DDGS and the Forage Challenge in Water-Limited Dairy Systems

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Water availability is increasingly influencing how dairy rations are formulated in arid regions. In Saudi Arabia, restrictions on cultivating water-intensive forage crops have increased the importance of imported roughages, particularly alfalfa hay. For large dairy operations, this creates a nutritional and economic challenge: maintaining milk production while reducing dependence on forage supplies that are expensive to transport and vulnerable to market disruptions. Dried distillers' grains with solubles (DDGS) offer an opportunity because they supply protein, energy, and digestible fiber in a concentrated ingredient.

However, replacing forage with DDGS requires understanding the difference between fiber concentration and fiber function. Although DDGS contains substantial neutral detergent fiber (NDF), its small particle size provides little of the physical stimulation associated with long forage particles. Recent research published in the *Journal of Dairy Science* offers important insights into how distillers grains interact with forage NDF and why their nutritional value depends on the composition of the complete ration.



What Happens When DDGS Meets Different Forage Concentrations?

Marcondes and colleagues (2026) evaluated Holstein cows averaging 32.5 kg of milk daily, comparing diets containing 0%, 20%, or 40% dried distillers' grains (DDG) with forage NDF concentrations of approximately 21% or 31% of dietary dry matter. At 20% DDG inclusion, milk production was maintained under both forage concentrations, whereas increasing inclusion to 40% reduced dry matter intake, nutrient digestibility, and milk production. The interaction between DDG and forage NDF was particularly revealing. In diets containing approximately 21% forage NDF, total-tract NDF digestibility increased from 44.3% without

DDG to 47.7% at 40% inclusion. In contrast, at approximately 31% forage NDF, digestibility declined from 49.6% to 45.3%.

Energy-corrected milk followed a similar pattern. At low forage NDF, production increased slightly from 33.5 to 34.7 kg/day with 20% DDG, whereas at high forage NDF, it declined from 33.5 to 31.3 kg/day. At 40% inclusion, energy-corrected milk fell below 29 kg/day under both forage concentrations. ***For dairy producers facing expensive or limited forage supplies, the practical implication is that moderate DDG inclusion can provide valuable digestible fiber and help reduce dependence on conventional feed ingredients without sacrificing milk production.*** However, adding more DDG is not necessarily better, particularly when dietary fiber is already high. The opportunity is to use DDG strategically in lower-forage rations, retaining enough physically effective fiber to support rumination while avoiding excessive total NDF that can restrict intake and nutrient utilization. This distinction is especially relevant to dairy operations in Saudi Arabia and other water-limited regions seeking to reduce their dependence on imported forage.

Why the Same Ingredient Produces Different Responses

The explanation lies in the physical and chemical properties of fiber. DDGS fiber originates primarily from corn cell walls remaining after much of the starch has been removed during ethanol production. Compared with many conventional forages, this fiber can have relatively high potential digestibility because of its lower lignification, providing fermentable substrate without contributing as much rapidly fermentable starch as corn grain. In rations with lower forage NDF, adding DDGS can increase the proportion of digestible non-forage fiber, potentially improving overall NDF digestibility while reducing reliance on starch-rich concentrates. However, when forage NDF is already high, slowly digestible and indigestible fiber fractions can occupy rumen space and restrict digesta passage. Adding substantial amounts of DDGS further increases total dietary NDF without providing the physical effectiveness of long forage particles, potentially limiting intake and productive efficiency.

The study illustrates these contrasting responses. At 40% DDG inclusion, total dietary NDF approached 41% in the low-forage treatment and 50% in the high-forage treatment, with both diets showing reduced intake and milk production. Interestingly, ruminal pH increased rather than declined at the highest DDG inclusion, likely reflecting reduced starch availability and feed intake. **The important message is that a stable rumen pH does not necessarily indicate an adequately balanced ration.** For dairy producers seeking to reduce forage inclusion, DDGS can supply valuable digestible fiber, but its benefits depend on maintaining sufficient physically effective fiber while avoiding excessive total NDF that could restrict

intake and nutrient utilization. The objective is not simply to replace forage fiber with DDGS fiber, but to balance their complementary functions within the complete ration.

