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Calf Note #224 – Predicting dry feed intake in calves to 4 months of age

Introduction

The ability to accurately and precisely predict intake of animals is fundamental to proper ration formation and nutritional management. A reasonable estimate of the amount of feed an animal – in our case, a calf – will eat in a given period of time is essential to formulating calf starters, milk replacers and determining when a young calf is ready for weaning.

Our ability to estimate intake in calves prior to 4 months of age is particularly difficult, as the calf goes through profound changes during this time. Also, we have to understand the effects of milk feeding programs, age, environment, and the starter or forage that we offer. Consequently, there are few published studies that have attempted to predict intake prior to and after weaning.

Note, that I'm referring to dry feed intake in this context. Except for calves fed ad libitum, we generally know the amount of milk or milk replacer the calf consumes every day.

When the calf is very young, it will eat little or no dry feed, instead relying on milk or milk replacer for all of its nutrients. At some point, the calf will learn that starter = feed and will begin consuming increasing amounts to augment nutrients (especially energy) from milk. As the calf is weaned, dry feed intake increases dramatically as the calf attempts to replace nutrients previously provided in milk.

The research group at Provimi North America (a division of Cargill, Inc.) recently published an important manuscript in the Journal of Dairy Science that predicted dry feed intake in calves from 3 days of age to 4 months of age. As first author, I had the opportunity to lead the team in collection, analysis, synthesis, and presentation of more than 60,000 daily observations of intake in calves from the U.S. and Europe under a wide variety of feeding conditions.

In the next several Calf Notes, I will go into greater detail regarding the specifics of the data, but here I want to show the most important equations and how to use them in predicting dry feed intake.

The Research

The manuscript is available in the Journal of Dairy Science. You can access the PDF version here. For a limited amount of time, the paper will be freely available; thereafter you'll need a subscription to the Journal to access it.

We collected daily dry feed intake (starter and forage, when offered) from 1,235 calves from 3 to 114 days of age. Almost all calves were bulls. Data were from Cargill facilities in Ohio, Minnesota, The

Netherlands, and data from 3 trials conducted at Iowa State University were included, also. Calves were fed varying amounts of milk or milk replacer (454 g/d to >1 kg/d) and weaned between 28 to 64 days of age. Calf starter (texturized of pelleted) were always offered for ad libitum consumption and water was always available. More details are available in the paper and we'll cover implications of management in future Calf Notes.

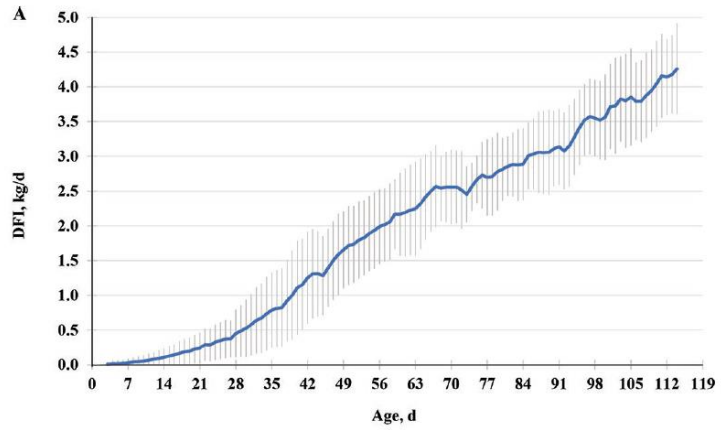

Figure 1. Dry feed intake (calf starter and forage, when offered) in calves from 3 to 114 d of age, kilograms per day. From: Quigley et al., 2021.

The Results

Dry feed intake (**DFI**) when expressed as kilograms per day (Figure 1) increased from 0 kg/d in the first week of life to >4 kg/d by the fourth month. The rate of increase was slow at first, but increased during the 5th and 7th week, when most calves were weaned.

Looking at DFI as a % of body weight (Figure 2), we clearly see the curvilinear nature of the relationship between age and DFI. During the first 2 weeks of life, calves ate <0.5% of their BW, but increased DFI through the weaning period to reach a maximum DFI of approximately 3% of BW by 65 days of age.

Because the pattern of intake showed a clear curvilinear pattern when expressed as kg/d or % of BW, we looked at different forms of equations to predict DFI. The first was nonlinear equations, including Gompertz, Exponential, and Logistic equations. Our second approach was to use linear models and include polynomial coefficients. We found that the nonlinear approach produced equations with better "fit" (more closely predicted the actual intakes) compared to the polynomial equations, and the Gompertz equations were best of all.

