FEEDS & FEEDING

A TECHNICAL PUBLICATION OF THE ANIMAL NUTRITION ACADEMY
Volume 2 – Issue 14

Improving milk nitrogen-use efficiency in dairy cows

Ioannis Mavromichalis, MSc, PhD

Milk nitrogen-use efficiency is one of the clearest indicators of nutritional performance in dairy cows. This issue explains the practical feeding and management decisions that convert more dietary nitrogen into milk protein and less into manure, improving both profitability and sustainability.

Milk nitrogen-use efficiency (MNUE) is calculated as milk nitrogen output divided by nitrogen intake, multiplied by 100. Milk nitrogen can be estimated by dividing milk true-protein yield by 6.38, whereas nitrogen intake equals crude protein intake divided by 6.25. For example, a cow producing 40 kg milk containing 3.2% true protein exports approximately 201 g nitrogen in milk. If she consumes 25 kg dry matter containing 16% crude protein, nitrogen intake is 640 g/day and MNUE is about 31%. Values around 25–35% are common, although comparisons must account for milk yield, stage of lactation, breed, diet, and body-protein changes.

Stop feeding protein insurance
Many dairy diets contain excess protein as insurance against variable forages, uncertain intake, or underestimated requirements. Many balanced high-producing TMR diets contain approximately 15.5–17% crude protein on a dry matter basis. Requirements depend on intake, milk protein output, forage composition, and metabolizable protein supply. Reduce crude protein in controlled steps of about 0.3–0.5 percentage units, then monitor intake, milk yield, milk protein yield, body condition, and MUN for two to three weeks before making another change.

Feed the rumen before feeding the cow
Rumen microbes require degradable protein and fermentable energy to produce microbial protein. When degradable nitrogen exceeds microbial capacity, ammonia is absorbed and converted to urea rather than milk protein. Inadequate rumen-degradable protein, however, can restrict fiber digestion and microbial growth. A 16.5% crude protein diet containing 62% RDP supplies approximately 10.2% RDP and 6.3% RUP on a dry matter basis. Control sorting, empty bunks, inconsistent TMR dry matter, and irregular feeding because synchronization on paper is irrelevant if cows consume a different ration.

Balance protein supply
Once rumen needs are met, evaluate metabolizable protein and its essential amino acid profile before adding more crude protein. RUP is not automatically superior protein; its value depends on intestinal digestibility and amino acid composition. A high-RUP ingredient may increase cost without improving milk protein yield if metabolizable protein is already adequate or another amino acid is limiting. Lysine, methionine, and sometimes histidine deserve attention, but they should be evaluated within the complete ration. No single protein ingredient or supplemental amino acid should be considered automatically necessary.

Protect dry matter intake every day
Heat stress, overcrowding, inadequate water, lameness, TMR heating, sorting, inaccurate mixing, and irregular feed delivery can reduce or destabilize intake. Microbial protein production and milk protein yield may then decline even though formulated crude protein appears adequate. Measure actual pen intake, correct forage dry matter frequently, and investigate persistent day-to-day deviations greater than about 5%. Examine refusals for sorting rather than recording only the amount remaining. Reduced intake cannot necessarily be corrected by adding protein because fermentable energy intake has also declined.

Measure nitrogen efficiency
Calculate MNUE for each main feeding group at least monthly using actual intake, analyzed dietary crude protein, milk yield, and milk true-protein percentage. Monitor kilograms of milk protein, not protein percentage alone, because a higher percentage may accompany lower milk volume. MUN is also useful. Approximately 8–12 mg/dL is a reasonable screening range for many herds, but not a rigid target because MUN is affected by production, breed, stage of lactation, sampling time, season, and laboratory method. Persistent high values may indicate excess protein or inadequate fermentable energy. Low values may indicate efficient nitrogen use or, when milk protein yield is disappointing, inadequate rumen nitrogen or metabolizable protein.

Start with forage quality
Forage influences intake, energy supply, microbial growth, and the form of protein entering the rumen. Mature forage may limit digestible energy, whereas lush pasture, heavily fertilized grass, alfalfa, and clover silages can supply large amounts of rapidly degradable protein. Poor ensiling may also convert true protein into soluble nitrogen and ammonia. Analyze forages for dry matter, crude and soluble protein, fiber, fiber digestibility, starch, sugars, and fermentation quality.

In brief, improving MNUE requires matching degradable protein with fermentable energy, maximizing microbial protein, supplying adequate metabolizable protein and essential amino acids, and removing unnecessary nitrogen. Calculate current MNUE, verify actual intake and forage composition, then reduce accumulated protein margins gradually. Judge every change by milk true-protein yield, MUN trends, cow condition, feed cost, and income over feed cost. The best diet is not the one with the lowest crude protein percentage, but the one that converts the greatest practical proportion of dietary nitrogen into milk protein without compromising production, health, or fertility.

DAIRY EDITION | 20 August 2026

Originally distributed through the Feeds & Feeding newsletter at LinkedIn. Archived permanently by Animal Nutrition Academy at www.animalnutritionacademy.com

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