

# Evaluating total mixed rations: falling through the pans and into nutritional management on the dairy

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## Abstract

Creating a well-balanced and properly mixed feed ration is essential to dairy cow productivity and health. The dairy's feeding manager should have two objectives: 1) to have the nutrient composition of the ration consumed by the cows the same as the one for the nutritionist's ration on paper, and 2) for the nutrient profile of the freshly delivered feed to be the same as the one in the leftovers the next morning. Along with the ingredients loaded in the mixture, the particle size distribution plays an important role in determining the ration the cow actually consumes and digests. It is important to evaluate the total mixed ration (TMR) to determine whether there is an opportunity to improve at any step in the process of making the feed, including the forage harvest, ingredient loading and mixing, and feed delivery. Useful, on-farm tools like the Penn State Particle Separator (PSPS) have proven to be key in monitoring TMRs on a variety of levels. Recording PSPS results along with lab nutrient analysis results over time will create a history of what is being fed out and consumed by the cattle and allow for monitoring of trends and identifying potential issues.

**Key words:** cattle, dairy, ration, TMR

## Résumé

La création d'une façon équilibrée et bien mélangé ration est essentiel à la productivité et de la santé de la vache laitière. Le gestionnaire d'alimentation laitiers doivent avoir deux objectifs : 1) d'avoir la composition nutritive de la ration consommée par les vaches la même que celle pour le nutritionniste's ration sur papier, et 2) pour le profil nutritionnel de l'fraîchement livrés flux pour être la même que celle dans les restes le lendemain matin. Avec les ingrédients chargé dans le mélange, la distribution de la taille des particules joue un rôle important dans la détermination de la ration la vache consomme réellement et recueils. Il est important d'évaluer la ration totale mélangée (RTM) pour déterminer s'il y a une possibilité d'améliorer à toute étape dans le processus visant à rendre les aliments pour animaux, y compris la récolte de fourrage, ingrédient chargement et mélange, et d'aliments du bétail. Utile, d'outils agricoles comme le séparateur de particules Penn State (PEPS) s'est avérée clé dans la surveillance des TMR sur une variété de niveaux. Enregistrement PSP les résultats ainsi que les résultats d'analyse des éléments nutritifs de laboratoire au fil du temps va créer un historique de ce

qui est extraite et consommés par le bétail et de permettre le suivi des tendances et d'identifier les problèmes potentiels.

## Bunk-side

A TMR evaluation performed at the feed bunk can be used to troubleshoot important issues with a TMR, including the ease of which cows can sort the ingredients and the consistency of the ration from one end of the bunk to the other. Several studies have shown that the longer the particle size of the forages, the easier it will be for the cattle to sort them from the ration. The forage ingredients are necessary to meet the cow's dietary fiber requirement, particularly the physically effective neutral detergent fiber (peNDF). In problem rations, sorting long pieces of forage will cause the actual ration consumed to be lower in peNDF, potentially leading to rumen upset and reduced rumination, which in turn affects the amount of saliva produced and therefore the buffer of rumen pH. Cows have been shown to selectively sort for the shorter feed pieces if given the opportunity; it is therefore essential that the size of the pieces are short enough to mix uniformly with other ingredients, and yet still have enough structural integrity to create a rumen mat that maintains rumen fill and promotes chewing time and saliva production.<sup>1</sup> When inadequate peNDF is consumed, cows may begin to show signs of metabolic disease such as displaced abomasum and acidosis, and milk fat percentages and feed efficiency may decline.<sup>2</sup>

The nutrient quality and particle size distribution of the feed refusals- the last remaining portions of the feed at the bunk before it is cleaned out for a new TMR delivery - tell a lot about how resistant the ration was to sorting by the cows. Rations with longer forages within the diet may not reflect the nutrient analysis of the ration at the end of the day as calculated at the time of delivery - essentially creating an entirely different diet.<sup>3</sup> The PSPS is a useful tool in evaluating the TMR refusals in comparison to what was fed out, with no need to send the samples off to a lab and have to wait days for results, including the lab and shipping fees. Furthermore, the TMR may be evaluated at several intervals over the course of the day to see how the ration is changing on an hourly basis. If the target percentages have been met, then there is no need to alter the protocol. Table 1 shows target percentages for forages and TMR that may be used as a reference when performing a particle size analysis with the PSPS. If the targets have not been met, however, troubleshooting the mixing procedure, moisture content of the feed,

**Table 1.** Reference for particle size for forages and TMR using the Penn State Particle Separator.

Screen	Pore Size (inches)	Particle Size	Corn Silage	Haylage	TMR
<i>Upper Sieve</i>	0.75	>0.75	3 - 8%	10 - 20%	2 - 8%
<i>Middle Sieve</i>	0.31	0.31 - 0.75	45 - 65%	45 - 75%	30 - 50%
<i>Lower Sieve</i>	0.05	0.07 - 0.31	30 - 40%	20 - 30%	30 - 50%
<i>Bottom Pan</i>		<0.07	<5%	< 5%	</=20%

or loading sequence may be areas for investigation.<sup>4</sup> Once attempts have been made to correct the problem, the PSPS can be used to quickly re-evaluate the situation.