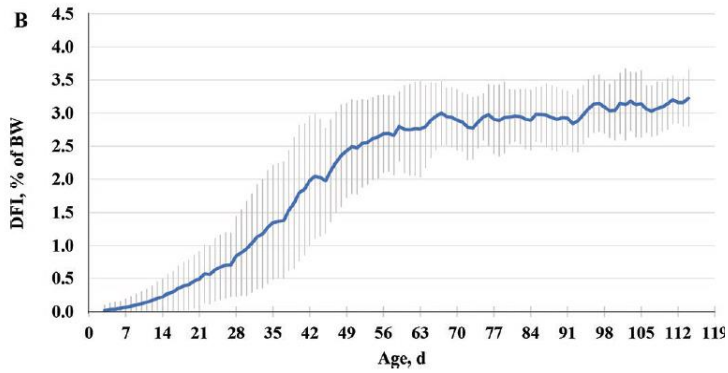

Figure 2. Dry feed intake (calf starter and forage, when offered) in calves from 3 to 114 d of age, % of body weight. From: Quigley et al., 2021.

Gompertz equations have been used to predict growth of animals, plants, and bacteria with great accuracy. Because DFI is closely related to growth in young calves, it's logical that this approach would result in reasonable predictions of intake.

The most important factors in predicting DFI included age of the calf, amount of milk consumed (more milk consumed = less DFI), body weight and rate of daily gain, environmental temperature, and the amount of forage and fiber

in the ration. However, temperature and ration characteristics – though statistically significant – didn't dramatically change predictions of DFI. Therefore, the simpler equations may be just as predictive compared to more complex equations.

We found that predicting DFI as kg/d was more accurate than predicting DFI as % of BW; therefore, I'll present only the kg/d data here. The equations for % of BW are available in the paper in the Journal of Dairy Science.

We consolidated milk intake, BW and ADG into one variable called "MEgap". This variable basically is the ME requirement of the calf on a given day minus the ME consumed in the milk or milk replacer. After weaning, MEgap is simply the ME requirement of the calf.

The Equations

The more complex and simple equations to predict DFI are:

$$\text{DFI (kg/d)} = 1.3207 \times e^{[(-5.3892 + 0.6376 \times \text{MEgap}) \times \text{EXP}(-0.0392 \times \text{Age})]} - 0.0013 \times \text{Temp} + 0.0032 \times \text{NDFDM} + 0.0026 \times \text{Age} \times \text{MEgap} - 0.3646 \times \text{PctForage}$$

$$\text{DFI (kg/d)} = 1.4362 \times e^{[(-4.6646 + 0.5234 \times \text{MEgap}) \times \text{EXP}(-0.0361 \times \text{Age})]} + 0.0025 \times \text{Age} \times \text{MEgap}$$

Here are the factors in the equations

- MEgap: difference of daily metabolizable energy (ME) requirement and ME intake from milk replacer. It is calculated as:
    - $\text{MEgap} = (0.1 \times \text{BW}^{0.75} + 0.84 \times \text{BW}^{0.355} \times \text{ADG}^{1.2}) - \text{MEI}$
    - BW = body weight (kg) of the calf on the day of prediction
    - ADG = target ADG, ranging from 0.2 to 1.2 kg/d
    - MEI = ME intake from milk or milk replacer, calculated according the 2001 Dairy NRC
    - When MEgap is negative, it is set to zero.
- Age = age of calf (days) from 3 to 114
- Temp = mean daily ambient temperature (°C)
- NDFDM = ration neutral detergent fiber (% DM)
- PctForage = percent forage in ration DM

It's relatively easy to implement these equations into a prediction of DFI. I've included a simple Excel spreadsheet that demonstrates how to implement the prediction equations. The link is here.

Summary

In future Calf Notes, we'll review the biological implications of each variable and how DFI changes as calves age.

These equations will help us to formulate rations for young calves to 4 months of age. We can use these equations to better predict how much a calf will eat, when it is ready for weaning and to better formulate dry feeds to meet nutrient requirements. This is an important paper – one of my best!

References

Quigley, J. D., T. S. Dennis, F. X. Suarez-Mena, C. E. Chapman, T. M. Hill, and K. M. Aragon. 2021. Models to predict dry feed intake in Holstein calves to 4 months of age. J. Dairy Sci. https://doi.org/10.3168/jds.2020-19581.

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