TURNING CORN SILAGE ANALYSIS INTO ECONOMIC VALUE FOR THE BEEF INDUSTRY

by

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B.S., Kansas State University, 2003

A THESIS

Submitted in partial fulfillment of the requirements

for the degree

MASTER OF AGRIBUSINESS

Department of Agricultural Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2016

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ABSTRACT

The corn silage market is typically focused heavily on the dairy market and results for corn silage plots are dedicated to the dairy industry specifically to get to the overall answer of $ Milk/Acre. The beef cattle industry is more interested in pounds of beef that can be gained from corn silage. There are roughly 6.2 million acres of corn silage in the US. Within that 6 million acres, roughly half is fed to beef cattle, but the corn silage industry has not focused on this aspect of the market.

Within Mycogen Seeds there has been an ever increasing demand to find a way to deliver the corn silage plot data in a useable format for beef producers. By delivering corn silage plot data to beef producers, Mycogen has aspirations of increasing it's market share of the corn silage market in Kansas as well as across the US, while at the same time increasing the awareness of how quality of a corn silage hybrid can affect a producers operation.

This thesis examines corn silage plot info sample analysis and specific feed analysis calculations. With these specific calculations, the corn silage plot will illustrate information in a form that beef producers will understand, $ Beef Produced/Acre. At the same time, this thesis will examine the industry wide concept that tonnage is the only component that is important when selecting a corn silage hybrid.

Finally this thesis will examine at what point ($/bushel) in the corn grain market does it make sense to start looking at utilizing corn silage over dry rolled corn by comparing price per MegaCalorie of energy by utilizing 25 year historical corn grain prices and using the Purdue Method of determining the cost of corn silage on a per ton basis.

TABLE OF CONTENTS

List of Figures iv
List of Tables v
Acknowledgments vi
Chapter I: Introduction 1
1.1 Industry Overview 1
1.2 Mycogen 2
1.3 Thesis Objectives 3
Chapter II: Literature Review 5
2.1 Effects of Corn Silage to Grain Corn Feed Mix Ratio on Cattle Performance 5
2.2 Effects of Corn Silage to Grain Corn Feed Mix Ratio on Meat Quality 8
Chapter III: Theory 12
3.1 Substitutes 12
3.2 Input Substitution Ratio & Input Price Ratio 12
Chapter IV: Methods 15
4.1 Solution Development for Corn Silage Plot Analysis 15
4.2 Corn Silage Plot Analysis Adjustments and Conversion to Economical Evaluation 20
4.3 Economic Evaluation of Corn Grain vs. Corn Silage for Feed Ration Options 32
4.4 Economical Analysis of Corn Grain vs. Corn Silage for Feed Ration Options 33
Chapter V: Conclusion 36
Works Cited 37

LIST OF FIGURES

Figure 3.1: Decreasing Rate of Substitution....................12

Figure 4.1: Mycogen Corn Silage Plot Form....................20

Figure 4.2: Cost of Corn Silage as Corn Grain Price Increases....................34

Figure 4.3: Evaluation of Grain Corn vs Corn Silage by $/Mcal....................34

LIST OF TABLES

Table 1.1: Mycogen Market Share and Potential Total Revenues 3
Table 2.1: Feed Mixes and Effect on Rate of Gain 6
Table 2.2: Differing Rates of Corn Silage and Effect on Rate of Gain 7
Table 2.3: Cattle Fat and Muscle Analysis Across Different Fed Diets 9
Table 2.4: Carcass Grades Across Different Feed Mixes 10
Table 2.5: Carcass Characteristics Across Different Corn Silage Feeding Rates 11
Table 3.1: Selecting a Least-Cost Feed Ration 14
Table 4.1: Corn Silage Plot Running in Excel 23
Table 4.2: Columns Taking out of Corn Silage Plot in Excel 24
Table 4.3: Columns Added into Corn Silage Plot in Excel 25
Table 4.4 : Corn Silage Plot Analysis with Section 4.1 Equations 27
Table 4.5 : Completed Beef Evaluation of Corn Silage Plot 29
Table 4.6 : Parameters for Corn Silage Plot Calculations 30
Table 4.7: Dry Rolled Corn Average NEm value 33

ACKNOWLEDGMENTS

The author wishes to thank Dr. Elizabeth Yeager for helping me through the thesis process as well as helping me to stay close to my timelines for completion. I would also like to thank Justin Waggoner as his knowledge in beef and feed nutrition were invaluable in getting this project completed. I also want to thank the Program Coordinator Deborah Kohl and the Program Associate Mary Bowen. Your hardwork and help has been much appreciated. Lastly, I want to thank my wife, Sara, and my wonderful kids Brody and Maggie for allowing me to obtain my Masters of Agricultural Business (MAB) degree. I can not wait to devote more time to you all – I love you all very much .

CHAPTER I: INTRODUCTION

1.1 Industry Overview

The corn silage market is typically focused heavily on the dairy market and results in silage plots are dedicated to the dairy industry to get to the overall answer of $ Milk/Acre. The beef cattle industry is more interested in pounds of beef that can be gained from corn silage. There are roughly 6.2 million acres of corn silage in the U.S. (2015 U.S. Crop Production Summary 2016). Within that 6 million acres, roughly half is fed to beef cattle; but the corn silage industry has not historically focused on this aspect of the market.

Typically when growers are asked what they want in corn silage, there is one answer, "tonnage." When discussing with producers in backgrounding and/or finishing of beef cattle, it is hypothesized they would want quality and not just tonnage, but there is not much feedback from growers and or industry professionals to indicate this.

Universities provide basic rations, but they have historically not focused on the quality of corn silage, rather they look at pounds of corn silage needed and do not adjust the ration based on the quality of the corn silage. This thesis will examine corn silage plot info (supplied by Mycogen), sample analysis and specific feed analysis calculations with the help of Justin Waggoner, Associate Professor / Extension Specialist at Kansas State University. With these specific calculations, the corn silage plot will show information in a form that beef producers will understand. The updated corn silage plot will look at price per unit of energy, MegaCalorie (Mcal), pounds of beef produced per acre and the total dollars of beef per acre produced to help determine what corn silage variety is actually more beneficial to a producers operation. The initial hypothesis is that quality and not just tonnage will be important when choosing corn silage varieties, based on the economics.

Finally this study will examine at what point does corn silage become economically advantageous to put in rations over grain corn. By comparing the price per unit of energy Mcal on both corn silage and grain corn, a determination can be made as the corn market moves on how this affects overall price per Mcal of energy.

1.2 Mycogen

By looking at this issue, information can be gathered that will allow Mycogen to start discussing with beef cattle/feeder operators at a different level than most in the seed industry discuss. They will be able to distinguish themselves as the authority when looking at what is the best corn silage for their operation. This will bring value to the corn silage market and allow Mycogen to become a leader in the Kansas market place. Optimizing corn silage in their feed rations will help producers gain the most pounds per day while at the same time being the most economical feed ration mix.

When you look at the potential economic gain, for Mycogen, of getting a 10% market share of the corn silage acres in Kansas is significant. The estimated corn silage acres in Kansas are around 170,000 acres (2015 U.S. Crop Production Summary 2016). Currently, Mycogen has 1-2% of the market share in Kansas, but this has not been a focus of Mycgoen's sales representatives in Kansas. With a 10% market share of these acres, there would be $1.59 million dollars in total revenue given current market prices, given the assumption that Mycogen will be adding new customers that have not been using the Mycogen corn silage, but a competitors portfolio (Table 1.1).

