Methods of Valuing Corn or Grain Sorghum Silage

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When hot, dry summer conditions affect corn or grain sorghum, producers may face the decision of what to do with a stressed or failing crop. Chopping for silage is one option, but if this silage will be sold, how should it be priced? Arriving at a price can be difficult when there are limited buyers and a largely unreported market. Many livestock producers (dairy or beef) who use silage tend to raise the forage themselves, and in these cases a market price isn't observed. So when a silage sale occurs because of a poor yielding crop originally planted for grain harvest, determining an acceptable price between parties can be a challenge. A new spreadsheet tool from the K-State Agricultural Economics Department called "Silage Price Estimates" uses a variety of pricing methods to suggest acceptable silage prices for buyers and sellers.

This spreadsheet is available at www.AgManager.info under "Decision Tools". The approach used by this tool is to look at the benefits of silage harvest from both the owner and buyer perspectives to determine the upper and lower boundaries of what is profitable for both parties. Comparing these values allows for negotiation of an acceptable silage price.

Two other cautions are worth mentioning: besides the economic value, one also needs to consider the potential for high nitrate levels. Nitrates can be high in forages with drought stress. Ensiling reduces nitrate levels significantly, but caution still needs to be used to prevent toxicity. Refer to Nitrate Toxicity, Publication MF3029 from KSU.

The second caution is that producers should always consult with their crop insurance agents before harvesting an insured grain crop for forage. If a grain loss is suspected, adjusters need to inspect the crop to document any possible loss. Sometimes this involves leaving a small area to harvest for grain at the end of the season. Insurance agents can also inform producers of any other restrictions which may apply under their insurance policy.

The rest of this article describes the tool and its use. Users will find the spreadsheet already contains a corn example with default values already entered for various production factors and prices. Of course, one's own actual production numbers and prices are needed to best estimate individual silage values. Cells with blue, bolded text are those which the user should change from default values; black numbers are formulas based on those inputs.

Owner's Perspective

From the owner's perspective, a lower limit on the value of the silage crop is the return received if the crop is harvested as grain. This assumes the original intent for the crop was grain and the option still exists to carry it to harvest. In a drought or hail scenario there may be relatively little value here, but in any case, the idea is to find the breakeven point where the owner would be indifferent between harvesting the crop as grain and selling it as silage. This would establish the minimum price for silage, since anything less means that harvesting the crop for grain would still offer more return.

The Breakeven Point between Grain and Silage Harvest

A key component in making the grain-versus-silage comparison is a reasonable estimate of potential grain yield. Some long-standing methods are available, but they involve field time counting plants, heads or ears, kernels, and so on. Some extension resources describing these methods for estimating corn yields in a standing crop are available here:

- Estimating corn yields using yield components, Iowa State University
- Estimating corn yield potential, Kansas State University
- Estimating potential corn yield, University of Nebraska

Likewise, the following resources discuss estimation of grain sorghum yields:

- Method for estimating sorghum yields, Kansas State University
- Estimating seed counts in sorghum heads for making yield projections, KSU

Next, grain price and grain moisture percentage must be entered. The grain price should be the local elevator price for the anticipated time when grain would be harvested. The grain moisture content is used to estimate the cost of grain drying, if that proves necessary.

Using the yield estimate entered earlier, the tool calculates how many pounds per acre of grain are expected to be harvested. This equals the yield per acre times the weight per bushel of grain. The "standard" weight for both corn and grain sorghum is 56 pounds per bushel, but drought-stressed crops may have a different test weight, and the tool allows this value to be changed, if appropriate.

Once the total weight of grain is estimated, this amount is used to estimate the total weight of silage (wet) using a measure called the "harvest index." The harvest index is the percentage of total harvested biomass that comes from grain – that is, the share of total silage weight represented by grain. Research indicates corn silage is typically comprised of 50% stover and 50% grain. Depending on the condition of the crop, this may vary. Two references on the harvest index for corn and grain sorghum are the following:

- Harvest Index: a predictor of corn stover yield, Michigan State University
- Sorghum Harvest Index in Relation to Plant Size, Environment, and Cultivar

Some users, particularly those with long experience in silage, may feel confident making their own estimate of silage yield, without resorting to the formulas and coefficients described above. These users can override the formula for silage yield by entering an estimate directly instead.

The percent dry matter of silage at harvest is also a key input. General recommendations are between 30-36% Dry Matter (DM) for quality silage. From this percentage, the tool will calculate silage yield in on a DM basis. This value will be needed later to calculate the amount of nutrients in the silage.

