HOARD'S DAIRYMAN

All corn isn't equal

by Alvaro Garcia, D.V.M.

CORN grain is the energy standard among all feedstuffs fed to cattle. It is an energy-dense feed, second only to oils, fats, or other feedstuffs rich in lipids.

Corn has traditionally been priced and sold per ton or by the bushel. That's because it has long been a feedstuff with homogeneous nutrient concentration, containing approximately 9% to 10% protein, 60% starch, and 3% oil on a dry matter (DM) basis. Some modern corn hybrids differ significantly and contain 8% protein, around 70% starch, and almost 4% oil.

However, it's not just the starch concentration that's important. The true value is really found when measuring starch levels digested by the cow.

Prolamins are proteins associated with the starch in corn and other cereal grains protecting the starch granules from enzymatic degradation. Prolamin in corn (zein) comprises 50% to 60% of all protein in the kernel and is cross-linked, encapsulating starch into water-tight globules.

The starch present in vitreous corn is more intricately associated with prolamin, improves its hydrophobicity, and thus reduces the accessibility of starch-degrading enzymes. Prolamin is responsible for this vitreous (glass-like) characteristic of certain corn hybrids that determine its digestibility, and thus how much energy livestock can obtain from it. Research at the University of Wisconsin has demonstrated that starch digestibility fell by 0.86 percentage units per percentage unit gain in grain prolamin (expressed as percent of starch).

Dellait Dairy Nutrition & Management, a company that I consult with, recently evaluated the results of thousands of shelled corn samples analyzed by the Dairy One Lab between 2004 and 2020. The analysis shows the high variability that can still be observed in the nutrient content of different types of corn, as seen in the table.

Corn starch varies

There is a need to quantify the potential energy difference, particularly starch, of different corn shipments and evaluate them based on the yield of animal products. Granted, these differences in performance are far greater for nonruminants, particularly poultry, than for cattle. However, they are still relevant for the latter, especially when margins are tight.

Most dairy farmers are aware of the "milk per ton" prediction developed to compare corn silages. In previous work, our team described that there was nearly 600 pounds of milk per ton spread when comparing 3,343 samples of U.S. processed corn silage. Although nutrition labs are not currently reporting "pounds of milk per ton of shelled corn," it is something forward-thinking dairy producers may want to consider. The difference expected in dairy cow performance merits the effort.

The table shows the "average" starch for U.S. corn is almost 70%. The analytical results also show that its digestibility ranges from 58% to almost 83% . . . that's 25 percentage points. Keep in mind that ground corn particles are denser than forage particles, and they do not float like less dense forage particles.

As a result, ground corn and its starch move out of the rumen faster through the reticulo-omasal orifice. This combination of extreme differences in digestibility, 25 percentage points, and accelerated transit through the gastrointestinal tract, particularly during early lactation, determines how many corn particles will show up intact in the feces.

Bear in mind, a dairy farmer may have paid the same for both corn shipments. After all, corn is corn, right?

Comparing two shipments

Let's suppose we choose between two corn shipments — A and B. We make a great deal buying Shipment B at $3.70 per bushel when prices for Corn A are hovering around $4. Both A and B corns have similar analytical starch contents of 70%. Since one metric ton contains roughly 39 bushels of corn, we paid $144.30 per ton for Shipment B, whereas Shipment A would have cost $156. In theory, we "saved" $11.70 per ton on Shipment B.

Since both shipments have 70% starch, there are 700 kilograms (1,544 pounds) of starch in each. Shipment A, however, has 560 kilograms (1,235 pounds) of digestible starch (700 x 0.80%), whereas Shipment B has 420 kilograms (925 pounds) (700 x 0.60%). We paid $344 per ton of digestible starch with Shipment B; with Shipment A, we would have paid $258. In short, we paid $86 more per ton of starch to save $11.70.

Regrettably, the story does not end there, as it continues with the loss of milk in the bulk tank. Pure starch contains 2.4 megacalories per kilogram (Mcal/kg) of net energy of lactation (NE_L). When we bought Corn B with 420 kilograms of digestible starch, we purchased 1,008 Mcal of NE_L (420 x 2.4 Mcal/kg) worth of starch. Similarly, we could have bought 1,344 Mcal of NE_L from starch had we purchased Corn A.

It takes 0.74 Mcal of NE_L to produce 1 kilogram (2.205 pounds) of milk containing 4% fat. Knowing this, Shipment B could have potentially made us 1,362 kilograms (3,000 pounds) of milk and Shipment A 1,816 kilograms (4,000 pounds) of milk, provided the other nutrients required were supplied.

In short, there are 1,000 pounds less milk that could have been produced with Shipment A. Let's expand that further . . . consider 10 hundredweights valued at $16 each or $160 . . . in other words, for every $11.70 saved, we left $160 on the table per ton of purchased corn. If you are feeding 15 pounds of shelled corn per head, that's 16 cents per cow daily.

What happens to your income over feed costs in that scenario?

Ideally, one should purchase corn based on the results of a near infrared reflectance spectroscopy (NIRS) analysis. This analysis will give the buyer the results observed in the table along with other nutrients of importance. For all practical purposes, one needs at least moisture, protein, starch, fat, and of course, mycotoxins.

The importance of buying dry corn cannot be stressed enough; after all, we don't want to pay for water. Remember that corn harvested in wet years usually undergoes more extensive drying. Drying can induce stress fractures in the kernels and more broken corn in shipments. Stressed and/or broken corn is more susceptible to develop molds and mycotoxins, so we need to avoid it when possible.

Avoid shipments that contain mostly small kernels. The larger the kernel, the more starch they have as a proportion of all other nutrients. Larger "full" kernels will bring you closer to that 70%-plus starch content that we look for.

Lastly, choose corn with lower protein concentrations. There are two reasons. One is similar to the consideration above, since the less protein, the more starch there will be in corn. Always keep in mind that we pay for the energy in corn, not its protein.

The second aspect is related to starch digestibility and, as a result, also to the energy in corn grain. Research has shown that the more total protein, the more prolamin protein in corn. More prolamin means more protection of the starch granules against degradation by the microbial as well as the cow's enzymes.

Nutrient composition of shelled corn

Metric	Samples	Average	Normal range	Standard deviation
% Dry matter	13,928	88.69	84.85 — 92.54	3.85
% Crude protein	10,539	8.86	7.46 — 10.26	1.40
% ADICP	6,280	0.45	0.95	0.50
% NDICP	6,108	1.16	0.86 — 1.45	0.30
% Starch	8,425	69.70	64.23 — 75.17	5.47
Starch digestibility	2,761	70.33	58.03 — 82.63	12.30
% TDN	8,407	88.01	85.38 — 90.64	2.63
NE_L, Mcal/Lb.	8,407	0.94	0.91 — 0.97	0.03
NE_m, Mcal/Lb.	8,407	1.00	0.96 — 1.04	0.04
NE_g, Mcal/Lb.	8,407	0.69	0.66 — 0.72	0.03

Source: Dairy One 2021

The author retired as a professor of dairy science at the South Dakota State University. He now consults with Dellait Dairy Nutrition & Management.