Table 1.1: Mycogen Market Share and Potential Total Revenues

Corn Silage Acres in KS	170,000
Number of Acres per bag of corn	2.67
10% Market Share in acres	17,000
Number of bags of corn	6,367
Avg cost per bag of corn	$250
Total potential revenue	$1,591,750
Minus current market share (2%) dollars	$318,250
Total potential gain from market differentiation	$1,273,500

The $1.27 million dollars net total revenue would be a gain in the Kansas market. This could be expanded across the country and realized in other states. This is only a 10% market share in Kansas. It is not unreasonable to consider a 25% market share ($3.9 million total revenue) or even 50% market share ($7.95 million total revenue).

1.3 Thesis Objectives

The objectives of the thesis are as follows:

1. Determine the values of corn silage analysis that are truly important to feed rations (ADF, TDN%, Mcal of NEm and NEg)
    a. Justin Waggoner's expertise will help in deciding which of these values are truly important in determing quality corn silage products for the beef industry.

2. Convert these values into an economic value that beef/feedlot producers and nutritionists find useful
    a. Justin Waggoner's expertise will help in coming up with the best equations to determine the outcomes we are looking for.
    b. Hypothesis: Tonnage is not the only factor to look at when determining a corn silage hybrid.
3. Find when there are advantages for corn silage over dry rolled corn in feed ration mixes, due to the fluxations in the corn grain market price
    a. Hypothesis: As corn grain price increases there will be an advantage for producers to look at corn silage over dry rolled corn for feed ration mixes.

CHAPTER II: LITERATURE REVIEW

2.1 Effects of Corn Silage to Grain Corn Feed Mix Ratio on Cattle Performance

A key component for finding a solution for this project is to determine how corn silage to grain corn feed mix ratios will affect cattle performance based on pounds of gain per day. When adjusting the feed rations, it is important to distinguish if the affect on the rate of gain per day while at the same time coming up with an economical feed mix. Many of the studies that examine the effect of corn silage in rations are dated. However, there is no reason to believe that the findings are no longer relevant today.

Perry and Beeson conducted a study in 1976 to look at silage and beef performance. They ran multiple experiments and found that a high corn silage feed mix (3.4% Corn and 91.9% Corn Silage component) was less efficient in rate of gain per day (2.01 lb/day gain) compared to high corn feed mix (43.6% Grain Corn and 46.6% Corn Silage at 2.31 lb/day gain) (Perry and Beeson 1976). In one of their five experiments, they looked at four different feed mixes (high corn silage, 1/3 full feed, 2/3 full feed and full feed). The experiment showed that 1/3 full feed, 2/3 full feed and full feed were not statistically different from each other (Table 2.1). The percentage of feed mix of grain corn and corn silage were as follows: 1/3 full feed – 10.6% grain corn and 84.5% corn silage, 2/3 full feed – 21.9% grain corn and 73% corn silage and full feed – 43.6% grain corn and 46.6% corn silage (Perry and Beeson 1976).

Table 2.1: Feed Mixes and Effect on Rate of Gain

Item	Levels of corn			
	Lot 1 1.5 lb corn	Lot 2 1/3 full feed	Lot 3 2/3 full feed	Lot 4 full feed
No. steers	20	20	20	20
Final wt, lb (kg)	892 (405)	947 (430)	953 (433)	953 (433)
Daily gain, lb (kg)	2.01 (.91)	2.27** (1.03)	2.31** (1.05)	2.31** (1.05)
Daily feed				
Corn, lb (kg)	1.5 (.7)	4.4 (2.0)	8.7 (4.0)	13.1 (6.0)
Supplement A, lb (kg)	2.0 (.9)	2.0 (.9)	2.0 (.9)	2.0 (.9)
Corn silage, lb (kg)	40 (18.2)	35 (15.9)	29 (13.2)	14 (6.4)
Feed per lb gain (air dry)	8.6	8.2	9.0	8.6
Total air dry corn per lb gain, lb	4.8[b]	5.1	6.3	6.9
TDN per lb gain, lb	5.5	5.4	6.3	6.4
Government grades[c]	8C, 12G	13C, 7G	17C, 3G	17C, 3G

**Gains for lots 2, 3 and 4 were significantly (P<.01) different than those of lot 1.

[a]480 lb (218 kg) initial weight.

[b]Includes corn from silage consumption. Air dry signifies 90% dry matter equivalent.

[c]C = choice; G = good.

Source: (Perry and Beeson 1976, pg. 550)

This helps show that a higher percentage of corn silage (up to 84.5%) can be used in feed mixes and not effect the rate of gain on finishing cattle. There have been other studies in the past that have shown grain corn to corn silage ratios of 50:50 and showed no differences on rate of gain compared to 80:20 ratios (Jesse, et al. 1976).

A more recent study was conducted in 1987 by Brennan, et al. to look at feedlot performance using different ratios of corn silage and corn grain. Their study found similar results while running three separate feeding trials. The study looked at feeding different mixes of corn silage in the diets as follows: 93%, 74%, 56%, 37%, 19% and 0% of the feed mix being corn silage (with the remainder being corn grain, alfalfa pellets and a supplement of varying rates to keep the Mcal of Metabolizable Energy (ME) rate around 25.5). The steers were feed a constant metabolizable energy intake and a separate trial with same ratios, but feed as ad libitum feed intake. Table 2.2 shows the results of their study on average daily gain with the steers receiving a constant metabolizable energy intake.

Table 2.2: Differing Rates of Corn Silage and Effect on Rate of Gain

	Percent energy from corn silage						
Item	93	74	56	37	19	0	SE[a]
No. of lots	3	3	3	3	3	3	2
Days on feed	175	175	175	175	175	175	
Initial wt, kg	316	318	316	315	317	315	
Final wt, kg	504	510	506	516	511	494	9.5
Total gain, kg	189	192	191	200	194	179	9.5
ADG, kg/d	1.07	1.10	1.09	1.14	1.10	1.02	.05
Daily feed DM, kg							
Corn silage	8.43	6.89	5.26	3.64	2.10	.61	
Corn grain	.10	1.10	2.08	3.06	4.02	4.85	
Alfalfa pellets		.52	1.04	1.56	2.08	2.54	
Supplement	.74	.75	.75	.75	.75	.75	
Daily DM intake, kg	9.27^{c}	9.26^{c}	9.13^{bc}	9.01^{bc}	8.95^{bc}	8.75^{b}	.17
Daily ME intake, Mcal	23.7^{b}	24.3^{bc}	24.5^{bc}	24.8^{bc}	25.2^{c}	25.2^{c}	.51
Feed efficiency[d]	8.70	8.97	8.44	7.95	8.18	8.90	.41
Energetic efficiency[e]	22.2^{bc}	23.5^{bc}	22.6^{bc}	21.9^{b}	23.0^{bc}	25.6^{c}	1.17

[a] $SE = \sqrt{\frac{s^2}{3}}$.

[b,c] Means within rows without a common superscript differ ($P<.05$).

[d] Expressed as kg feed DM/kg gain.

[e] Expressed as Mcal ME/kg gain.

Source: (Brennan, et al. 1987, pg. 25)

The data shows similar results in both the constant energy intake and the ad libitum feed intake. The steers had similar rates of gain from 74% of the diet being corn silage down to 19% of the diet being corn silage, with 37% of the diet being corn silage as having the highest rate of gain (Brennan, et al. 1987).

With the ever increasing use of ethanol, the cattel feeding industry has begun utilizing a by product of the ethanol industry called modified distillers grain with solubles (MDGS) in feed ration mixes. A study conducted by Burken (2014) that looked at new approaches in corn silage utilization in beef finishing diets. This study looked at using corn silage with 40% MDGS and found that “corn silage and MDGS can replace corn in finishing diets” (Burken 2014, pg. 80). The data from the experiments showed that feeding 45% corn silage compared to 15% corn silage in a 40% MDGS ration decreased the average daily gain and also decreased the gain to feed ratio (Burken 2014). However, at the same time as the percent of corn silage was increased in the 40% MDGS diet the ruminal pH was increased, which in turn improved the rumen environment to help increase fiber digestion (Burken 2014). This data help support that there are potential other avenues of bringing corn silage into beef rations, while decreasing the usage of grain corn.