Fiber Is Only Part of the Equation

Distillers' grains also influence protein and energy balance. In the experiment, increasing DDG inclusion displaced corn grain, SBM, bypass SBM, and cottonseed, reducing dietary starch while progressively decreasing crude protein digestibility. Protein quality may also have contributed to the responses, since excessive heating during ethanol coproduct processing can reduce intestinal amino acid availability, particularly lysine. In diets with lower forage NDF, milk protein concentration declined with increasing DDG inclusion, suggesting that maintaining crude protein concentration alone may not ensure adequate amino acid supply for milk protein synthesis.

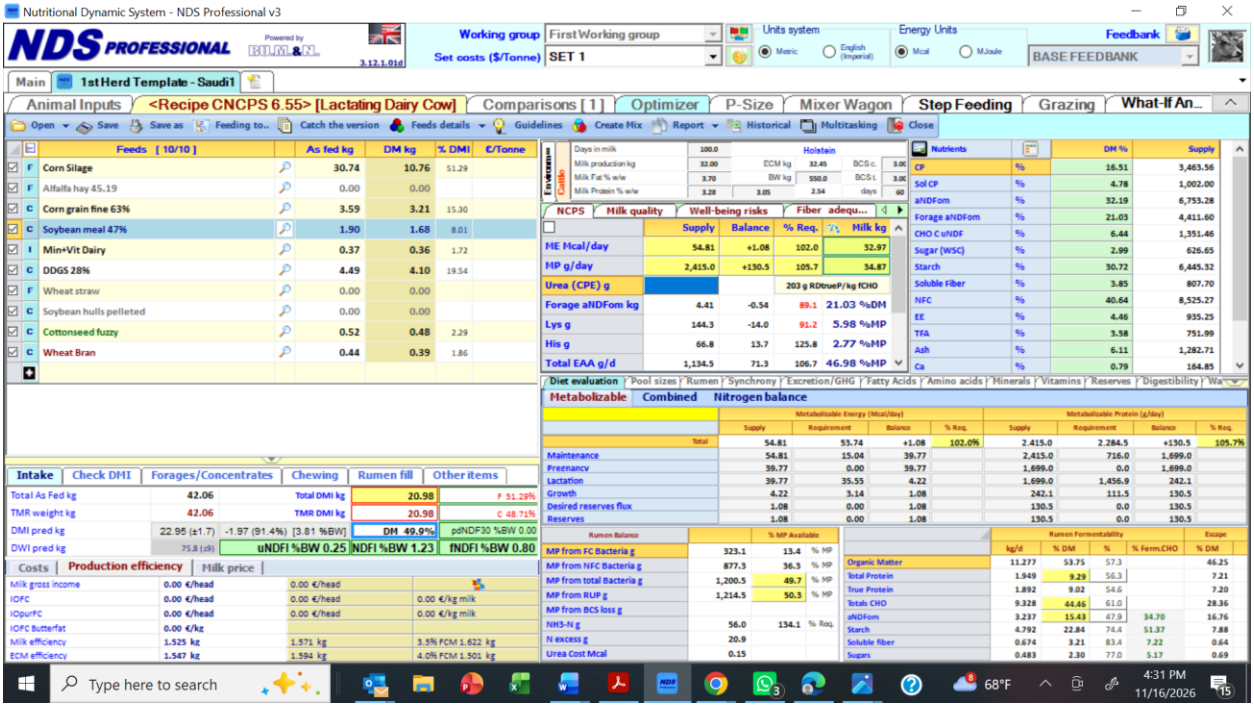


Figure 1. *NDS Professional simulation of a ration containing 19.5% DDGS and 21.0% forage NDF, formulated for a Holstein cow producing 32 kg of milk daily. The formulation approximates the low-forage-NDF, 20% DDG treatment of Marcondes et al. (2026). Bear in mind this is not an exact reproduction because commercial DDGS differs from this experimental DDG (no solubles). Predicted nutrient adequacy, including a lysine supply below the NDS target in this case, is illustrative and does not establish equivalent animal performance or constitute a feeding recommendation.*

