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NDS Dynamics

Welcome to the NDS Dynamics newsletter!

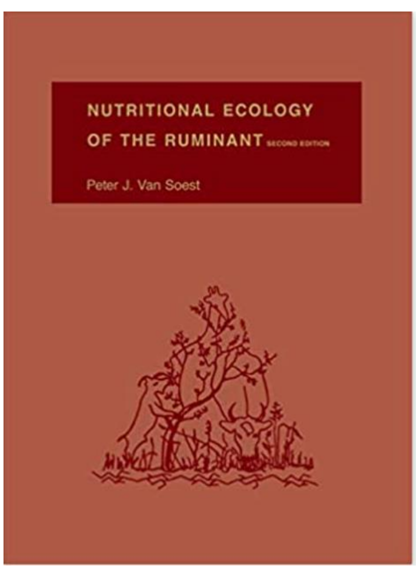
Dear readers,

Sunday the 21st of March, Peter Van Soest left this world. You may have heard his name when you were studying or reading about ruminant nutrition. He was a true genius!

A lot of what you find embedded in NDS Professional originates from the genius he was and a lot of research that is still being done nowadays comes from his bright mind.

All we can do is to thank him for the towering legacy he left behind. We also like to remember him while he drinks some scotch, or in the field while he twists some grass around his fingers, to demonstrate the fragility concept of a forage, or while he chews on some silage to assess the success or the failure of the fermentative process; talking to anyone, from a student to a farmer to a rector of a University with no distinction.

R.I.P. Pete!



This month the RUM&N team decided to publish a special issue about the recently implemented NDF rate calculator in NDS Professional. Since its implementation, a bit longer than one year ago (January 2020), the NDS rate calculator has raised some questions from few users about the differences with the previous NDF rate calculator. Therefore, with this issue, Dr. Emiliano Raffrenato (RUM&N R&D) gives us an overview about the research that lead to the recent updates on the NDF rate calculator and some tips on how to correctly use NDS Professional when overestimation of the ME and MP allowable milk is noticed. Furthermore, Ermanno Melli (RUM&N, R&D) presents the results of the validation process of the updated model.

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

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Recent update and opportunities of the CHO-B3 kd characterization in NDS

By Emiliano Raffrenato
RUM&N R&D Department

In January 2020 NDS implemented a revision of the NDF rate characterization. The revision maintained the main mathematical and model principles from Raffrenato et al. (2019). That paper described the equations used in a Vensim model finalized to find the optimal value for a pdNDF kd, when having only few time points of NDFd. So, we were dealing with an optimization for a non-linear fermentation curve. Similarly, to all non-linear optimizations, the Vensim model needed initial values for the parameters' estimation. In that case those initial values were given by constant ranges. We revised this by adding forage-specific starting values of the parameters to be used by the non-linear optimization.

Since the implementation of the upgrade, we were able to collect important feedback from users around the globe and gather a large amount of data to further validate the optimization. The original validation of the model was performed and resulted in a good evaluation. We recently realized that a small part of the samples (around 5%) resulted in a slight overestimation of the rates. These samples were mainly with overall kd above 7-8%/h and when the difference between NDFd at 120 and 240 hours was very small. The issue was linked to the initial parameters' estimation mentioned above. These cases drastically decreased when the 12h NDFd was present, to emphasize one more time the importance of this time-point NDFd. We, therefore, improved the model with a small revision of the range estimation to avoid this issue. In most cases, you should not see any remarkable change in your recipes' outputs. However, in cases where you noticed an overestimation of the ME and MP allowable milk, due to the characterization of one of those forage samples described above, it will be sufficient to open the recipe and the ingredients having a kd estimation using 3 or 4-time points NDFd and re-save those ingredients again to implement the updated characterization. Update your version of NDS to have the latest B3-kd estimation. While we write this newsletter, the latest NDS Professional version is *3.9.9.06*.