The next section of the owner's calculations is the "*Grain Harvest Costs*" component. If the crop is harvested as grain, then harvesting costs must be considered, since they reduce the net return of this option to the owner. Tool defaults show per bushel and per acre harvesting costs based on the K-State Custom Rates Estimates found on the AgManager.info website. The owner can use these or different custom hire costs, or enter their own projected harvesting costs.

The next section, "*Fertilizer Value of Lost Stover,*" estimates the value of nutrients lost when stover is removed by silage harvest. These values are estimated for N, P, and K by pricing the lost nutrients in stover at current fertilizer prices. Several references are available describing research on the nutrient content of corn stover:

- Nutrient removal when harvesting corn stover, Iowa State University
- A General Guide for Crop Nutrient and Limestone Recommendations in Iowa, Iowa St. Univ.
- Corn Stover Removal: Nutrient Value of Stover and Impacts on Soil Properties, University of Nebraska
- Corn stover: what is it worth? Michigan State University

The tool allows the user to adjust the shares of nutrient *(*in the column *"Percent to Account for")*that they wish to recover. If the owner is not concerned about these, this share may be reduced to zero.

The final section in the Owner's Perspective is the "*Break-even Results*," which assembles the findings from the other areas. The goal is to determine the minimum price the owner would be willing to accept for silage (priced standing in the field), given the net return they could otherwise expect by harvesting grain.

The return to harvesting grain first counts the value of the harvested grain (price x yield), less the cost of harvesting it. Regarding stover value, a producer who harvests the crop for grain would typically leave the stover on the field and take advantage of its nutrient value for future crops. Thus, harvesting the crop as silage means the owner must recover the value of lost nutrients to match soil nutrient content in the case of grain harvest.

Looking at an example is helpful. The default values in the tool show an example for corn of a 40-bushel yield, a market price of $3.50 per bushel, 56 lbs. test weight, and a 40% harvest index. This produces an estimate of 2.8 tons of silage (wet) out of the field.

With these assumptions, the value of the harvested grain is $140 per acre. Harvesting costs are about $34 per acre, and if silage is cut, stover removal is worth about $7 per acre in nutrients that the owner would need to replace with additional fertilizer. This means the owner would want to get at least $112.71 per acre, or $40.25 per ton for silage standing in the field (assuming the buyer pays the silage harvest cost). The owner should be unwilling to accept a lower price than this break-even amount because harvesting the crop for grain offers a higher return.

Some alternative scenarios are possible, and the tool can be adjusted accordingly. One case would be harvesting the crop for grain, leaving the residue on the field, and then leasing the residue to a cattle producer for grazing. If stover is left on the field and grazed, fertilizer value of stover lost to silage should not be counted because grazing cattle will cycle most of the nutrients and return them to the field (they are not lost), with the exception of carbon (C) and N if the growing calves are used to graze the stover. However, in most cases mature cows or cow/calf pairs would be used and little N would be removed in this grazing scenario. Additionally, a per-acre grazing charge would add extra value to the "harvest for grain" option. The break-even section includes another cell called "Other Adjustments to Value" for this purpose.

Another case: suppose the crop is harvested for grain, then the stover is baled and sold. In this case, fertilizer cost should be included (since it will be lost to the producer), but a stover sales amount should be entered. Remember to account for any costs associated with harvesting stover, either by baling or by grazing.

Buyer Perspective

The buyer perspective looks at the value of silage and compares it to alternative feedstuffs. This will involve several steps, including accounting for shrinkage loss of silage after it has been put into storage, recognizing the cost of harvesting the silage, and determining the amounts and costs of alternative feeds which would provide an equivalent level of energy and protein. This section presumes the buyer is interested in determining the cost of alternative feeds which would provide the same TDN and crude protein as a ton of silage; this cost would serve as an upper bound on the silage price.

The first section, "Silage yield calculations," recognizes silage will shrink after placed into storage. The buyer, of course, is ultimately concerned with the number of pounds that will actually be fed, and so the tool accounts for this loss when calculating final silage yield. The user must provide a percent shrinkage factor here, which is applied to the initial silage yield calculated in the preceding Owner's section. Below are listed some extension references with further background on minimizing storage losses:

- Preventing Silage Storage Losses, University of Wisconsin
- Shrinking Your Forage Shrink, Michigan State University
- Minimizing Shrink Loss in Forage Storage Methods, South Dakota State Univ.

Forage losses through shrinkage, spoilage, distribution, and feeding activities are common to some degree or another with all livestock feeds, and livestock producers are used to absorbing these effects in stride. A user can ignore the question of feed losses by setting the storage loss coefficient to zero.