For practical formulation, replacing soybean meal (SBM) with DDGS requires evaluating metabolizable protein and individual amino acids. Digestible lysine and methionine supply must be balanced alongside rumen-degradable protein and fermentable energy to sustain microbial protein synthesis and milk production. This becomes particularly important when DDGS replaces both protein supplements and starch-rich concentrates in reduced-forage diets. Commercial DDGS also differs from the DDG evaluated in this experiment because the addition of solubles can alter fat, sulfur, and other nutrient. The practical implication is that DDGS inclusion should be determined by the nutritional contribution of the complete ration, not by a fixed inclusion percentage or crude protein equivalence with SBM.

Applying the Findings to Saudi Arabia

For dairy operations in Saudi Arabia, reducing dependence on imported alfalfa requires maintaining adequate physically effective fiber while replacing part of its nutritional contribution with alternative ingredients. Wheat straw can supply physical structure, although its limited digestibility restricts its energy contribution. DDGS and soybean hulls provide more digestible non-forage fiber, offering greater flexibility in ration formulation. However, replacing forage requires evaluating more than total NDF concentration, particularly rumen fill, fermentable energy, and metabolizable amino acid supply.

To examine these relationships, two rations were simulated using 2026 NDS Professional for 700 kg Holstein cows producing 42 kg of milk daily at a dry matter intake of 26 kg. The conventional ration contained 30% alfalfa hay and 5% DDGS, while the alternative reduced alfalfa to 15% and increased DDGS to 20%. Both used identical animal inputs, allowing predicted nutrient adequacy to be compared. The simulations illustrate nutritional tradeoffs rather than experimentally validated feeding recommendations.

The Brazilian experiment evaluated 550 kg Holstein cows producing 32 kg of milk daily. However, the application to Saudi Arabia requires considering larger, higher-producing cows, with a proposed body weight of 700 kg and milk production of 42 kg/day. These differences affect maintenance requirements, dry matter intake, and nutrient demands. Consequently, the Brazilian formulation serves as a nutritional reference for understanding the interaction between DDG and forage NDF, rather than as a direct comparison of productive performance. The subsequent NDS Professional simulations use identical animal inputs for both Saudi rations to evaluate whether reducing imported alfalfa while increasing DDGS can maintain predicted nutrient adequacy under higher production demands.