Use of two vs. one pool system

For at least ten years we have been hearing about a fast and slow pool of NDF, besides the indigestible NDF (i.e. uNDF240). The first time this new NDF characterization was described was at the Cornell Nutrition Conference of 2010 when Raffrenato and Van Amburgh (2010) showed how a fast degrading, a slowly degrading, and an indigestible NDF could better describe the NDF fermentation profile in forages. This was the beginning of a new "era" in NDF characterization, especially allowed by more accurate estimation of iNDF. In reality, Dr. Mertens had already hypothesized in his Ph.D. thesis (1973) that NDF degradation could be better described by at least two pools of degradable NDF. Back then, an issue was probably the non-accurate iNDF estimation, done with earlier time points (e.g. 72 or 144 h instead of 240 h), and the fact that *in-vitro* NDFd were not commonly available in commercial laboratories. Later in the years, the model was also not implemented when iNDF was estimated using ADLx2.4.

Since the 2010 CNC publication, most commercial laboratories have invested in the updated characterization of the carbohydrates' fractions B3 and C, by making more time points NDFd available to CNCPS users. Since 2014, NDS Professional has allowed users to input the NDFd time points and use the Vensim model described by Raffrenato and Van Amburgh in 2010. In the meanwhile, both the CNCPS 6.5 and 6.55 were updated to allow the use of the newly defined CHO-C fraction, for both forages and non-forages, which is now used also to evaluate diets and their rumen fill potential. Unfortunately, both versions did not implement the fast and slow degrading pools, that supposedly will be implemented in version 7 of the CNCPS.

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We have read various publications showing results with fast, slow and indigestible NDF for various years. However, in CNCPS we still assume that B3 is only one uniform pool with a single kd. This means that we have estimated one fractional rate of degradation that would attempt to fit as much as possible the two degrading pools. In both 2010 and 2019, Raffrenato et al. had mentioned using a weighted average kd, using the rates and proportions (i.e., weights) of fast and slow pools and this is what NDS still does. The alternative would be to ignore the presence of the pools and use the time points to fit one kd. Both systems will give one single B3 kd that, in most cases, would not be able to fit the two pools curve and, depending on how different the fast and slow pools and rates are, the error will vary. Below is an example of a common case to show you the possible outcomes. We will consider only the B3 fraction since the estimation of the C fraction (i.e. indigestible NDF) is the same since depending on the uNDF240 value.

Example:

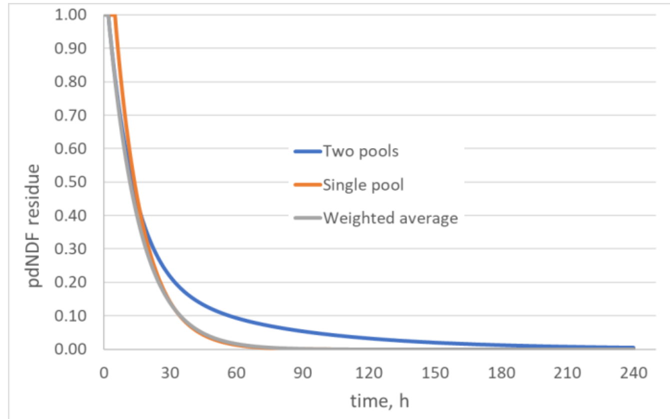
kdfast = 8.40 %/h

kdslow = 1.67 %/h
Fast pool size = 0.77

Slow pool size = 0.23

Single pool kd = 6.39 %/h

Weighted ave. kd = 6.82 %/h



It is apparent from the figure above that both the single pool kd and the weighted average kd are "close" to the real two-pools profile only in the first section of the fermentation (i.e. <30 h). Furthermore, if we apply the popular formula by Waldo et al. (1972) to quantify the amount of fast and slow B3 fermented [kd/(kd + kp)] and assuming a kp of 1.6%/h, for each kg (or lb) of B3, the rumen would ferment 0.763 kg of B3. This value would be the sum of the digested fast and slow pools and we assume it is the "control" or reference value of our comparison. When using the single pool kd or the weighted average kd, we would obtain 0.800 or 0.810 kg of B3 digested, respectively.

