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The Relationship Between Corn Grain and Forage Yield: An Update

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Understanding the relationship between corn grain and forage yield is important to dairymen and grain farmers who often contract with each other for corn silage production. Recently, the grain versus forage relationship has been used to set government Loan Deficiency (LDP) Payments to farmers for corn silage acres.

Arriving at a fair and equitable price for corn silage is difficult due to the number of factors involved that are dynamic and biologically variable. Factors include grain yield, forage yield, production costs, grain price, harvesting costs, grain drying costs, fertility value of stover, and forage quality (especially starch content and neutral detergent fiber digestibility-NDFD).

Some growers will want to calculate the forage price based on corn grain yield (as the alternative harvestable crop) and some dairymen will want to calculate the price based on alternative forages (primarily alfalfa as the alternative forage source). In either case, the final price is affected by supply and demand of corn grain within a region.

The objective of this paper is to describe the relationship between grain and forage yield. For the growing seasons between 1997 and 2004, experiments were conducted to measure the impact of hybrid, plant density, planting date and row spacing on corn performance. It is difficult to obtain data for both corn grain and forage yield as usually one or the other is harvested in a field or research plot situation. In these studies, forage yield and quality was measured in four of eight rows in the plot. The four remaining rows were left for later grain yield and quality measurements.

The relationship between grain yield and forage yield

Grain yield treatment means ranged from 0 to 256 bushels per acre while dry matter forage yields ranged from 3.0 to 12.3 tons dry matter per acre. The relationship between grain yield and forage yield is shown in Figure 1. Little grain yield was measured when forage yields were below 2 to 3 tons dry matter per acre. The relationship between grain yield and forage yield was mostly linear through forage yields of 8 tons dry matter per acre.

To calculate the value of an acre of corn silage, the amount of grain contained in one ton of silage (grain equivalent) is multiplied by the corn price and the forage yield. For example, if corn yielded 150 bushels/A and was 65% moisture, the grain equivalent is 7.4 bushels of grain per ton of corn silage (Table 1). An average yield is 20.4 T/A. If corn is priced at $2.00 per bushel, the value of the field is 7.4 bu/T x $2.00 /bu x 20.4 T/A = $302/A or $14.80 /T. Further negotiation would need to be conducted over harvest, ensiling, and storage costs.

Table 1. Bushels of grain contained in a ton of corn silage. Values are derived from experiments conducted in Wisconsin between 1997 and 2004.

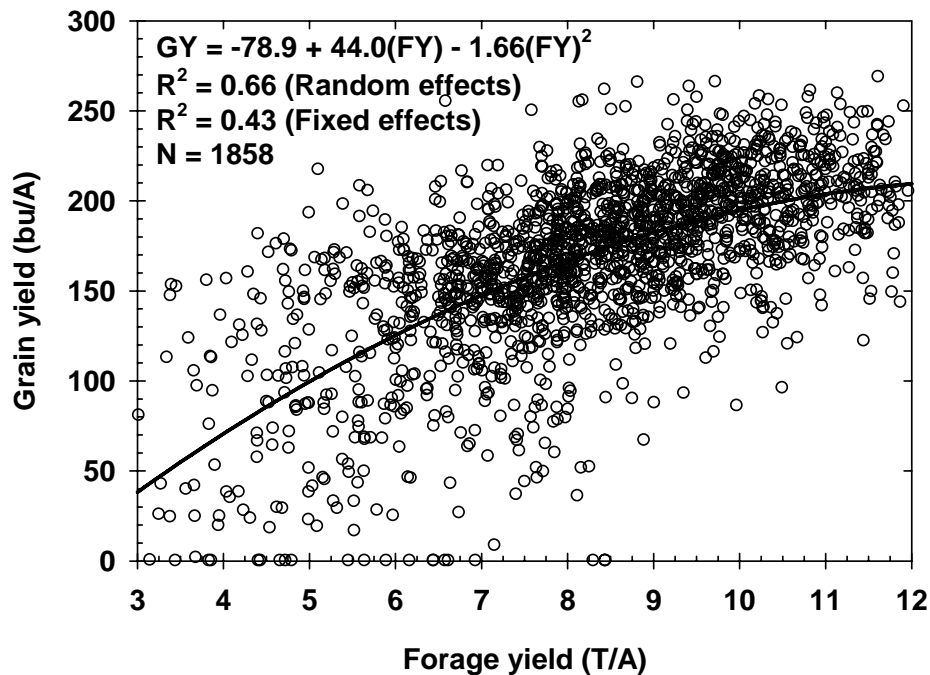| Grain yield @ 15.5% moisture	0% moisture		60% moisture		65% moisture		70% moisture	
	Silage yield	Grain equivalent per ton of silage	Silage yield	Grain equivalent per ton of silage	Silage yield	Grain equivalent per ton of silage	Silage yield	Grain equivalent per ton of silage
Bu/A	T/A	Bu/T	T/A	Bu/T	T/A	Bu/T	T/A	Bu/T
25	2.6	23.8	6.6	3.8	7.5	3.3	8.7	2.9
50	3.4	23.1	8.4	6.0	9.6	5.2	11.2	4.5
75	4.1	22.3	10.4	7.2	11.9	6.3	13.8	5.4
100	5.0	21.4	12.6	8.0	14.3	7.0	16.7	6.0
125	6.0	20.4	15.0	8.3	17.1	7.3	20.0	6.3
150	7.1	19.3	17.8	8.4	20.4	7.4	23.7	6.3
175	8.5	17.9	21.3	8.2	24.3	7.2	28.4	6.2
200	10.6	15.9	26.4	7.6	30.2	6.6	35.2	5.7