2.2 Effects of Corn Silage to Grain Corn Feed Mix Ratio on Meat Quality

Another area that needs to be looked at is meat quality. A company can offer the most economical feed mix, but if it negatively affects the quality of meat the consumer receives that will have a negative impact on the industry. Multiple studies have been performed looking at grain corn and corn silage feed mixes and the effects on meat quality. Young and Kauffman found when looking at a grain corn diet vs. corn silage diet that “the data are interpreted to indicate when cattle are finished to similar carcass composition acceptability of steaks and roasts from cattle finished on high forage diets will be similar to those of cattle finished on high grain rations” (1978, pg. 48). The data showed that fat levels (marbling) and muscle analysis were similar across the different diets (see table 2.3).

Table 2.3: Cattle Fat and Muscle Analysis Across Different Fed Diets

Item	Diet			SEM[a]
	Grain	Corn silage	Haylage-corn silage	
Number	14	14	14	. . .
Initial scan				
Fat thickness, cm	.48	.46	.46	.01
Rib eye area, cm^2	47.7	49.7	49.7	.07
% Muscle[b]	66.2	66.8	66.7	.10
Kg muscle[c]	130	130	130	.63
Pre-slaughter fat scan, cm	1.09	.94	.97	.05

[a]Standard error of the mean.

[b]Calculated from the equation reported by Kauffman *et al.* (1975) where percent muscle = 65.79 + .23 (loin eye area, cm^2) − 2.92 (fat thickness, cm) − 2.28 (marbling score). All steers were assigned an initial marbling score of 4 (slight).

[c]Initial weight (kg) × arbitrary dressing % (54%) × percent muscle = kilogram muscle.

Source: (Young and Kauffman 1978, pg. 42)

A study conducted by Perry and Beeson looked at carcass grading, while looking at different feed rations. The study found "Types of diet had little consistent effect on U.S. grades of carcasses produced. Generally, those fed higher levels of corn silage graded just as well as those fed lower levels of silage" (1976, pg. 553). A summation of one of the experiments in the study is below in table 2.4 (carcass grades bottom line of the table : C = Choice and G = Good – note: Good refers to Select in US current grading standards (Bertelsen 2016)).

Table 2.4: Carcass Grades Across Different Feed Mixes

Item	Lots 1, 2, 3, 4 High corn silage	Lots 5, 6, 7, 8 Limited corn silage	Lots 9, 10, 11, 12 9 ground ear corn; 1 soy
No. steers	24	24	24
Final wt, lb (kg)	1082 (492)	1047 (476)	1016 (462)
Daily gain, lb (kg)	2.20* (1.00)	2.09 (.95)	1.94 (.88)
Daily feed			
Corn silage, lb (kg)	32.8 (14.9)	16.1 (7.3)	...
Corn, lb (kg)	2.0 (.9)	10.1 (4.6)	...
Soybean meal, lb (kg)	2.0 (.9)	2.0 (.9)	...
Complete mixture,lb (kg)	...	...	16.3 (7.4)
Feed per lb gain (air dry), lb	8.1	8.4	8.4
Total air dry corn per lb gain, lb[b]	4.0	6.4	6.0
TDN per lb gain, lb	4.6	5.4	6.0
Government grades	16C, 8G	13C, 11G	16C, 8G

[a]526 lb (239 kg) initial weight, 250-day experiment.

[b]Includes corn from corn silage consumption and excludes cob portion for Lots 9, 10, 11 and 12.

**Calves fed high corn silage diets gained significantly ($P<.01$) faster than those fed limited silage or than

Source: (Perry and Beeson 1976, pg. 552)

A newer study conducted in 1987 by Brennan, et al. also looked a varing rates of corn silage in a diet and its affects on carcass quality. As previously discussed, this study used varing percentages of corn silage in the diet from 93% down to 0%. The study found "results support earlier research by Young and Kauffman (1978), who observed that when cattle are fed to similar carcass composition, beef from steers fed high forage diets is similar in eating qualities to beef produced from steers finished on high grain diets" (1987, pg. 29). The summation of one of their trials looking at a constant energy intake is below in Table 2.5 (Note: Good refers to Select in US current grading standards (Bertelsen 2016)).

Table 2.5: Carcass Characteristics Across Different Corn Silage Feeding Rates

Item	Percent energy from corn silage						SE^a
	93	74	56	37	19	0	
No. of lots	3	3	3	3	3	3	3
Final wt, kg	504	510	506	516	511	494	9.5
Hot carcass wt, kg	308	311	309	315	312	301	5.7
Dressing percentage	60.3	61.0	61.3	62.0	61.9	61.5	.58
Loin eye area, cm^2	79.3	77.8	78.8	80.6	78.5	78.7	1.32
Backfat, cm	1.17	1.22	1.17	1.19	1.27	1.24	.12
Marbling score[b]	3.75	4.09	4.18	4.01	4.05	3.93	.31
Yield grade	2.38	2.45	2.39	2.65	2.65	2.41	.20
Quality grade[c]	6.58	7.04	7.01	6.91	6.92	6.43	.38

[a] $SE = \sqrt{\frac{s^2}{3}}$.

[b] Marbling score: 3 = slight; 4 = small; 5 = modest; 6 = moderate.

[c] Quality grade: 5 = Good; 6 = Good +; 7 = Choice −; 8 = Choice.

Source: (Brennan, et al. 1987, pg. 27)

The above data helps support that the quality of the meat will not be affected by the multiple ration combinations that a producer might use to add weight to their steers as long as the rations stays at a 1:1 Corn to Corn Silage ratio or higher.

CHAPTER III: THEORY

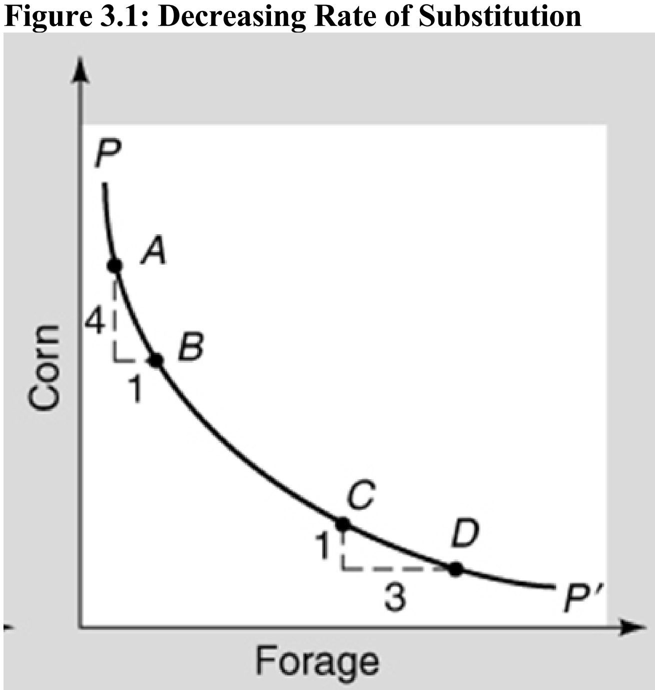
3.1 Substitutes

A substitute is defined as, "Goods for which an increase (decrease) in the price of one good leads to an increase (decrease) in the demand for the other good" (Baye 2010, pg. 40). In this case, it is looking at the price of one ingredient into the feed ration that can adjust the need for a second ingredient. The initial hypothesis is as corn grain price increases, there is a the need for corn silage to take a bigger percentage of the ration as it will be the preferred source for its lower price per unit of energy, Mcal.

