Agricultural Economics
Staff Paper #97-45
September, 1997

# PRICING AND USE OF IMMATURE CORN AS SILAGE FOR BEEF CATTLE

by

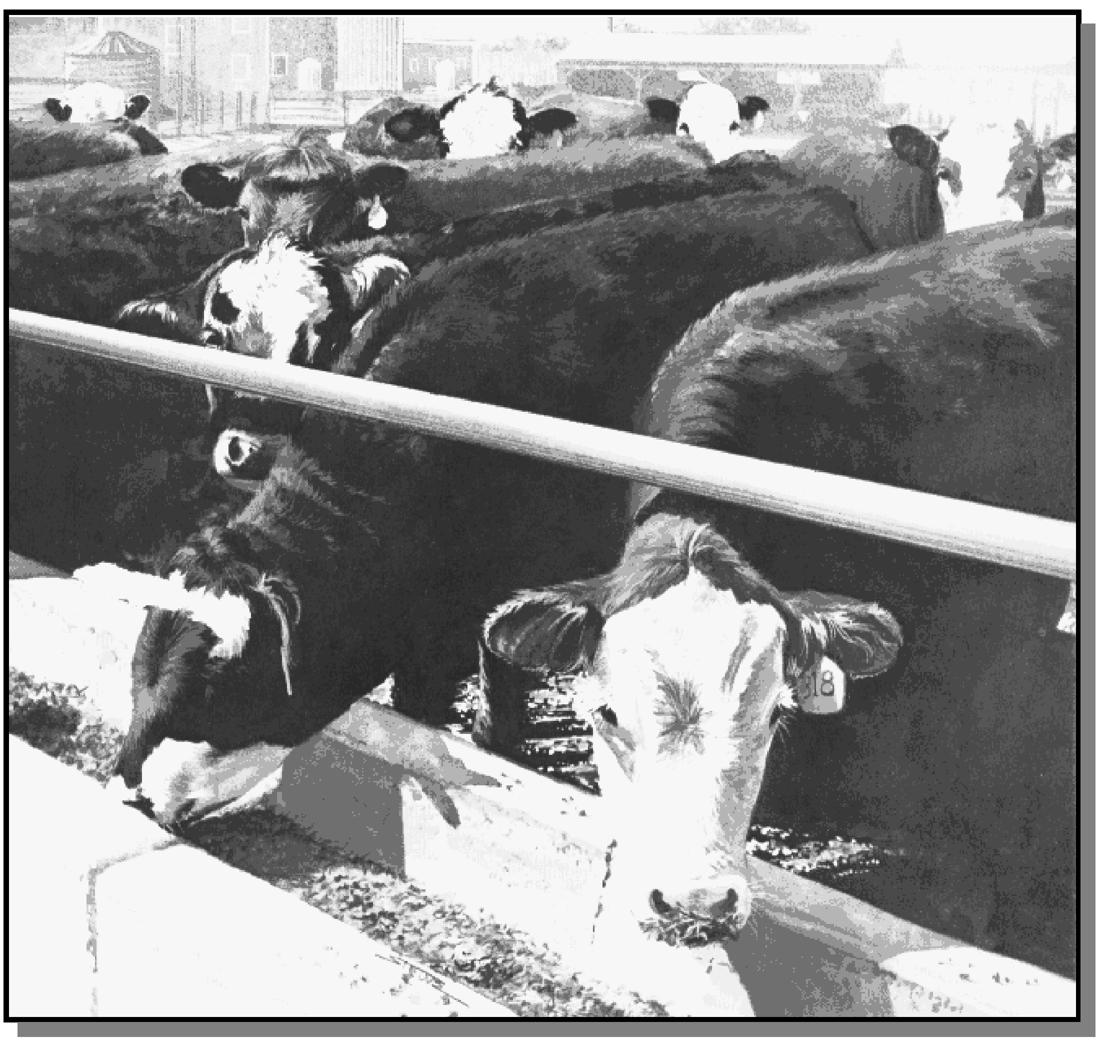
J. Roy Black
Gerald Schwab

Agricultural Economics

Steve Rust
Dan Buskirk

Animal Science

Michigan State University
East Lansing, MI 48824



# TABLE OF CONTENTS


INTRODUCTION . . . . 1

I. ALTERNATIVE USES FOR IMMATURE CORN . . . . 1

II. NITRATES AND GASES . . . . 2
- Accumulation in the Corn Plant in Drought-Stressed Plants . . . . 2
- Ensiling Reduces Nitrate Concentration . . . . 4
- Nitrate Toxicity . . . . 4
- Silo Gases . . . . 5

III. STORAGE OF SILAGE . . . . 6
- Storing the Silage . . . . 6

IV. FEEDING . . . . 6
- Nutrient Characteristics . . . . 6
- Nitrate Toxicity . . . . 8

V. ECONOMIC VALUE OF IMMATURE CORN SILAGE . . . . 8
- Concept . . . . 8
- Economic Value At The Feedbunk:
  - Establishing a Maximum Bid Price . . . . 9
  - Economic value of immature corn silage in growing and finishing cattle diets . . 10
  - Economic value of immature corn silage for beef cows . . . . 11
- Economic Value the Field . . . . 13