### Harvest-side

Though the TMR is a complete and balanced feed that ultimately gets fed to the cattle, the harvest and handling of the forages that go into the diet must be considered from an early point to assure that even months down the line you can expect quality feed to be placed in front of the cows. The length of the forage cut can, and most likely will, continue to shorten post-chopping due to the various mechanical processes that affect it before it is delivered. For instance, field studies have shown that the longest particle sizes may be reduced by up to 50% by the time the forage has completed all phases of harvesting, from the cut, to storage, mixing, and delivery of the ration.<sup>4</sup> Not only can long particles pose a problem for sorting, but rations with too many fine particles have been shown to create similar metabolic disorders in cattle who are being fed a ration deficient in fiber.<sup>5</sup> The PSPS may also be used to evaluate the particle length of individual forages as they are being harvested. Determining particle length at the harvest provides an important opportunity to make corrections if need be to make sure that the feed will be properly mixed into the ration down the road. The fresh forage samples tend to have higher moisture levels than the TMR or a similar feed, but do not require drying before shaking since the moisture content has not shown to have negative outcomes in PSPS results as long as the boxes are shaken at or even above the suggested rate to make sure smaller pieces have the chance to sift down. The idea of using the PSPS is to analyze the feed sample as would be fed to the animal, and so changing the characteristics of the feed before shaking down is counter-productive.<sup>6</sup> The bins of the PSPS have also revealed to be valuable in analyzing feeds for other harvest-related properties besides particle length; for example, corn silage kernel processing can be evaluated by observing the amount of whole kernel or cob left in a freshly harvested sample. It is essential that changes be made at this point in the process since little can be done later on apart from altering the ration all together.<sup>5</sup>

### Technique and Analysis

The PSPS was first introduced in 1996, consisting of two sieves of differing pore sizes and a pan that will catch any material that made it through the sieve for on-farm or field forage analysis. Later a third sieve of smaller sized pores was developed to further break down the particle length of the feeds being sampled, proving especially useful in TMR testing where a wide variety of ingredients exists. The PSPS is considered an objective tool for breaking down particle length categories of a feed. Although it is performed manually and difference in technique can potentially create tester bias, adherence to the protocol developed for this tool has shown to result in good consistency between and within users, even successfully mimicking laboratory equipment to analyze particle size.<sup>7</sup> Pennsylvania State University has done extensive testing and research with this tool and describes in detail the proper procedure for using the PSPS through a variety of journal references and other resources available online.<sup>5</sup> Depending on the evaluation required, the forage or TMR samples may be taken from a specific location, or several areas along the bunk. When a consistency evaluation is being performed, labeling the samples according to the location they were collected will be useful to determine if the TMR at one end of the feed bunk is the same at the other end. However, when attempting to get a sample that will represent the entire feed bunk, it is necessary to collect handfuls of feed equally spaced down the bunk, and then mixed together for the PSPS evaluation so that one feeding area is not characterized more so than the other. To help reduce the effects of sampling error, two to three subsamples can be taken and shaken down from the primary sample, with the average recorded as the final result. Dairy One provides publically available sample collecting suggestions that may be used when collecting forage or TMR samples for your own on-farm sample testing.

These data can then be entered into a simple spreadsheet to numerically or graphically demonstrate the particle size distribution per pan, and compared to other feed samples, or the same sample over time. There is a spreadsheet available online for easy calculating provided by Penn State University, but the template is simple enough to create on

your own and customize as you wish for following trends over time.<sup>5</sup> Nutritionists and other consultant figures are also good frames of reference when monitoring the TMR quality of the herd and should always be used as a reference when available.

### Conclusion

It is a delicate process to create a complete feed that will provide a cow with everything it needs to thrive on the dairy in a single ration, but thanks to the development of the PSPS the process can be monitored on farm without having to send samples to the lab, and executed by farm staff with only a small amount of training. A TMR evaluation analyzing the particle length of the feed is an effective test that can produce a valuable set of data about what the cows are eating, and - equally as important - what they are not. Perhaps the problem occurred at the very beginning at harvest with equipment settings, or a little further down the road with the mixing and handling of the forages that created particle lengths too long or short. Regardless of where it happened, the PSPS is a tool to evaluate the forages or the TMR at any point in the process. When used on the farm, the immediately-available results can prompt informed decisions that can reduce the

risk of digestive upset in the animals, and money lost in feed costs or lost milk production. The key to making the PSPS an effective monitoring tool is to collect and summarize this data routinely and in a consistent way so that a history is established and important changes can be detected early.

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