3.2 Input Substitution Ratio & Input Price Ratio

Input substitution and input price ratio can help in determining which feed option is the least cost option. In relation to grain corn vs. corn silage there should be a decreasing rate of substitution, that can be represented by Figure 3.1 (Kay, Duffy and Edwards 2004).

Figure 3.1: Decreasing Rate of Substitution



(Kay, Duffy and Edwards 2004, pg. 119)

From Figure 3.1, the isoquant is represented by PP'. An isoquant is a line representing a combination of two products that will produce the same rate of weight gain in cattle. In this example, as corn is reduced by 4 units (Point A to Point B) and 1 unit of forage is needed to replace the 4 units of corn taken out of the ration to still keep us at the same rate of weight gain, providing an input substation ratio of 4. Looking at the second set of points (C & D) 3 units of forage is needed to replace 1 unit of corn taken out of the ration to still keep the same rate of weight gain, giving an input substitution ratio of 1/3. This is an example of a decreasing rate of substitution.

When looking at the ratios of inputs the input substitution ratio can be represented by the amount of input replaced divided by amount of input added (Kay, Duffy and Edwards 2004).

Mathematically, this is written as:

(Equation 3.1)

Input Substitution Ratio = amount of input replaced/amount of input added

Another ratio that is important to look at is the input price ratio. The input price ratio can be represented by the amount of input added divided by amount of input replaced (Kay, Duffy and Edwards 2004). Mathematically, this is written as:

(Equation 3.2)

Input Price Ratio = price of input being added/price of input being replaced

When making a decision on which substitute option is optimal, there is a need to find where the input substitution ratio = input price ratio. If they are not equal, the option that is as close as possible without having the input price ratio exceed the input substitution ratio needs to be found. An example of this is illustrated in Table 3.1. Options are shown in a table format that represent selecting a feed-cost ration replacing hay with grain.

Table 3.1: Selecting a Least-Cost Feed Ration

Feed Ration	Grain (lbs)	Hay (lbs)	Input Substitution Ration	Input Price Ratio
A	825	1350		
B	900	1130	2.93	1.47
C	975	935	2.6	1.47
D	1050	770	2.2	1.47
E	1125	625	1.93	1.47
F	1200	525	1.33	1.47
G	1275	445	1.07	1.47

grain at 4.4₵ and hay at 3.0₵

Source: Table 8.1 from Kay, Duffy and Edwards 2004, pg. 120

In this situation, option E is the best option as it is closest in having input substitution ratio equaling the input price ratio, without the input price ratio being the greater of the two ratios. There is a need for a similar approach in finding the least-cost feed ration option when choosing between grain corn and corn silage in the feed ration mix.

CHAPTER IV: METHODS

4.1 Solution Development for Corn Silage Plot Analysis

After consulting with Justin W. Waggoner, Ph.D., P.A.S, Associate Professor/Beef Systems Specialist with Kansas State Research and Extension, the key to changing the corn silage plot into usable information for the cattle producer as well as their nutritionist will be to get each hybrid down to a simple variable that can be represented across multiple feed stuffs, the amount of energy, contained within the respective feeds. The unit of energy used by nutritionists is the Mega Calorie or Mcal. A MegaCalorie is defined as one million times larger than one calorie (Saha, et al. 2013). A calorie is defined as the smallest unit of energy required for an animal to perform a specific function (Saha, et al. 2013). In the case of this thesis, the Mcal is used to help in determining pounds of gain in beef per acre by each individual corn silage hybrid.

The first variable that will need to be calculated is Dry Matter Tons based on a 100% basis to get everything on the same level. To obtain that value for each hybrid, the following equation is used:

(Equation 4.1)

*Dry Matter Tons on a 100% Basis = Total Yield in Tons * Dry Matter %*

The next variable that will need to be calculated is total digestible nutrients (TDN%). To find the TDN%, the corn silage analysis obtained from each plot, specifically Acid Detergent Fiber (ADF) is used in the following equation obtained from National Forage Testing Association (Undersander, Mertens and Thiex 2013):

(Equation 4.2)

$$TDN\% = 88.9 - (0.779*ADF)$$

Once the TDN% is found, metabolizable energy (ME) of the corn silage, Net Energy Maintenance (NEm), Net Energy Gain (NEg) potential of the corn silage, dry matter intake of the steer (assuming a 500lb steer that is consuming 1% of it's body weight in corn silage), NEg Supply (supply of Mcal giving the intake variable previously mentioned), net energy allowable gain per day (assuming maintenance requirements for energy and protein have been met) are needed. The ME variable will be found using an equation obtained from National Forage Testing Association (Undersander, Mertens and Thiex 2013). The remainder of the variables will be calculated by utilizing equations from Nutrient Requirements of Beef Cattle (National Research Council 2001)

(Equation 4.3)

$$ME\ (Mcal/kg) = (TDN * 0.01)*4.409*0.82$$

(Equation 4.4)

$$NEm\ (Mcal/kg) = (1.37*ME)-(0.138*ME^2)+(0.0105*ME^3)-1.12$$

(Equation 4.5)

$$NEg\ (Mcal/kg) = (1.42*ME)-(0.174*ME^2)+(0.0122*ME^3)-1.65$$

(Equation 4.6)

$$Dry\ Matter\ Intake\ (kg) = (500/2.20462)*0.01$$

(Equation 4.7)

$$NEm\ Supply\ (Mcals) = Dry\ Matter\ Intake * NEm$$

(Equation 4.8)

$$NEg\ Supply\ (Mcals) = Dry\ Matter\ Intake * NEg$$

(Equation 4.9)

$$Net\ Energy\ Allowable\ Gain\ (kg/day) = 13.291*((NEg\ Supply^{0.9116})*(245^{-0.6837}))$$

Once the net energy allowable gain is determined, it is converted to pounds per day of net allowable gain by using the following equation:

(Equation 4.10)

$$Net\ Energy\ Allowable\ Gain\ (lb/day) = Net\ Energy\ Allowable\ Gain\ (kg/day) * 2.20462$$

By utilizing equation 4.10, the determination of quality in the corn silage hybrid can be compared. The higher the value, the more energy per pound of corn silage there is to utilize by the cattle.

All of the previous values will be extremely important to determine which corn silage hybrids are giving the producer the most value per acre. To drive it to one of two economical indicators, the corn silage hybrids are examined to determine which is lowering the price per unit of energy ($/Mcal). To get to this value the cost per ton of corn silage is determined and the following equations is used to determine price unit of Mcal:

(Equation 4.11)

$$Cost\ per\ pound\ of\ corn\ silage\ on\ dry\ matter\ basis = Cost\ of\ corn\ silage\ per\ ton/(2000\ lbs*Dry\ Matter\ \%)$$

(Equation 4.12)

$$Cost\ per\ unit\ of\ Mcal = Cost\ per\ pound\ of\ corn\ silage\ on\ dry\ matter\ basis\ /\ NEm$$

To determine the cost per ton of corn silage, Purdue's Method (Hendrix, 2002) of determining corn silage values is used:

(Purdue Method Equation 1)

*Lbs of Dry Matter = 2000 Lbs * % Dry Matter*

(Purdue Method Equation 2)

*Lbs of Grain = Lbs of Dry Matter * 0.50 (% of Grain in Dry Matter)*

(Purdue Method Equation 3)

Lbs of No. 2 Grain Corn = Lbs of Grain / 0.845 factor

(Purdue Method Equation 4)

Bushels (bu) of No. 2 Grain Corn = Lbs of No. 2 Grain Corn/56 (Lbs/bu of corn)

(Purdue Method Equation 5)

*Value of No. 2 Grain Corn = Bushels (bu) of No. 2 Grain Corn * Market Price*

(Purdue Method Equation 6)

*Input Costs = $1.00 * Every 100Lbs of Dry Matter*

(Purdue Method Equation 7)

Cost of Ton of Corn Silage = Value of No. 2 Grain Corn + Input Costs

By utilizing Purdue's Method this allows an adjustment for current and future corn grain prices as well as dry matter % in the determination of corn silage tonnage value.