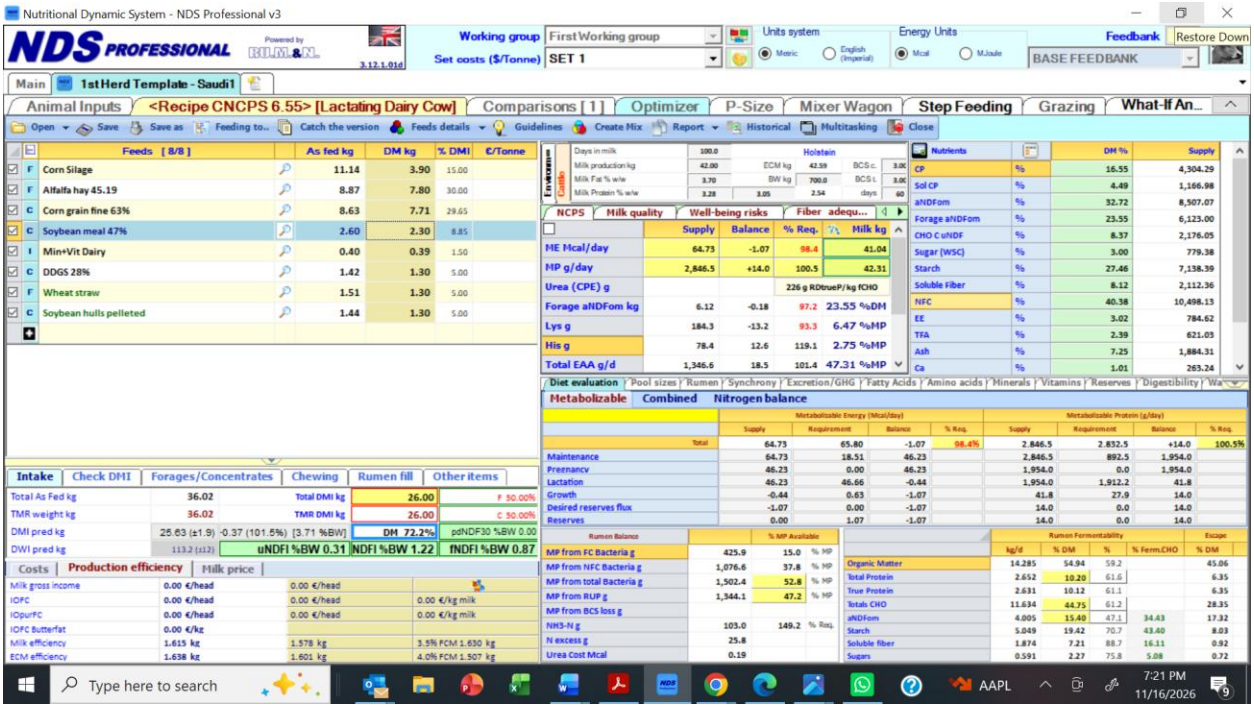
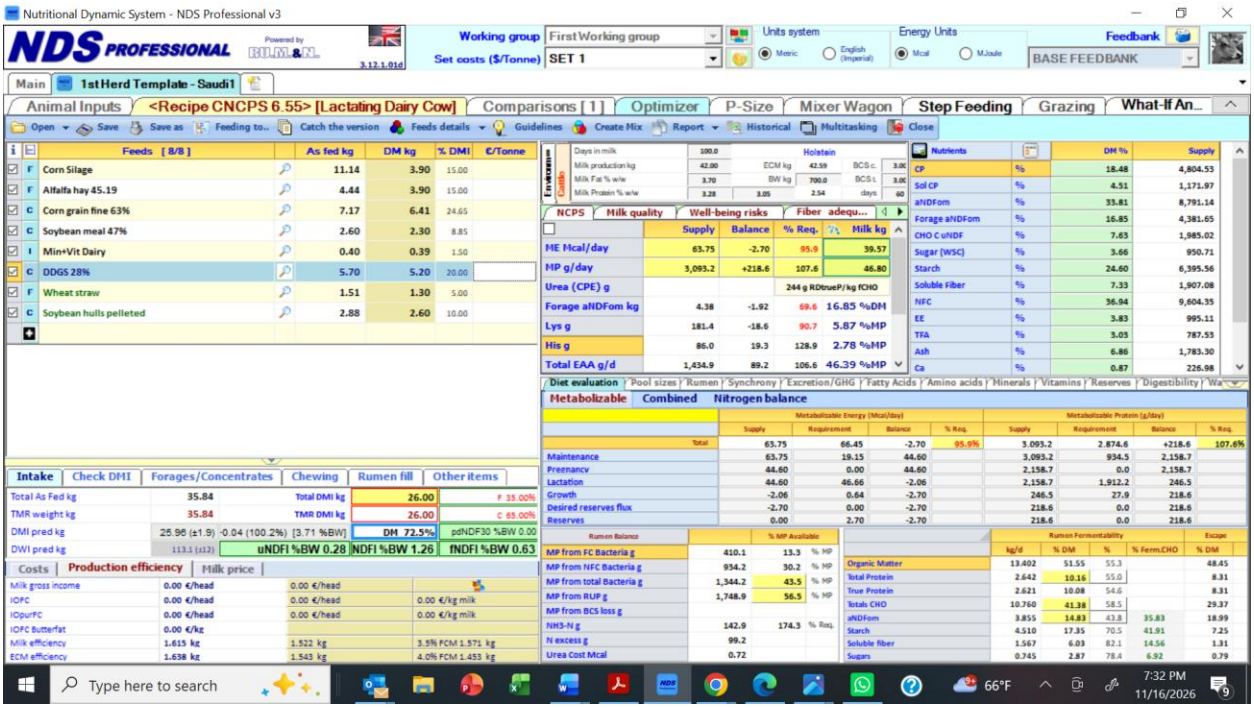