Figure 1. The relationship between corn grain and forage yield in Wisconsin between 1997 and 2004.

Factors that affect the grain equivalent calculation

Anything that affects grain or forage yield will affect grain equivalents contained in corn forage. Depending upon grain yield level, grain equivalents per ton of corn silage ranged from 3.3 to 7.4 bushels per ton of silage at 65% moisture (Table 1). These values are slightly higher than the values calculated by Jorgenson and Crowley in 1972.

The amount of moisture has a major influence on this relationship and needs to be considered to accurately determine fair silage prices. Grain yield per ton of silage for four moisture levels is shown in Table 1. For a field that yields 150 bu/A, the grain equivalents range from 17.9 bu/T at 0% moisture to 6.3 bu/T at 70% moisture.

The growing environment affects the relationship between grain and forage yield. Depending upon year, grain equivalents ranged from 6.4 to 9.4 at a 150 bu/A yield level (Table 2). Due to the drought in 2005, many cornfields are shorter than normal but corn yield appears to be high. If this observation holds true and grain yield is relatively greater than forage yield, grain equivalents will be higher than normal.

Table 2. Year effect on grain equivalents contained in corn silage at Arlington, WI.

Year	Grain yield equivalent								R^2
	25	50	75	100	125	150	175	200	
	bushels of grain (15.5%) per Ton of corn silage (65% moisture)								
2004	1.8	3.3	4.5	5.5	6.3	6.9	7.2	7.1	0.78
2003	---	---	---	---	---	9.4	6.6	5.2	0.65
2002	---	---	---	---	9.4	8.3	7.5	6.8	0.51
2001	1.9	3.5	4.8	5.9	6.8	7.4	7.8	7.9	0.53
2000	---	---	8.7	8.7	8.4	7.9	7.0	---	0.53
1999	---	3.4	4.6	5.4	6.0	6.4	6.7	6.8	0.59
1998	---	---	---	---	8.0	8.1	7.9	7.3	0.40
1997	8.2	9.9	10.3	10.3	9.9	9.3	8.1	---	0.44

In summary, the grain equivalents shown in Table 1 on average reflect the grain versus forage yield relationship. Forage moisture and year significantly affect grain equivalents and must be considered when negotiating a contract. Since the grain equivalent calculation is variable, when buying corn silage, the purchaser should chop corn as it is harvested to determine forage quality. Ideally, contracts should be based on corn silage quality rather than grain equivalents.