The last indicator in turning corn silage plot data into an economic value is to come up with total pounds of beef gained per acre and what the economic value of those pounds of beef are per acre. First the amount of cattle per day that can be fed off of one acre of a corn hybrid is determined by utilizing the dry matter content and dry matter intake basis.

After finding the amount of cattle that can be fed the number of cattle is multiplied against the daily intake amount to get the total gain per acre (kg/acre). Finally this can be converted into the value of pounds of beef per acre.

(Equation 4.13)

*# of cattle per day/acre = ((Tons of Dry Matter on 100% Basis *2000)*0.453592)/Dry Matter Intake*

(Equation 4.14)

*Total kg/acre of beef = # of cattle per day/acre * Dry Matter Intake*

(Equation 4.15)

*Total lb/acre of beef = Total kg/acre of beef *2.20462*

Now that total lbs of beef is determined, the following equation is used to estimate total dollars of beef raised per acre of a corn silage hybrid:

(Equation 4.16)

*Total $ of beef/acre = Total lb/acre of beef * current market price*

With the above equations, the quality and economic evaluation of a corn silage plot can occur.

4.2 Corn Silage Plot Analysis Adjustments and Conversion to Economical Evaluation

Figure 4.1 shows the current format for a corn silage plot that is exported out in the Mycogen system.

Figure 4.1: Mycogen Corn Silage Plot Form

2015 Harvest Results

Mycogen SEEDS

Alfalfa Farms - Corn Silage Plot
Planted: Syracusr, KS
County : Kearny
Planted: 5/18/2015
Harvest: 9/15/2015

Territory: 7B
Herbicide:
Insecticide:
Fertility: --
Irrigation: Yes

Gross $Milk/Acre are calculated at 0.18/Lb

Company	Variety	Entry Number	Kernel Processed	Yield T/Acre @65%	% Dry Matter as Fed	DM Yield Tons/A	Harvest Population	Maturity Check	NDF % of DM	NDFD Digestibility % of DM	% Crude Protein % of DM	% Starch % of DM	Starch Digestibility % of Starch	Ash % of DM	NFC % of DM	TDN % of DM	NEl Mcals /lb	$Milk /Acre	Milk /Ton lbs	Rank Milk /Ton	Milk /Acre lbs	Rank Milk /Acre
Mycogen	T14749VH	6	Y	31.1	42.5	8.0			38.6	52.5	7.1	35.9	0.91	3.7	49.1	68.4	0.750	$5129	3562	5	28496	1
Mycogen	TMF2H706	9	Y	30.2	42.3	7.8			38.9	51.4	7.3	32.3	0.91	4.0	48.3	66.7	0.740	$4881	3490	8	27117	5
Mycogen	TMF2L825	2	Y	30.1	40.4	7.8			41.3	48.1	6.8	31.6	0.93	4.2	46.0	66.2	0.730	$4747	3403	11	26373	7
Mycogen	TMF2L874	1	Y	29.8	39.3	7.7			38.4	51.5	7.5	31.4	0.94	3.9	48.4	67.5	0.750	$4902	3555	6	27231	4
Mycogen	TMF2R720	7	Y	29.6	43.0	7.6			36.6	50.6	7.4	36.0	0.91	3.8	50.7	68.6	0.760	$4951	3614	4	27503	2
Mycogen	TMF2R737	5	Y	29.3	47.4	7.5			35.9	52.6	7.4	37.8	0.87	4.0	51.2	67.8	0.760	$4910	3627	3	27275	3
Mycogen	TMF2L874	11	Y	29.1	39.4	7.5			38.2	51.2	7.5	32.1	0.94	4.1	48.5	67.8	0.750	$4790	3553	7	26612	6
Mycogen	TMF2H747	3	Y	28.8	47.9	7.4			42.8	53.0	6.8	34.3	0.86	3.9	45.1	64.9	0.730	$4577	3436	9	25426	8
Mycogen	TMF12Q57	4	Y	27.6	44.7	7.1			40.5	50.4	7.3	31.4	0.89	4.6	46.1	65.6	0.730	$4363	3419	10	24241	10
Mycogen	TMF06S67	10	Y	26.8	48.3	6.9			35.6	51.6	6.9	39.1	0.86	3.5	52.3	67.8	0.770	$4564	3685	2	25353	9
Mycogen	BMR14B96	8	Y	25.0	42.3	6.4			37.5	63.8	8.1	32.3	0.91	4.3	48.5	71.5	0.760	$4271	3696	1	23728	11
Plot Average				28.9	43.4	7.4			38.6	52.4	7.3	34.0	0.90	4.0	49.1	67.5	0.748	$4735	3549		26305	

Milk/Ton and Milk/Acre Calculated using: **Milk 2006** From: UW Extension

University of Wisconsin Corn Silage Evaluation System
Authors: Randy Shaver & Patrick Hoffman - Department of Dairy Science
Joe Lauer & Jim Coors - Department of Agronomy

Saturday, February 13, 2016 7:57:31 PM

Page 1 of 1

Table 4.1 shows how the silage plot form looks running in the background of Excel. Within the file there are different columns that are specific for silage analysis and the dairy market. *Business Enterprise* relates to the brand of the corn silage hybrid. *Name* relates to the corn silage hybrid naming nomenclature. *Trait* relates to the insect and herbicide technology trait that is expressed by each corn silage hybrid. *Entry Number* relates to the order of each hybrid as they were planted in the plot. *Kernel Processed* relates to if the corn kernels were processed, a method in breaking the corn kernel into smaller pieces to aid in starch utilization, by the forage harvester.

Columns that relate to yield and dry matter ability of each hybrid are: *Yield Tons* relates to the total wet tons of each corn silage hybrid weighed in the plot. *Yield Rank* relates to the order of rank for total wet tons of each corn silage hybrid. *% Dry Matter* relates to the percent of dry matter content of each corn silage hybrid. *DM Yield Tons* relates to tons of dry matter based on a 35% dry matter basis – this is utilized by seed companies to try and put each hybrid on a level playing field and try to find a standard across the industry for comparisons, but in this thesis it allows for too much gray area that can cause errors in the data.

Columns that relate to quality characteristics of each hybrid are: *% NDF* relates to the % Neutral Detergent Fiber contained within the dry matter portion of the each corn silage hybrid. *% NDFD* relates to Neutral Detergent Fiber Digestiability contained within the dry matter portion of each corn silage hybrid. *% CP of Dry Matter* relates to the Crude Protein contained within the dry matter portion of each corn silage hybrid. *% Starch* relates to the starch content contained within the dry matter portion of each corn silage hybrid. *Starch Digestibiltiy % of Starch* relates to percent of the starch content that will be digestible by animals. *% Ash* relates to the ash content that is contained within the dry matter portion of each corn silage hybrid. *NFC % of DM* relates to Nonfibrous Carbohydrates contained within the dry matter portion of each corn silage hybrid. *TDN % of DM* relates to the Total Digestible Nutrient contained in the dry matter portion of each corn silage hybrid – this column will not be used in this analysis and instead a formula that is corn silage specific for beef is utilized. *NEL* relates to MCal per pound of each corn silage hybrid utilized for the dairy industry.

