermented in the rumen, thus increasing the rate of digestion of that feed. Thus, rumination can potentially impact feed intake levels. For example, if rumination is limited, longer, more fibrous particles will stay in the rumen for a longer duration of time, causing the rumen to feel fuller, potentially limiting dry matter intake (DMI) and reducing milk production. Associations of rumination time and DMI are variable, however, f we control for much of the variability between cows, rumination can be predictive of both DMI and milk production (Johnston and DeVries, 2018). The saliva produced during chewing and bolus formation in rumination not only aids in re-swallowing of that bolus, but also acts to maintain rumen pH through its buffering abilities, thus helping avoid ruminal acidosis. Related, there is research to suggest that monitoring of rumination behavior, at a herd level, may provide some insight into rumen health (DeVries et al., 2008).

Not only do behavioral patterns influence the risk of poor rumen health, but may also change in response to changes in the rumen environment. Research data indicate that cattle will either change feed preferences or begin to sort in favor of long forage particles in mixed ration in response to experience of a bout of acidosis (DeVries et al., 2014). Further, there is evidence that the degree to which they change their sorting is directly related to the degree of acidosis incurred. From a practical standpoint, this means that obvious changes in the diet selection patterns of cattle within a herd may indicate that they are experiencing some disruption to normal rumen function.

Overall, feeding behavior of dairy cattle is related to rumen health and function. It is well established that eating patterns and diet selection may lead to poor rumen health. Further, cattle may change their feeding behavior in response to poor rumen health. Finally, there are may opportunities to alter feeding behavior, not only through dietary formulation, but also feeding and housing management.


# NDS Dynamics

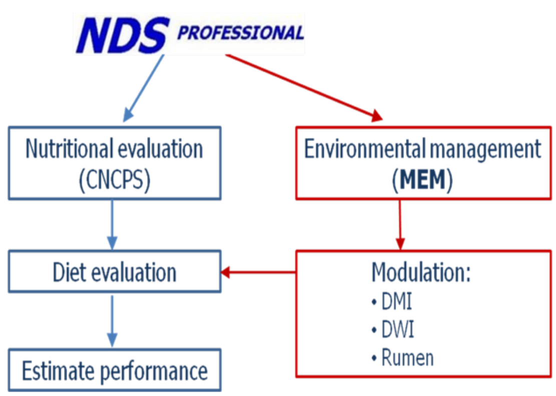
## *NDS Management Environment Model*

*By E. Melli*
*RUM&N R&D Department*

One of the main objectives of the NDS Professional platform is to provide an appropriate decision-making tool not just from a nutritional standpoint, but also for economics and managerial aspects.
The NDS Management Environment Model (MEM) represents an example of development towards this strategy.

The rationales behind this advanced tool are:

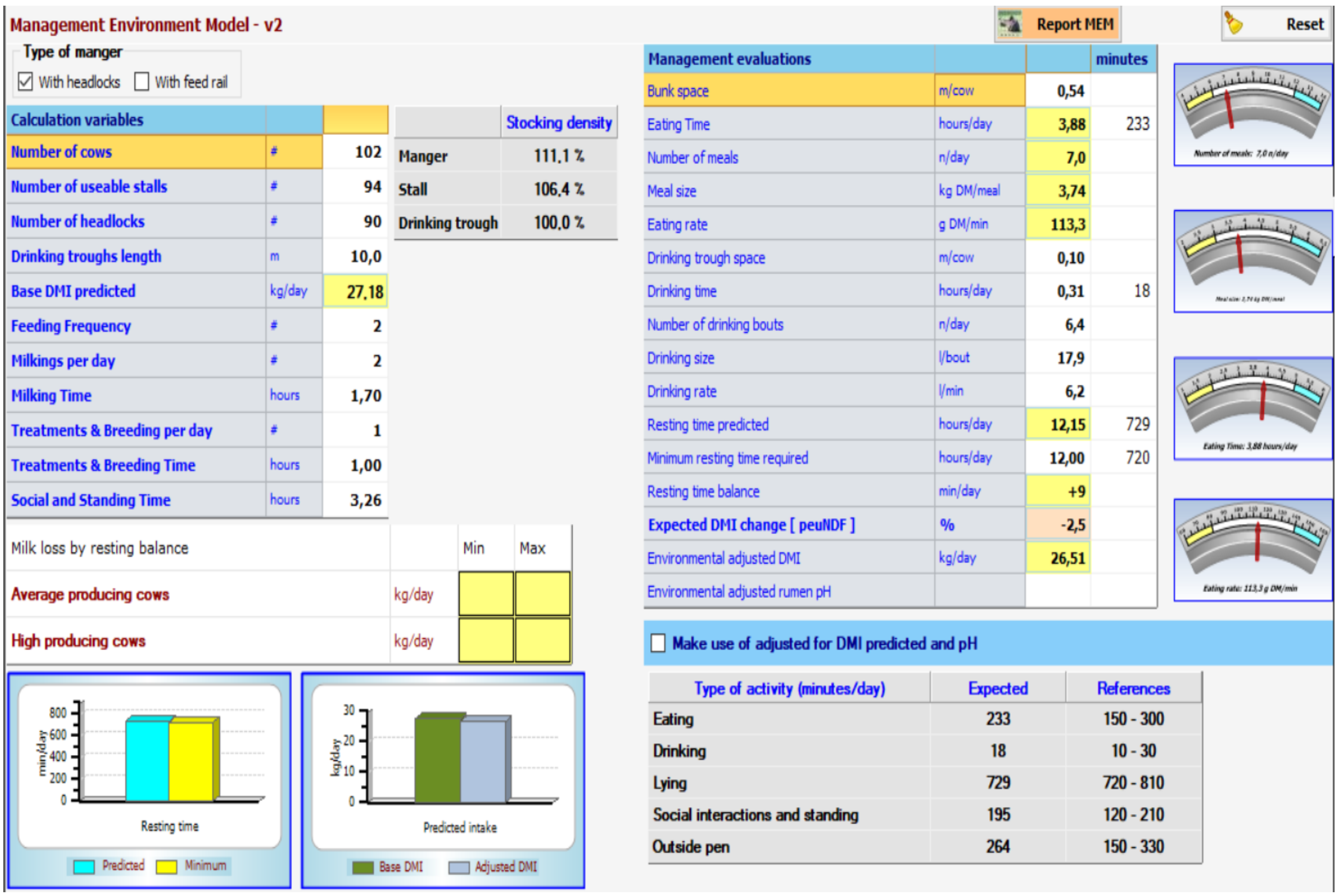
- An accurate measuring or prediction of DMI improve ration formulation and it is a critical component of nutrition models
- Feeding behavior of dairy cattle determines DMI which is broadly controlled by rumino-reticular fill and chemostatic mechanisms but modulated by the animal's feeding environment