The next section deals with the nutrient content in the silage. Silage certainly can vary in nutrient composition, and composition often is not known until after the fact. Nevertheless, an estimate of crude protein (CP) and TDN is needed to assess silage value. A KSU publication which lists typical nutrient values of common feedstuffs is the following:

- Nutritional Composition of Feedstuffs for Beef Cattle, KSU

This publication indicates droughty corn silage would contain about 64% TDN and about 9.3% CP; these values are the default coefficients used in the decision tool. Note that these feed values are values on a dry matter basis, and the tool includes this adjustment.

Once the nutrient content of a ton of silage has been calculated, the tool calculates the quantity of alfalfa and rolled corn grain needed to provide the same quantity of TDN and CP found in a ton of the silage. This is a rather simple approach for an alternative ration, but both feedstuffs are widely available and commonly used, and this provides a quick starting point, after which a user might consider other feeds using more sophisticated means.

The calculation of alfalfa and corn needed to match TDN and CP in the silage is found in the section, "*Alternative Ration with TDN and CP equivalent to a ton of silage,*" on the right-hand side of the Buyer page. A user may adjust the prices, nutrient content, and percent dry matter. The user should update prices, in particular, to reflect both current local markets and should include any delivery costs to the farm.

The calculator determines the pounds of alfalfa and corn needed on a DM basis, converts to the number of pounds as-fed, and uses the feedstuff prices to calculate the cost of these ingredients. The default example in the tool shows that about 113 pounds of alfalfa and 503 pounds of rolled corn would provide the same TDN and CP as a ton of silage, at a cost of about $41.

The buyer must then consider their silage harvest costs. Custom rates are used for harvest costs and include charges for chopping at $9/ton, hauling at $3/ton (this will in reality depend on mileage), and filling/packing at $1/ton. Users may consult the K-State Custom Rates report for the latest going rates. The total harvest cost per ton is multiplied by the tons per acre at harvested moisture to get a per acre cost, which will be deducted from the value of silage. Users should enter their own harvest charges, if known, as these will vary according to local conditions.

All of these components from the Buyer's perspective are compiled in the final section, "*Silage Value to Livestock Owner*." It shows the results in terms of both price per ton and price per acre. It calculates the price the buyer (livestock owner) would be willing to pay for silage standing in the field, given silage harvest costs (assumed paid by the buyer), shrinkage losses, and the cost of an equivalent feed ration.

It also provides an opportunity to consider if there will be additional or reduced costs from feeding silage versus alternative feeds. These can be entered in the line labeled, "Other Cost Adjustments." For example, with the lower dry matter content in silage, more loads of a feed wagon may be needed to deliver the same nutrient ration to cattle. For example, if it costs the livestock owner an additional $0.50 per ton to feed silage versus alternative feedstuffs, this should be counted as a reduction to what they can pay for silage.

The break-even calculation starts with the alternative ration cost, at about $41 in this example for the corn and alfalfa needed to match the TDN and CP found in a ton of silage. Storage losses (or shrinkage) are calculated as the percent silage loss times the alternative ration cost. The silage harvest cost and any other cost adjustments are also subtracted.

In this example, the silage buyer (livestock owner) would be indifferent between a silage price of about $22 per ton and the alternative ration, given the costs of harvesting silage and storage losses. Paying more than this amount for the crop standing in the field would result in higher overall costs than the alternative ration, since the buyer must also account for harvest costs and shrinkage.

At this point, the livestock buyer might consider a more detailed analysis of their options for an alternative ration, particularly whether other feed ingredients could be used to obtain a ration with comparable nutrients and perhaps lower cost. If the user has calculated an alternative ration cost from other sources, they could still enter this value in the "Alternative Ration Cost" cell and override the amount calculated in the tool's other section. The break-even price would then be re-calculated by applying the other costs for storage losses and harvesting.

Sensitivity Analysis

From the preceding discussion, it is clear that a large number of factors can influence the prices an owner and buyer would consider for a silage crop standing in the field. Perhaps the most important of these will be the actual grain yield of the field, the price of grain at harvest (since it would occur later than silage harvest), the harvest index, and the moisture content of the silage.

The numbers used as examples in the tool actually show a case where a buyer would not be willing to pay what the crop owner would likely demand. That is, were the buyer to offer about $22 per ton (or roughly $61 per acre) for the silage standing in the field, the owner might conclude that grain harvest is still preferred, since he/she might expect to get about $113 per acre, or $40.25 per ton by going the latter route.

The advantage of a spreadsheet decision tool, of course, is that it facilitates a relatively quick comparison of results across a range of possible values. Producers are encouraged to consider not only their most likely outcomes for these variables, but also a range of potentially high and low values. This will contribute to a better-informed decision about their stressed grain crops.

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