NDS Dynamics

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Note: With this issue of <u>NDS Dynamics</u> we will be changing the newsletter schedule to every 4-8 weeks. Content will continue to spotlight elements of CNCPS and unique NDS features, usually in 1-2 page articles, with the intent of enhancing NDS users familiarity with aspects of the CNCPS model and the NDS platform that contribute to more effective ration formulation. This issue will feature the first of a two part series on peNDF, and two features of NDS that facilitate NDS users ability to make better formulation decisions and troubleshoot issues related to peNDF and rumen pH: the "P-Size Tab", and the "Fiber Adequacy Tab".

The NDS P-Size Tab: Improving Ration Performance with Accurate Ration peNDF Content

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How important is it to use measured peNDF in rations versus a peNDF calculated based on library values? When measured pef was used instead of tabular library values, Grant and Cotanch (2005) reported that the difference in MP allowable milk was a whopping 5.5 to 6.6 lbs. In addition to avoiding costs arising from subclinical ruminal acidosis (**SARA**), this indicates that determining the actual peNDF of a ration is very important economically.

Adequate physically effective fiber (**peNDF**) is essential in dairy rations, largely based on the importance of maintaining rumen pH in a range that optimizes diet digestibility and animal productivity and health. Diets formulated with inadequate peNDF can result in reduced ruminal pH and in ruminal acidosis (either SARA or clinical lactic acidosis). Reduced ruminal pH is associated with milkfat depression and with many serious health disorders such as laminitis, hemorrhagic bowel syndrome, rumenitis, liver and lung abscesses, toxic indigestion, off-feed incidents, and displaced abomasum. In the excellent and seminal paper defining peNDF as fiber that stimulated chewing (Mertens, 1997), the author acknowledged that multiple factors in addition to simply particle size are co-determinants of chewing, and he evaluated his peNDF proposal against literature values for rumen pH. Inadequate ration peNDF also decreases diet digestibility and feed efficiency due to increased rate of passage, decreased rumen retention time, and because of reduced microbial efficiency at lower pH. However, overly increasing ration peNDF content by adding NDF to the diet in excess of the peNDF needed may reduce diet digestibility and energy density (and thus productivity) if more extensively fermentable carbohydrate sources are displaced, or if intake becomes limited by gut fill. Bottom line, like Goldilocks and the three bears, the porridge (ration & peNDF) has to be "just right", not too hot, and not too cold!

But, during the ration formulation process accurately knowing the precise amount of peNDF that the ration will supply is difficult, partly because before it is mixed and fed it is difficult to know what the actual peNDF content of a formulated ration is. This is partially because often the physical effectiveness factor (**pef**) of the forage ingredients has not been measured prior to formulating and feeding a diet, and "book values" from the feed library are used. However, work at Miner Institute (Grant and Cotanch, 2005) has demonstrated that there is a large amount of variation in the pef compared to the library "book" or "table" values of individual feeds. *<u>This indicates that it is important to assess the actual peNDF of the feeds being fed, and not rely on library default values</u>*. In addition, the TMR mixing process varies tremendously between dairies, and has large but variable effects on peNDF as presented to the cows. This variation is related to mixer type, knife and auger sharpness and wear, mixing time, kicker plate adjustment, mix pause settings, ingredient addition order, feed dry matters, etc. Therefore is important to measure the pef on a diet ***<u>after</u>*** it has been mixed. Fortunately for NDS users, a feature in the NDS program, the **P-Size** tab, facilitates identifying the actual pef in a ration, adjusting the pef of single included feeds, and if needed, reformulating rations with more appropriate peNDF.

Another confusing aspect of ration peNDF evaluation is that the estimate of what particle size constitutes an "effective" particle size in terms of being retained in the rumen (and therefore ruminated) has changed since the original Mertens (1997) paper, at least in field applications. Mertens (1997) originally proposed and defined peNDF as the particle size and NDF characteristics that affect chewing activity, which he stated was related to the particle size that was large enough to be retained in the rumen and not pass out through the reticulo-rumen orifice. At the time, he and others considered a 1.18 mm particle size as the critical threshold for rumen retention, largely, however, based on earlier work in sheep, and on extensive sieving of cattle feces. Fecal particles < 1.18 mm indicated larger particles were retained, although other cutpoints were also considered reasonable. More recent work has indicated that the critical particle size threshold for rumen retention in cattle is larger than 1.18 mm (Grant and Cotanch. 2005, Oshita et al. 2004), and is likely between 2 mm and 4 mm, and may vary with forage species. It seems likely that comminution from chewing during eating and rumination contributes to particle size reduction between ingestion and fecal excretion. This may be some of the reason prior to feed ingestion a larger particle size threshold for feed particles than for the fecal particles can be used. In any case, in some recommendations it is not always clear what particle size is referred to as "peNDF".