Columns that relate to economics of each hybrid are: *$Milk/Acre* is an economic evaluation of each corn silage hybrid on the dollars of milk produced per acre. *Milk per ton* relates to the amount of milk each ton of each corn silage hybrid can produce. *Milk per Ton Rank* relates to the rank among the hybrids based off of how much milk each ton can produce. *Milk per Acre* relates to how many pounds of milk each corn silage hybrid can produce given their quality and tonnage. *Milk per Acre Rank* relates to the ranking among the corn silage hybrids based on how many total pounds per acre of milk each hybrid can produce.

Table 4.1: Corn Silage Plot Running in Excel

Business Enterprise	Name	Trait	EntryNumber	Kernel Processed	Yield Tons	Yield Rank	% Dry Matter	DM Yield Tons	% NDF	NDFD	% CP of Dry Matter
Mycogen	TMF2L874	SSX	1	Y	29.8	4	39.3	7.66	38.4	51.5	7.5
Mycogen	TMF2L825	HX1RR	2	Y	30.13	3	40.4	7.75	41.3	48.1	6.8
Mycogen	TMF2H747	SSX	3	Y	28.79	8	47.9	7.4	42.8	53	6.8
Mycogen	TMF12Q57	SSX	4	Y	27.58	9	44.7	7.09	40.5	50.4	7.3
Mycogen	TMF2R737	SSX	5	Y	29.26	6	47.4	7.52	35.9	52.6	7.4
Mycogen	T14749VH	SSX Component	6	Y	31.12	1	42.5	8	38.6	52.5	7.1
Mycogen	TMF2R720	SSX-RA	7	Y	29.6	5	43	7.61	36.6	50.6	7.4
Mycogen	BMR14B96	SSX Component	8	Y	24.97	11	42.3	6.42	37.5	63.8	8.1
Mycogen	TMF2H706	SSX	9	Y	30.21	2	42.3	7.77	38.9	51.4	7.3
Mycogen	TMF06S67	SSX	10	Y	26.76	10	48.3	6.88	35.6	51.6	6.9
Mycogen	TMF2L874	SSX	11	Y	29.13	7	39.4	7.49	38.2	51.2	7.5

% Starch	Starch Digestibility % of Starch	% ASH	NFC % of DM	TDN % of DM	NEL	$ Milk/Acre	Milk per ton	MilkperTon Rank	Milk per Acre	MilkperAcre Rank
31.4	0.94	3.93	45.5	72.6	0.75	4901.58	3555	6	27231	4
31.6	0.93	4.2	44	71.3	0.73	4747.14	3403	11	26373	7
34.3	0.86	3.85	45	71	0.73	4576.68	3436	9	25426	8
31.4	0.89	4.57	44.8	71.3	0.73	4363.38	3419	10	24241	10
37.8	0.87	3.95	49.7	73.9	0.76	4909.5	3627	3	27275	3
35.9	0.91	3.69	47.9	73	0.75	5129.28	3562	5	28496	1
36	0.91	3.76	49.2	73.6	0.76	4950.54	3614	4	27503	2
32.3	0.91	4.27	46.1	73.9	0.76	4271.04	3696	1	23728	11
32.3	0.91	4.03	45.9	72.3	0.74	4881.06	3490	8	27117	5
39.1	0.86	3.46	50.5	74.6	0.77	4563.54	3685	2	25353	9
32.1	0.94	4.13	45.4	72.5	0.75	4790.16	3553	7	26612	6

From the previous information, the following columns will be eliminated: TDN % of DM, NEL, $Milk/Acre, Milk per Ton, Milk per Ton Rank, Milk per Acre and Milk per Acre Rank. Table 4.2 shows these columns that are deleted, which is original data calculated from Mycogen equations for the dairy market, and replaced with columns (highlighted in green) shown in Table 4.3, that are tied back to equations shown in section 4.1.

Table 4.2: Columns Taking out of Corn Silage Plot in Excel

NEL	$ Milk/Acre	Milk per ton	MilkperTon Rank	Milk per Acre	MilkperAcre Rank
0.75	4901.58	3555	6	27231	4
0.73	4747.14	3403	11	26373	7
0.73	4576.68	3436	9	25426	8
0.73	4363.38	3419	10	24241	10
0.76	4909.5	3627	3	27275	3
0.75	5129.28	3562	5	28496	1
0.76	4950.54	3614	4	27503	2
0.76	4271.04	3696	1	23728	11
0.74	4881.06	3490	8	27117	5
0.77	4563.54	3685	2	25353	9
0.75	4790.16	3553	7	26612	6

Table 4.3: Columns Added into Corn Silage Plot in Excel

NFC % of DM	DM Yield @ 100% DM Basis	Cost/Ton of Corn Silage	ADF	TDN % of DM	NEm (Mcal/Lb)	NEg (Mcal/100Lb)	Net Energy Allowable gain, (lb/day)	$/Mcal	Pounds of Beef Gain/Acre	$ Beef/Acre	$/Acre Rank
47.9											
45.9											
44											
45.5											
49.2											
49.7											
45.4											
45											
44.8											
50.5											
46.1											

Once the columns are added into the Excel file, the ADF values of each hybrid from the lab analysis are imported and use the equations from section 4.1. Table 4.4 shows the analysis. Each column estimates an equation in the background as follows: *TDN, % * calc* is utilizing Equation 4.2, *ME, Mcal/kg* is utilizing Equation 4.3, *NE maint., mcal/kg* is utilizing Equation 4.4, *NE gain, Mcal/kg* is utilizing Equation 4.5, *Dry Matter Intake* is utilizing Equation 4.6, *NE maint. Supply Mcals* uses Equation 4.7 (note this is not used in further calculation of what this thesis is after, however, discussing with Justin Waggoner this was included in case anyone wanted to look at maintenance needs instead of looking at gains), *NE gain. Supply Mcals* uses equation 4.8, *Net Energy Allowable gain, kg/d* is utilizing equation 4.9, *Net Energy Allowable gain, lb/d* uses Equation 4.10, Head/day/acre uses Equation 4.13, *Total kg/gain acre* uses Equation 4.14 and *Estimated total lb gain/acre* is utilizing Equation 4.15.

Table 4.4 : Corn Silage Plot Analysis with Section 4.1 Equations

TDN, % *calc	ME , Mcal/kg	NE maint., mcal/kg	NE gain, Mcal/kg	Dry matter intake (500 lb steer @1.0% BW dry basis) kg	NE maint. Supply Mcals	NE gain. Supply Mcals
70.28	2.5410	1.642	1.035	2.268	3.725	2.347
69.35	2.5072	1.613	1.009	2.268	3.658	2.288
68.26	2.4677	1.578	0.978	2.268	3.579	2.218
69.81	2.5241	1.628	1.022	2.268	3.691	2.317
71.22	2.5748	1.672	1.061	2.268	3.792	2.406
71.37	2.5804	1.677	1.065	2.268	3.803	2.416
69.58	2.5156	1.620	1.015	2.268	3.675	2.303
68.57	2.4790	1.588	0.987	2.268	3.602	2.238
68.72	2.4846	1.593	0.991	2.268	3.613	2.248
71.68	2.5917	1.686	1.074	2.268	3.825	2.435
70.98	2.5663	1.664	1.054	2.268	3.775	2.391

Net Energy Allowable gain, kg/d	Net Energy Allowable gain, lb/d	Head/day/acre (DM yield/dry matter intake)	total kg/gain acre	Estimated total lb gain/acre
0.673	1.48	5290.39	3559.14	7839.52
0.657	1.45	5111.52	3359.40	7399.56
0.639	1.41	4869.00	3110.85	6852.09
0.665	1.46	4684.55	3115.26	6861.80
0.688	1.51	5091.19	3503.49	7716.94
0.691	1.52	5547.68	3831.78	8440.05
0.661	1.45	4590.88	3035.11	6685.27
0.644	1.42	5516.15	3553.30	7826.64
0.647	1.42	4931.29	3189.47	7025.27
0.696	1.53	5170.02	3597.25	7923.46
0.684	1.51	4224.92	2891.17	6368.21

A version that will be used for a future template for corn silage plot data specific for beef producers is shown in Table 4.5. Some values in Table 4.4 were moved and placed in Table 4.5. The following columns values came from Table 4.4: *Pounds of Beef Gain/Acre* uses the values from column *Estimated total lb gain/acre* relating to the specific corn silage hybrid and Net Energy Allowable Gain (lb/day) uses values from column Net Energy Allowable gain, lb/d relating to the specific corn silage hybrid.