In the past decade, several pieces of research and field observations highlighted that greater stocking density at the feed bunk and free-stall increases aggressive interactions, displacements, and alters meal patterns, rumination, and resting behavior, especially for subordinate cattle.
From this, it follows that the combination of housing facilities and management routines define the physical and social environment within which dairy cattle consume the feed. All these factors can modulate DMI resulting in large variations in the production and profitability responses.
The **NDS MEM** incorporates key parameters to predict the behavior and the regulation of feed intake and its goal is to include the analysis of the parameters of intake and resting as an integral part in the prediction of DMI and the formulation of dairy rations, to better predict feeding and other behaviors, cow performance, and health responses. The MEM model is designed as a tool for modeling the influences that social environment can have on intake in dairy cows, allowing more accurate prediction of intake, including assessments of the physical and social environment.
A secondary objective of the model is to provide a structure able to relate lying and resting time, time spent for feeding and rumen fermentation, with feed bank management.

The model is included in the ***Animal inputs*** tab of the ***Recipe*** feature.
Among the inputs for the feed and feeding environment, we can list stocking density, feeding frequency, type of manger, and other key behavioral components. Through those specific inputs related to the pen where the recipe is fed, the feature can provide several output evaluations that should design, for the analyzed pen, the current scenario about the social interaction on eating and resting time, DMI prediction, and rumen pH adjustment.
This model was designed to be used by dairy farmers or professionals to input specific farm variables to assess the effect of management decisions on DMI, milk production, and behavior. It can be used on a routine basis to obtain a better interpretation of animal responses and to identify possible areas for improvement in herd efficiency and profitability.


# NDS Dynamics



Management Environment Model - v2

Report MEM

Reset

Type of manger

☑ With headlocks ☐ With feed rail

| Calculation variables | | |
|---|---|---|
| Number of cows | # | 102 |
| Number of useable stalls | # | 94 |
| Number of headlocks | # | 90 |
| Drinking troughs length | m | 10,0 |
| Base DMI predicted | kg/day | 27,18 |
| Feeding Frequency | # | 2 |
| Milkings per day | # | 2 |
| Milking Time | hours | 1,70 |
| Treatments & Breeding per day | # | 1 |
| Treatments & Breeding Time | hours | 1,00 |
| Social and Standing Time | hours | 3,26 |

| | Stocking density |
|---|---|
| Manger | 111,1 % |
| Stall | 106,4 % |
| Drinking trough | 100,0 % |

| Milk loss by resting balance | | Min | Max |
|---|---|---|---|
| Average producing cows | kg/day | | |
| High producing cows | kg/day | | |

| Management evaluations | | | minutes |
|---|---|---|---|
| Bunk space | m/cow | 0,54 | |
| Eating Time | hours/day | 3,88 | 233 |
| Number of meals | n/day | 7,0 | |
| Meal size | kg DM/meal | 3,74 | |
| Eating rate | g DM/min | 113,3 | |
| Drinking trough space | m/cow | 0,10 | |
| Drinking time | hours/day | 0,31 | 18 |
| Number of drinking bouts | n/day | 6,4 | |
| Drinking size | l/bout | 17,9 | |
| Drinking rate | l/min | 6,2 | |
| Resting time predicted | hours/day | 12,15 | 729 |
| Minimum resting time required | hours/day | 12,00 | 720 |
| Resting time balance | min/day | +9 | |
| Expected DMI change [ peuNDF ] | % | -2,5 | |
| Environmental adjusted DMI | kg/day | 26,51 | |
| Environmental adjusted rumen pH | | | |

☐ Make use of adjusted for DMI predicted and pH

| Type of activity (minutes/day) | Expected | References |
|---|---|---|
| Eating | 233 | 150 - 300 |
| Drinking | 18 | 10 - 30 |
| Lying | 729 | 720 - 810 |
| Social interactions and standing | 195 | 120 - 210 |
| Outside pen | 264 | 150 - 330 |



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