Silage to Beef Application –

Updates and Equations Explained

A.S.Leaflet R

Garland Dahlke, ISU extension and outreach program specialist;

Iowa Beef Center

Summary and Implications

The Corn Silage to Beef Application has been made available both independently through the Iowa Beef Center website and incorporated into the BRaNDS Appendix as a means to rank the potential value of corn silage varieties used in beef rations. After this span of use adjustments to the evaluation have been made and are provided in detail in the following excerpt.

Introduction

Resurgence in the use of corn silage for beef rations is currently under way in the upper Midwest. Improvements in harvesting equipment, corn silage quality traits, yield per acre and the need for fiber in beef cattle rations are some of the reasons driving this interest. Sorting through the varieties of corn used for silage however becomes daunting if one is to provide guidance in terms of variety selection or ranking when trying to determine the most appropriate varieties to grow for silage for beef cattle. Grain yield per acre generally has been the driving force when looking at the variety selection for beef feed, but with the wide spread availability of varieties with improved digestibility and the use of silage for beef cattle outside of a feedlot the value of the fiber in terms of providing energy must be recognized.

The dairy industry has already initiated an evaluation that involves the inclusion of fiber digestibility in the evaluation of the silage and presents the query in terms of milk per acre. The beef industry can do the same, but in this case it would be in terms of beef produced per acre. With the beef industry however we need to address fiber digestibility. In terms of the feedlot animal generally, a high energy ration containing high levels of starch is provided in turn impedes fiber digestion due to the reduced pH that occurs in the rumen. More digestible fiber is still of value, but not to the extent it may be in beef rations designed to maintain or allow animals to grow with minimal reductions in rumen pH.

Another point of interest in corn silage is that of protein. Although one generally considers feeding corn silage as a source of energy, the contribution of the protein from this feed probably should not be overlooked. We may see samples from 5 ½% crude protein to 10% crude protein in a season. Although not a great concentration when compared to other forages, it is quite substantial when considering one variety may have about twice the protein of another and this protein does matter in terms of diet supplementation.

Material and Methods

The basis for comparison is guided by the National Academies of Science, Engineering and Medicine publication, "The Nutrient Requirements of Beef Cattle". Since this application was designed for evaluation of silage in the United States all inputs and outputs are presented in terms of U.S. Standard measures rather than metric. The animal used as the model for comparisons is a 900 pound steer in a thermal neutral environment. The inputs and their subsequent use in calculations are as follows.

Primary Inputs used for Reporting Ranks:

Program Screen Image 1

High Energy Ration	2	1=yes, 2=no
Urea Balance	1	1=yes, 2=no
Report Beef or NE per acre	2	1=beef, 2=NE g

High Energy Ration (yes/no)

When corn silage is used in rations where high levels of starch and sugars are included such as in the feedyard, it is common to have rumen pH levels below "6". In this case fiber digestibility is reduced as well and the program will reduce the inputted NDF digestibility value to 0.3 x the NDFd value entered. (The original models presented used a reduction multiplier of 0.5 and 0.7 but for all practical purposes feedyard diets have 50%+ starch and sugars without buffers in them and fiber digestion will be greatly impaired.) If the diet is intended for growing cattle or for maintaining them the multiplier is "1" giving NDFd full value.

Urea Balance (yes/no)

When the Urea Balance is set to "yes" protein is no longer the limiting element in projecting weight gain from the silage, energy would be. This setting when set to "yes" uses feed grade urea as the protein supplement to overcome any protein shortage since it would not affect the energy of the silage. Those varieties that have lower crude protein values would require slightly higher levels of urea and the cost of this addition is factored into the cost per lb beef or cost per mega calorie of NE g. Currently the urea cost is set to $500 per ton, but can be changed by the user. Since crude protein would tend to always limit growth for the reference steer it may be best to always make comparisons with the urea balance set to “yes”.

Report Beef or NE g per Acre

The program ranks varieties on either the beef produced per acre or the mega calories of NE g produced per acre. If “Beef” is selected the total cost of producing the crop per acre is divided by the projected beef yield. If NE g is selected the total cost of producing the crop per acre is divided by the projected mega calories of NE g yield per acre. The lowest cost per selected unit is the best ranking. Since production costs and yields are not always disclosed, it is conceivable that beef yield per ton of silage dry matter or NE g yield per ton of dry matter would suffice.

Corn silage Analysis Inputs

Program Screen Image 2

Tons / Acre	Cost / Acre	% DM	% Cr.Pro.	% NDFom	% Fat	% Ash	% NDF Digest.	% u NDFom
25	$550.00	35	7	32	3	5	65	15

Tons/Acre = tons of harvested wet silage per acre

Cost/Acre = total production cost per acre of harvested silage

% DM = percent dry matter of the sample

% Cr.Pro. = percent crude protein of the sample

% NDFom = percent neutral detergent fiber organic matter of the sample

%Fat = percent fat of the sample

%Ash = percent ash of the sample

% NDF digest. = percent NDF digestibility of the sample – 48 hour incubation

%uNDFom = percent indigestible NDF of the sample – originally the uNDF240 was used but it may be more practical to use the uNDF48 instead.