The following columns are estimating an equation in the background as follows*:* *DM Yield @ 100% DM Basis* is utilizing Equation 4.1, *Cost/Ton of Corn Silage* uses Purdue Method Equation 1-7, *NEm (Mcal/Lb)* is taking the value from column *NE maint., mcal/kg* times a factor of 2.20462 to convert to pounds, *NEg (Mcal/Lb)* is using the value from column *NE gain, Mcal/kg* times a factor of 2.20462 to convert to pounds, $/Mcal uses

Equation 4.12 and $Beef/Acre uses Equation 4.16. Lastly the *ADF* column is the corn silage analysis data that was pulled from the original samples sent to the lab. The columns in white are the original values used to compare the data better against the total field tons recorded in the plot records.

Table 4.5 : Completed Beef Evaluation of Corn Silage Plot

DM Yield @ 100% DM Basis	Cost/Ton of Corn Silage	ADF	TDN % of DM	NEm (Mcal/Lb)	NEg (Mcal/100Lb)	Net Energy Allowable gain, (lb/day)	$/Mcal	Pounds of Beef Gain/Acre	$ Beef/Acre	$/Acre Rank	Yield Rank	Yield Tons	Name
13.23	$41.19	23.9	70.28	0.74	0.47	1.48	0.065	7840	$12,229.65	3	1	31.12	T14749VH
12.78	$41.00	25.1	69.35	0.73	0.46	1.45	0.066	7400	$11,543.31	6	2	30.21	TMF2H706
12.17	$39.16	26.5	68.26	0.72	0.44	1.41	0.068	6852	$10,689.26	9	3	30.13	TMF2L825
11.71	$38.09	24.5	69.81	0.74	0.46	1.46	0.066	6862	$10,704.41	8	4	29.8	TMF2L874
12.73	$41.68	22.7	71.22	0.76	0.48	1.51	0.064	7717	$12,038.43	5	5	29.6	TMF2R720
13.87	$45.94	22.5	71.37	0.76	0.48	1.52	0.064	8440	$13,166.47	1	6	29.26	TMF2R737
11.48	$38.19	24.8	69.58	0.73	0.46	1.45	0.066	6685	$10,429.03	10	7	29.13	TMF2L874
13.79	$46.43	26.1	68.57	0.72	0.45	1.42	0.067	7827	$12,209.56	4	8	28.79	TMF2H747
12.33	$43.32	25.9	68.72	0.72	0.45	1.42	0.067	7025	$10,959.42	7	9	27.58	TMF12Q57
12.93	$46.81	22.1	71.68	0.76	0.49	1.53	0.063	7923	$12,360.60	2	10	26.76	TMF06S67
10.56	$41.00	23	70.98	0.75	0.48	1.51	0.064	6368	$9,934.40	11	11	24.97	BMR14B96

Behind the numbers in Table 4.5 were some calculated values that were used in the equations shown below in Table 4.6 (cost per ton of corn silage, steer weight, % dry matter intake and current corn grain market price).

Table 4.6 : Parameters for Corn Silage Plot Calculations

Parameters and Market Prices		
Weight of Steer	500	
Dry matter intake	1%	By Weight Dry Basis
Beef Market Price/Lb	$1.56	
Market price of corn	$3.64	

The results after running the data are as hypothesized. The data does support that not only is tonnage an important factor, but also the quality of the corn silage along with dry matter % content of the hybrid. T14749VH hybrid, which is an experimental 114 day hybrid, came out ahead on total field tonnage, ranked 3rd once quality was taken into account. The reason for this change was that the hybrid's dry matter % was 42.5% which drove down the total dry matter tons based on a 100% basis. However, due to it having a low ADF value and high TDN%, it still was in the top percentile of $ per acre of beef raised. What is noticeable is that the two hybrids TMF2H706, a 109 day RM hybrid, and TMF2L825, a 117 day RM hybrid, that came out 2 and 3 respectively in total field tonnage turned out to be 6 and 9 respectively in $ of beef per acre raised once quality of product was put into account. This was due to lower % dry matter content, higher ADF and lower TDN% values. TMFR737, a 112 day RM hybrid, and TMF06S67, a 106 day RM hybrid, came out ahead from a quality standpoint. TMF2R737 was 6th in total field tonnage, but came out 1st in $ of beef per acre raised when adding in quality and TMF06S67 was 10th in total field tonnage, but 2nd in $ of beef per acre raised due to the fact that they both were higher in % dry matter content and had lower ADF values, which in that gave them a lower cost per unit of Mcal. All of this data supports that tonnage is not the most important factor when selecting a corn silage hybrid, but instead producers should look at the following four factors when determining a quality corn silage hybrid: total field tonnage, higher % dry matter content, lower ADF values and higher TDN%.

From this analysis, Mycogen should be able to execute this formulation in building a corn silage plot form specific for beef producers. This will allow Mycogen to have grower meetings next fall along with new corn silage plots that will be strategically placed in Kansas. Mycogen will now have a way to express what a quality corn silage product can do economically for their operation assuming the cost of seed, input and production costs are the same.

4.3 Economic Evaluation of Corn Grain vs. Corn Silage for Feed Ration Options

The next section will look at how does the market price of grain corn affect the $/Mcal of dry rolled corn and corn silage. "Where do economics state that corn silage should replace dry rolled corn in the feed ration?" That answer is determined by running the highest through the lowest market price for grain corn over last 25 years, which in turn estimates the cost per ton of silage that can be converted into $/Mcal, utilizing the Purdue Method of determining corn silage values (Hendrix 2002). By having the $/Mcal of both dry rolled corn and corn silage, it can be determined which option would be the preferred depending on how the market moves.

There will be two assumptions made to estimate this data, that the NEm value of corn silage is 0.74 Mcal/lb and % dry matter content of 43.5%, which is the average of the corn silages in the corn silage plot above. The equation to determine the $/Mcal in the spreadsheet is used from previous equations:

(Equation 4.11)

*Cost per pound of corn silage on dry matter basis = Cost of corn silage per ton/(2000 lbs*Dry Matter %)*

(Equation 4.12)

Cost per unit of Mcal = Cost per pound of corn silage on dry matter basis / NEm

The second assumption is that dry rolled corn will have a NEm value 1.02. This value tends to be the average NEm value of dry rolled corn as shown below in Table 4.7 from North Dakota State University (Lardy 2013).

Table 4.7: Dry Rolled Corn Average NEm value

Corn Type	Dry Matter	TDN, %	NE_m, Mcal/lb	NE_g, Mcal/lb	CP, %	Escape Protein, % of CP
Dry Rolled Corn	86	90	1.02	0.70	9.8	60
Ear Corn	87	83	0.92	0.62	9.0	60
Steam-flaked Corn	82	94	1.06	0.73	10.0	45
High-moisture Corn	75	90	1.02	0.70	10.0	40
High-moisture Ear Corn	75	83	0.92	0.62	8.7	40
High-moisture Snapped Corn	74	81	0.90	0.59	8.8	40

Table adapted from Stock, R., R. Grant, and T. Klopfenstein. 1995. Average composition of feeds used in Nebraska. G91-1048-A. University of Nebraska.