Furthermore, when pef is actually measured it is often done by different methods, and the methods are not consistent in their resulting pef values. The pef obtained by measuring the material remaining on the top two screens (19 mm, 8 mm) of the original 3 screen Penn State Particle Separator (**PSPS**) is not a valid estimate of pef, nor does it match pef derived from material remaining on the top 3 PSPS screens of the 4 screen PSPS when the third screen is 1.18 mm, nor the newer PSPS 4 mm third screen. The 4 screen PSPS with the current 4 mm third screen does reasonably match the original Mertens definition using vertical dry sieving with the 1.18 mm screen (Heinrichs, 2013; Schulling et al., 2015). Also, the PSPS measures feeds based on horizontal shaking, which separates particles primarily by length, whereas the original concept of peNDF determination as proposed by Mertens (1997) was based on vertical shaking of dry samples. Vertical shaking separates particles mostly by diameter or width; therefore PSPS results obtained by horizontal shaking are somewhat discrepant with the original vertical separation used in the definition of peNDF. An alternative field method, the Z-Box developed at Miner Institute, uses manual vertical shaking. However, the Z-Box uses different size screens (3.187 mm for TMR) than the 1.18 used by Mertens (1997) in the derivation of the peNDF system. Nonetheless the Z-Box agrees well with the vertical dry sieving technique using a 1.18 mm screen (Cotanch & Grant 2006).

Nutritionists should ensure that the method they are using in the field to determine the pef factors of diets and the feeds used in their diets is providing the best estimate of fiber effectiveness possible. For field use, the NDS staff strongly recommends use of the four screen PSPS with the current 4 mm screen, or alternatively the Z-Box with the appropriate screen. Both are useful for assessing pef, but the advantage of the PSPS over the Z-Box is that the proportion of material remaining on the PSPS top (19mm screen) provides information on the sortability of a screened TMR sample, whereas the Z-Box does not provide information on sortability .

NDS has a great feature that facilitates formulating and managing rations using correct peNDF values: the **P-Size** tab, located toward the top of the main recipe screen. The NDS P-Size tab permits a user to plug in the results from either the Z-Box or the 4 screen PSPS (PSPS with the current 4 mm screen, NOT the 1.18 mm screen), and after entry, auto-calculates the "observed" pef for a given ration. (Figures 1 & 2 below). The user can then compare the "observed" pef with the "estimated" pef (calculated based on the extant current pef values for feeds in the ration). The value for the peNDF in the ration is also shown in the information box at the top center of the screen. The displayed ration peNDF is calculated using the "estimated" pef for the ration multiplied by the ration NDF content, and is auto-calculated by NDS.

The feeds in the ration, and the current pef values of each, are shown on the upper right quadrant of the P-Size tab. The peNDF fields shown there in the upper right are editable right there for individual feeds in the ration, without having to navigate to the feed library. When the "observed" and "estimated" pef values differ, users can use their knowledge of the individual ration feeds, which might include for instance prior screening of corn silage or haylage, or perhaps observation of the extent to which an ingredient like premium quality alfalfa hay is reduced to a "powder", or observing that the silage chop is extremely fine or coarse, and then make a subjective empirical adjustment to just those selected feeds to bring the "estimated" pef in line with the "observed" pef of the ration. The user would typically select feeds to adjust that would be expected to have the greatest variance from the currently applied or tabular value. After the adjustment is made, and the estimated pef is rendered to a value similar to the observed pef, the revised adjusted value for the peNDF of the ration will be a better estimate of the ration peNDF content. The "updated" values of pef for individual feeds are now automatically saved with the feeds, and are used in the next ration revision. If there is need to reformulate the ration to adjust the peNDF, it will now better reflect the true peNDF.