Therefore, whenever we replace the two-pool B3 system with one single value we are decreasing accuracy and precision. We, at RUM&N, always aim for progress and hope to see the two pool system for the B3 fraction implemented in the CNCPS. This, as seen above, will definitely improve the overall ME and MP allowable milk predictions, especially in high forage diets and/or high quality forages. When we have the necessary NDFd values, NDS Professional already calculates the fast and slow B3 fractions for both forage and non-forage ingredients and therefore such an update would be truly needed and welcomed.

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Accuracy of ME and MP allowable milk in NDS

By E. Melli
RUM&N R&D Department

One of the main goals we have here at RUM&N is to provide tools that can deliver high levels of prediction accuracy. From a practical standpoint, ME and MP allowable milk are the most important predictions, because they allow to evaluate the calibration of the model and make more reliable decisions.

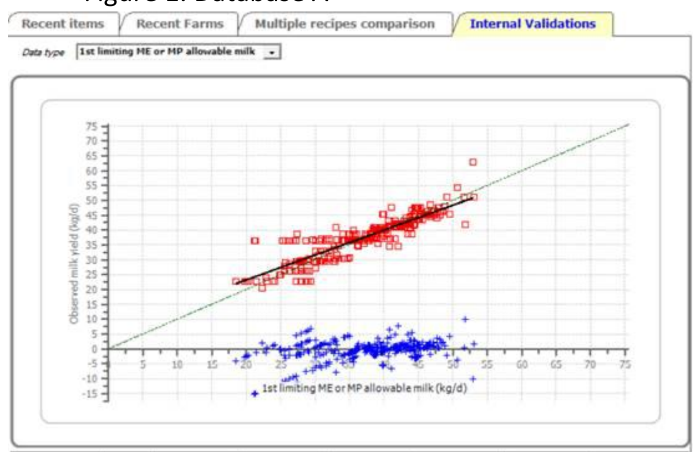
This note summarizes the results of the internal validation conducted to verify the accuracy of NDS predictions for the allowable milk, the magnitude of the residuals, and the directionality of the bias.
Using the **Internal Validation** tool available in NDS for internal purposes, we processed a few databases from NDS users. The analysis was conducted considering the following specifications:

- all the forages included in the recipes have been checked for the NDFD using either 3 or 4-time points
- the CHO B3 rate has been calculated using the last version of the Raffrenato calculator embedded within NDS
- all rations saved as of January 1, 2020, have been included and evaluated with CNCPS v6.55
- no outlier has been removed
- the R2 was not adjusted (as done in Van Amburgh et al., 2015)

The figures below show observed milk yield versus NDS first-limiting MP- or ME-allowable milk. The residuals are also shown on the graphs.

The databases involved in this analysis show that the accuracy of ME and MP allowable milk prediction is good (R^2 0.79) when the accuracy of the inputs for the observed milk is reasonably high (Database A, Figure 1). Also, the residuals seem to be homogeneously distributed without a specific tendency to over or underestimation.

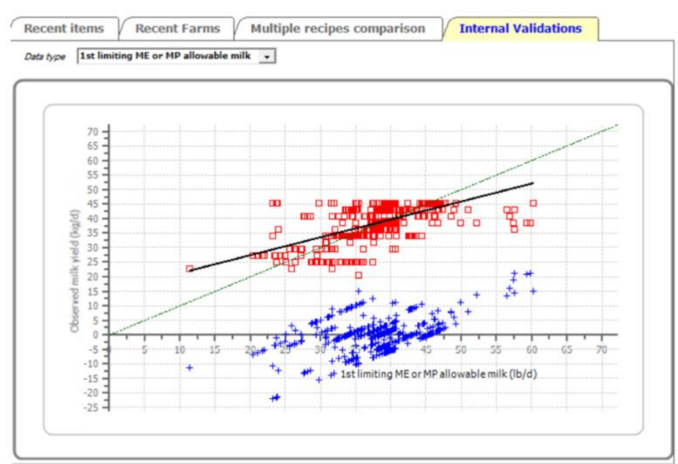
Figure 1. Database A



	N	Intercept	Slope	R2	RMSE	CCC	MSPE
ME or MP	341	6,487	0,838	0,786	3,31	0,883	9,478