Source: (Lardy 2013, pg. 2)

To obtain the dry rolled corn Mcal/$ value the following equation will be utilized:

(Equation 4.17)

$$\text{Cost per unit of Mcal Dry Rolled Corn} = \text{Market Price} / (56 * NEm)$$

4.4 Economical Analysis of Corn Grain vs. Corn Silage for Feed Ration Options

Using a monthly average cash grain price from the FarmDoc website, the lowest price for grain corn in the last 25 years was $1.40/bu, on 10/1/86, and the highest was $7.63, on 8/1/12 (University of Illinois 2016). These values are used as the high and low for our analysis on $/Mcal pertaining to rolled grain corn and corn silage. Figure 4.2 shows how the cost of corn silage is affected as the price of grain corn increases. Figure 4.3 shows the results once the data is compiled and put together.

Figure 4.2: Cost of Corn Silage as Corn Grain Price Increases

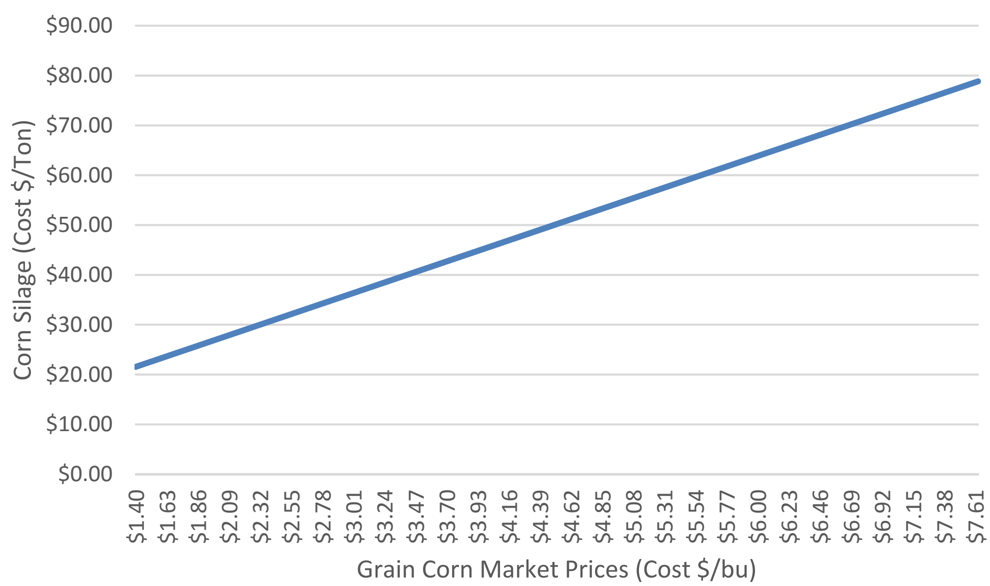
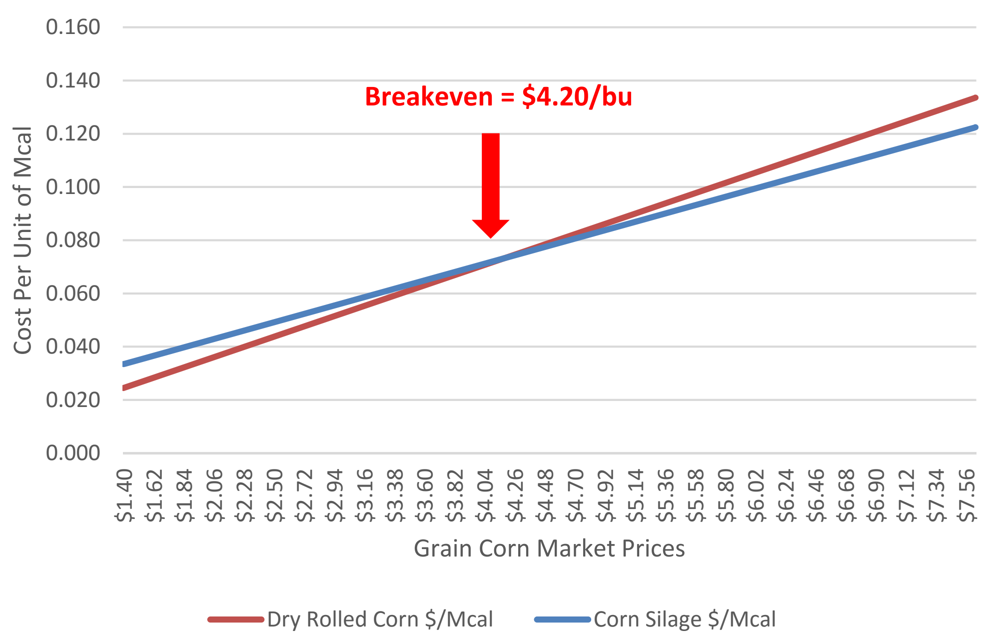


Figure 4.3: Evaluation of Grain Corn vs Corn Silage by $/Mcal



After processing the data it definitely looks like as the market price of grain corn increases (which in turn increases the cost of corn silage) the separation widens between the cost of dry rolled corn and corn silage, with corn silage being the cheaper source of energy at a cost of $4.20/bu of corn or greater (given the assumptions above on the corn silage). At the grain corn futures price of $3.64/bu dry rolled corn would have a $/Mcal cost of 6.4₵ and corn silage would be 6.5₵, giving dry rolled corn a 0.1₵ per unit of Mcal advantage for feed rations. As the corn grain prices move higher, above $4.20/bu there is an advantage to using corn silage as it is the cheaper source of energy, since we have already established 1 Mcal of dry rolled corn is equal to 1 Mcal of corn silage. In fact, at the highest trade level of corn, $7.63/bu there is 1.2₵ per unit of Mcal advantage with corn silage (12.2₵/Mcal) over dry rolled corn (13.4₵/Mcal).

Looking at historical monthly corn grain prices from January 2006 to February 2016 (University of Illinois 2016), the times that the corn grain market was at or over $4.20/bu was 44.6%. There is definite evidence that producers could find the corn grain market in their favor to utilize corn silage over dry rolled corn in their feed rations.

CHAPTER V: CONCLUSION

After reviewing the data in this thesis, there is no doubt that tonnage is not the only factor that a beef producer should look at when determining what corn silage hybrid they should select for the following year. After the data has been reviewed, a producer should look at the following when determing a quality corn silage hybrid for the next year: total field tonnage, higher % dry matter content, lower ADF values and higher TDN%. By finding the corn silage hybrids that have all four of these factors, a producer may have a better ability to increase their return on the acre as well as in their beef cattle. As it has been demonstrated in this thesis, getting to a quality corn silage is not just about tons produced, but is a total plant package that can bring about true economic returns.

Lastly when deciding on when it is a good time to use more corn silage over dry rolled corn, there is a definite advantage of using corn silage when corn grain hits $4.20/bu or higher.

From the finding of this thesis paper, it is recommended that Mycogen implement the equations utilized in this paper along with adding the format built to show the value of each corn silage hybrid and what it can bring to a beef producer. There have been discussions with both the head nutritionist and data manager with Mycogen Seeds and both are pleased to use this process in building a new corn silage plot form for the beef industry. There is no doubt that this format will help in comparing hybrids, but at the same time, raising the awareness that producers need to be more concerned about multiple factors and not just quantity, but quality. Lastly, this will put Mycogen Seeds in the light as the leading experts of corn silage when compared to competitors in the beef market place.

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