Corn Silage Analysis Outputs

Program Screen Image 3

Daily DM Intake	Silage ADG	Beef per Acre	$ / lb Beef	$ / ton Wet	$ / ton DM	Beef Rank	Calc. NE g	NE g per acre	$ / Mcal NE g	Rank NE g $
23.3	2.2	1681.0	$0.37	$22.0	$62.9	4	0.36	6272	$0.09	4

Daily DM Intake = projected pounds dry matter intake for the reference steer consuming the sample – the lower of the following two calculations DMI-A, DMI-B are used taken from the 2016 NASEM publication.

DMI-A *= (Wt^0.75 x (0.2435 x NEm-0.0466 x NEm ^2 - 0.0869)) / NEm) x 2.2045*

Wt *= 900 / 2.2045*

(900 is the weight of the reference 900 pound steer)

NEm *= calculated NEm x 2.2045*

DMI – B *= (900 x 0.012) / (NDFom x 0.01)*

Calculate Net Energy –Maintenance provided as Mcal NEm per pound dry matter

Calc NEm = $(1.37 \times ME - 0.138 \times ME^2 + 0.0105 \times ME^3 - 1.12) / 2.2456$

ME *= DE x 0.82*

DE *= (4.5 x %* Cr.Pro *x 0.01 x DMd x 0.01) + (4 x %NDFom x 0.01 x %NDFd48 x 0.01 x pH adj) + (9 x %Fat x 0.01 x DMd x 0.01) + (4 x %NFC x 0.01 x DMd x 0.01)*

%NDFd48 *= laboratory 48 hour NDF digestibility*

pH adj *= 1 for low energy ration(low starch and sugars), 0.3 for feedyard ration, reduced the digestibility of the fiber to 30% of what was indicated from the laboratory NDFom digestibility*

Calculate Dry Matter Digestibility (DMd) is calculated as a percent.

DMd *= 100 – Ash – uNDFom*

Calculate Nonfiber Carbohydrate (NFC) as a percent of the sample

%NFC *=100 – %Ash – %Fat – % Cr.Pro – %NDFom*

Calculate Net Energy –Gain provided as Mcal NEg per pound dry matter

Calc NEg = $(1.42 \times ME - 0.174 \times ME^2 + 0.0122 \times ME^3 - 1.65) / 2.2456$

Calculations – Referenced on Requirements of a 900 lb beef steer

Silage ADG - lbs / day uses the lower of the following – ADG allowed from Energy intake or ADG allowed by protein intake. If the Urea Balance input is set to "yes", ADG –Energy is used. It should be noted these equations, taken also from the NASEM publication are used to predict and empty body weight gain. Animal weight gain from gut fill will be considerably higher.

ADG – Energy = $13.91 \times 358.71^{-0.6837} \times availableNEg^{0.9116})) \times 2.2045)$

availableNEg *= ((DMI x NEm - 6.33) / NEm x NEg)*

(6.33 is the NE requirement for maintenance on the 900 lb steer used for model)

ADG – Protein (MP) *=((29.4 x 5.673 + Net MP)/268) x 2.2045*

Net MP *=((Feedmp +Microbialmp) - 301) x (0.834 - (298.8 x 0.00114))*

Feedmp *=(CP% x 0.01 x DMI x 0.32) x 453.6 x 0.75*

Microbialmp *= CP% x 0.01 x DMI x 0.68 x 453.6 x .64*

Beef per Acre (all values in lbs) *= (Tons/Acre x DM%)/ (DMI / Silage ADG)*

$ per Lb Beef *= Cost/Acre / Beef per Acre*

If silage yield and production cost is not given per acre we could calculate:

Beef per ton of silage DM*. = 2000 / (DMI / Silage ADG)*

This does leave out some significant items, yield and cost, but it may be the best we can do in many instances.

NEg per acre and Cost per Mcal NEg are also potential outputs to consider. We essentially calculate this already and the NEg has a fairly good correlation to Beef per Acre, however the DMI element can modify the outcome a bit and rerank varieties a bit when energy intake is directed by the DMI.

NEg per acre *= Calc NEg x Tons/Acre x DM% x 2000*

$ per Mcal NEg *= Cost/Acre / NEg per acre*

Results and Discussion

The Corn Silage to Beef application is currently a work in progress meaning that more adjustments may occur over time. Through this time the model has been tested over existing feed trials that had large corn silage components present in the ration. Other ingredients tend to confound the results a bit by their contribution of nutrients to the ration, but the expected differences in variety NDF digestibility and subsequent performance seem consistent between the model presented here and the results. Items that may need further consideration would include dry matter intake estimations. Currently the estimation is guided by net energy intake and fiber intake. As this model insinuates, not all NDF is created the same and thus the NDF intake could be subject to change. Use of a dNDFom or uNDF intake model may be more appropriate. However the net energy intake guide should compensate for some deficiencies at this time. The use of a calculated NFC to describe plant sugar and starch contributions may be somewhat simplifying of things, but here we are dealing with a longer gut retention time than what we would probably observe in a dairy cow so this aspect will be left alone at this time.