At the opposite, when observed milk yield is not timely updated based on current production, the accuracy of the predictions clearly drops (R^2 0.37), demonstrating that the model is not properly calibrated (Database B, Figure 2).

Figure 2. Database B



	N	Intercept	Slope	R2	RMSE	CCC	MSPE
ME or MP	631	15,02	0,62	0,37	5,5	0,61	24,7

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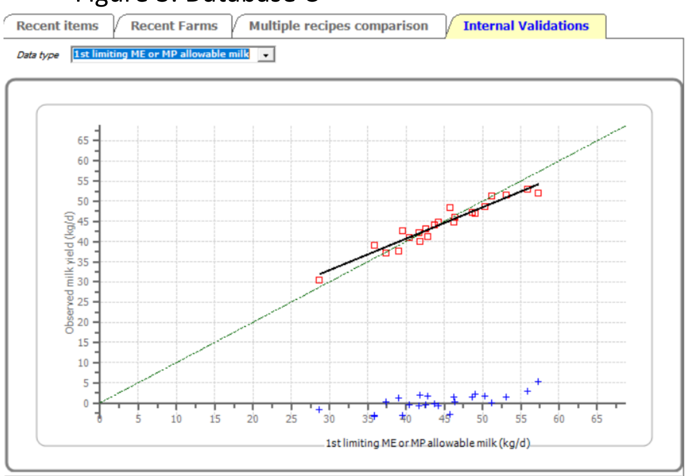
The best accuracy is observable with Database C (R^2 0.93). It includes diets used in recent experimental trials where all conditions and inputs have been thoroughly verified.

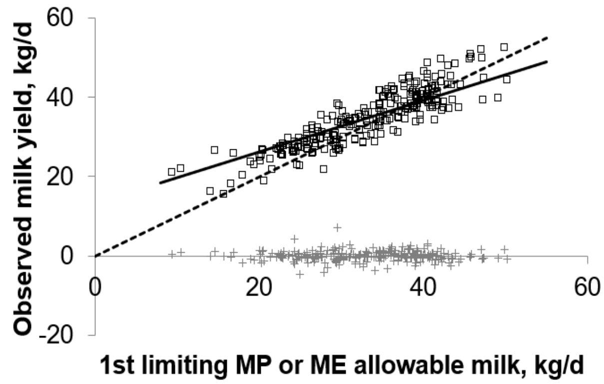
Figure 3. Database C



	N	Intercept	Slope	R2	RMSE	CCC	MSPE
ME or MP	23	9,55	0,78	0,93	2,1	0,94	2,3

Given the relatively small number of rations included in this database, the results do not necessarily represent a validation of the current model using the recent Raffrenato rate calculator included in NDS, but appear to agree with the conclusions reported in Van Amburgh et al. (2015) (Figure 4. Validation of the CNCPS 6.5 model).

Figure 4. Validation of the CNCPS 6.5 model



	Inter	Slope	R^2_{BLUP}	R^2_{MP}	RMSE	CCC	MSPE
MP or ME	13.17	0.65	0.97	0.78	1.6	0.83	12.8

In conclusion, when the predictions of the model are so far from reality it is not just a matter of single values as, for instance, forage degradation rate, but these inaccuracies, very frequently, are related to the definition of critical inputs as intake, BW, yield and components, BCS change, etc. We strongly believe that a major prerequisite for evaluating the accuracy of the outcomes is to use accurate and up-to-date inputs.

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>***