The NDS P-Size tab provides nutritionists who are NDS users with two tremendously useful advantages. The peNDF based on the adjusted pef values derived after screening the ration will be a better estimate of the actual ration peNDF, and thus provides a more correct peNDF value for ration evaluation, especially if only tabular values were initially used in formulation. This is especially useful, for instance, when troubleshooting butterfat depression, loose manure, or toxic indigestion. Even better, because the assigned pef values remain assigned to the feeds used in the ration, the ration can be reformulated using the new adjusted pef values for the feeds. If troubleshooting indicates a change in the peNDF is called for, it will now be easier to realize the targeted ration peNDF since the adjusted pef values of the feeds now better reflect their actual pef. The following two images illustrate this process. Figure 1 shows a ration with the tabular values, which suggests incorrectly that the peNDF level might be ok. Figure 2 shows the ration after the pef values on the hays and the corn silage have been adjusted, showing that the actual peNDF is lower than expected. Great tool, and this nutritionist has found it very useful for refining rations and for troubleshooting.

Note that the P-Size tab is a utility tool developed by the NDS team, and is not a component of the CNCPS model itself. *Questions about use of this feature should be directed to the NDS support team, and not to the CNCPS group at Cornell.*

Figure 1. Note that the peNDF fields of the forages (purple box at right) contain the default tabular values from the feed library; the estimated pef of the ration (center, red & black box) is different than the observed pef (red box, bottom center), and that the ration peNDF is 21.83% (green box).

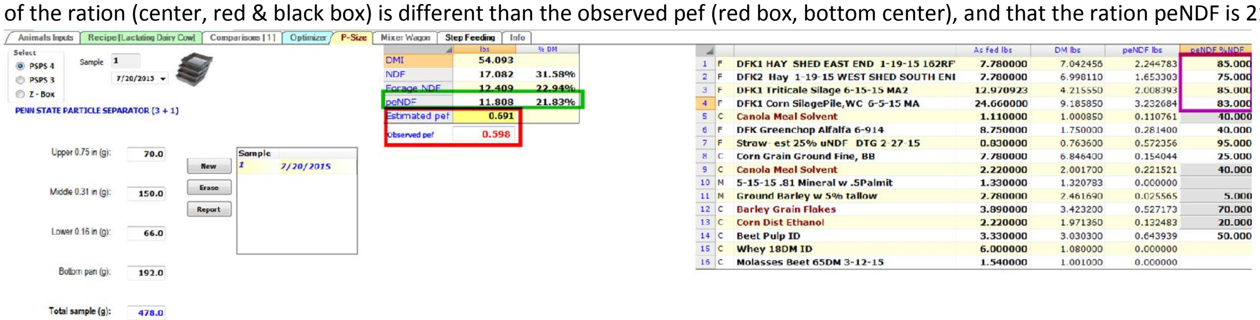
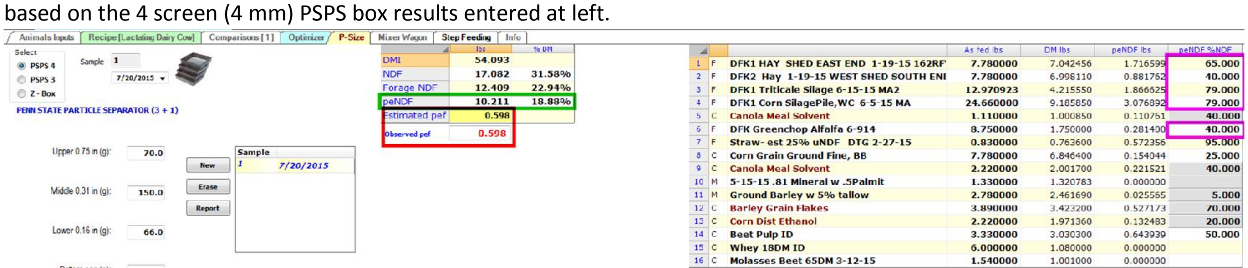


Figure 2. Note that the peNDF of the forages (purple box at right) is adjusted such that the estimated pef of the ration (center, red & black box) matches the observed pef (red box, center bottom), and that the ration peNDF is now 18.88% (green box), which better reflects the actual pef based on the 4 screen (4 mm) PSPS box results entered at left.



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