Figure 2. *NDS Professional simulation of a conventional Saudi dairy ration formulated for a 700 kg Holstein cow producing 42 kg of milk daily. The diet contains 50% forage dry matter, including 30% alfalfa hay, 15% corn silage, and 5% wheat straw, with DDGS contributing 5% of dietary dry matter. Predicted forage NDF is 23.55%, with energy and metabolizable protein adequacies of 98.4% and 100.5%, respectively. The formulation serves as the reference for evaluating reduced-alfalfa diets with greater DDGS inclusion. Results represent model predictions rather than experimentally measured animal performance.*

Reducing Alfalfa Dependence Through DDGS and Alternative Fiber Sources

The second simulation explores a more aggressive reduction in imported alfalfa, replacing part of its contribution with DDGS and soybean hulls while maintaining corn silage and wheat straw inclusion. Total forage decreases from 50% to 35% of dietary dry matter, providing an opportunity to examine whether non-forage fiber can maintain nutrient adequacy when conventional forage availability is restricted.

Figure 3. *Simulation of a reduced-alfalfa ration for a 700 kg Holstein cow producing 42 kg of milk daily. Alfalfa hay inclusion is reduced from 30% to 15% of dietary dry matter, while DDGS increases from 5% to 20% and soybean hulls from 5% to 10%. Although total NDF increases to 33.81%, forage NDF declines to 16.85%, representing only 69.6% of the model's requirement. Metabolizable protein reaches 107.6%, but energy adequacy declines to 95.9%, with energy-supported milk estimated at 39.57 kg/day. These model predictions illustrate the nutritional constraints of replacing forage with non-forage fiber and do not constitute experimental validation or a recommended commercial ration.*



Conclusions

The NDS simulations above illustrate both the potential and the limitations of replacing imported alfalfa with DDGS and other non-forage fiber sources. Reducing alfalfa from 30% to 15% of dietary dry matter while increasing DDGS to 20% maintained total dietary NDF and increased metabolizable protein supply. However, forage NDF adequacy declined from 97.2% to 69.6%, while predicted energy-supported milk decreased from 41.0 to 39.6 kg/day. These results suggest that a more moderate reduction in alfalfa, supported by adequate physically effective forage and carefully balanced energy and amino acid supply, may be a more practical strategy. For water-limited dairy systems in Saudi Arabia and elsewhere in the Middle East, the objective should not be to eliminate imported forage, but to use it more efficiently. Such an approach requires further formulation and on-farm validation before commercial adoption.

Reference

Marcondes, Marcos I., Vinícius S. S. Viana, Sebastião C. Valadares Filho, Edenio Detmann, Jéssica M. V. Pereira, Alex L. Silva, Daiana F. Quirino, Kellen R. Oliveira, Wellington P. F. Amorim, and Polyana P. Rotta. 2026. "Effects of Dried Distillers Grains Combined with Low and High Forage Levels for Dairy Cows on Productive Performance." *Journal of Dairy Science* 109 (11): 11730–11744. https://doi.org/10.3168/jds.2026-28621.