VI. SHOULD YOU HARVEST YOUR CORN AS SILAGE OR AS GRAIN—ASSUMING IT IS WORTH HARVESTING? . . . . 15

## LIST OF TABLES

Table 1. Nitrate-Nitrogen Levels in Drought-Stressed Corn Plants . . . . . . . . . . . . . . . . . . . . . . . . 3
Table 2. Methods of Expressing Nitrate and Nitrite Contents of Feeds, and Multiplication Factors for Conversion to Nitrate . . . . . . . . . . . . . . . . . . . . . . 3
Table 3. Toxicity of Nitrate-Nitrogen . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 4
Table 4. Impact of Drought-Stressed vs Normal Corn Silage on Feedlot Performance . . . . . . . . 7
Table 5. Nutrient Values of Normal and Drought-Stressed Corn Silage . . . . . . . . . . . . . . . . . . . 7
Table 6. Nutrient Characteristics used in Budgeting . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10
Table 7. *Maximum* Bid Price for Corn Silage at the Feedbunk — For Use By Cattle Feeders . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 10
Table 8. Maximum Bid Price ($/ton) for Immature Corn Silage On an As-Fed Basis at the Feedbunk — For Use by Non-Lactating and Low Milking Ability Lactating Beef Cows . . . . . . . . . . . . . . . . . . . . . . . . . . 12
Table 9. Maximum Bid Price ($/ton) for Immature Corn Silage On an As-Fed Basis Feedbunk — For Use by Non-Lactating and Low Milking Ability Lactating Beef Cows . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . 12

# PRICING AND USE OF IMMATURE CORN AS SILAGE FOR BEEF CATTLE[1]

## INTRODUCTION

How best to use immature corn is the question being addressed in this paper. Immature corn was a problem in 1988, 1992, 1996 and potentially in 1997. In 1988, corn in many parts of Michigan was under considerable drought stress and grain content was well below normal. In 1992, many farmers had immature corn at harvest due to abnormally low “heat units” over the course of the summer. In 1996, many corn producers experienced late planting due to wet soil conditions, followed by cooler than normal temperatures combined with drought which resulted in immature corn and concern for timing of the first killing frost before the corn kernel reaches physiological maturity. In 1997, emergence of timely-planted corn was slow due to cold soils through May. The growing season was also cool with much of Michigan lagging 200 growing degree days below normal by September. The end result is concern with immature corn, its potential uses, and its value.

*Immature corn* is defined as corn that fails to reach adequate maturity and can not be sold at normal, prevailing market values without steep price discounts. Corn that is drought-stressed, heat unit deficient, water logged, or frosted meets our definition. This fact sheet discusses factors to consider in *pricing* and determining how to *use* immature corn.

Part I outlines *alternatives* available to farmers with drought-stressed or immature corn standing in the field. Part II focuses on potential *problems* related to nitrate accumulations in corn plant forage and silage when the plant has faced drought stress. This discussion is particularly relevant for growers who are considering green-chopping. Part III discusses temporary *storage* of corn silage, particularly by farmers who don’t ordinarily harvest corn as silage. Part IV discusses *feeding* management. Part V discusses *economic valuation* — both at the feedbunk and in the field. Part VI discusses whether you should harvest your corn as grain or as silage — assuming it’s worth harvesting.

## I. ALTERNATIVE USES FOR IMMATURE CORN

Farmers with cattle can harvest their immature corn for silage. Feeding trials over the last two decades have shown that corn silage made from plants that are in *good* condition, but poorly pollinated, will contain 85-90% of the energy per pound of dry matter that’s contained in normal corn silage. The crude protein content of the whole corn plant is an indicator of the energy concentration of immature corn plants. Immature corn plants in good quality will have crude

[1]This paper is an update of AEC Staff Paper No. 96-82 entitled, "Pricing and Use of Drought-Stressed and Immature Corn as Silage for Beef Cattle."

protein (CP) that is 10% to 15% higher than that of normal corn silage, depending upon the timing of the stress that limited pollination and when the plant is harvested. That typically places CP in the 8.8% to 9.2% of plant dry matter (DM). If the CP value is substantially greater — 11% to 12% of plant DM — the plant likely has a much lower energy value.

Cash corn growers alternatives include:

- Plow down the field early to permit timely planting of fall-seeded crops.
- Allow corn to mature as grain and harvest if you expect the value of the corn grain harvested to exceed harvest costs.
- Sell the whole corn plant to a cattle feeder, cow-calf operator, or dairy farmer — either as a standing crop in the field ("on the stump") or as silage harvested and delivered to the feeder's silage storage facility.
- Hire someone to custom harvest the corn as silage and purchase feeder cattle to grow-out for sale as heavier feeders or finished weight cattle. This alternative requires livestock facilities and knowledge of feeding cattle. Silage storage facilities will probably be temporary and storage losses would exceed those experienced by livestock producers with permanent storage. This option will also require a willing lender.
- Hire someone to custom harvest the corn for use as silage and feed dairy or beef heifers on a contractual basis. This will require feeding facilities or fenced lots and a working relationship with a dairy or beef farmer.

For guidelines on making corn silage, see North Central Regional Publication NCR 574, *Corn Silage Production, Management and Feeding* and National Corn Handbook Fact Sheet NCH-49, *Corn Silage Harvest Techniques*, distributed by Michigan State University. See, also, Michigan State University Extension Bulletin E-1660, *Feeding Corn Silage to Beef Cow Herds*, and E-1139, *Protein-Mineral Supplements for Growing and Finishing Cattle fed Corn-Corn Silage Rations.*

## II. NITRATES AND GASES

### Accumulation in the Corn Plant in Drought-Stressed Plants

Nitrate can accumulate in drought-stressed corn plants. Highest levels of nitrate accumulation occur where drought occurs during the period of most active nitrate uptake by the plant. Occurrence of drought during or immediately after pollination has been associated with the highest nitrate accumulations.

Extended drought before pollination is less likely to result in high accumulations of nitrate. Resumption of normal plant growth from heavy rainfall will reduce nitrate accumulation in the plant, but harvesting should be delayed for the first few days after heavy rainfall.

The nitrates taken up by plants are normally reduced and incorporated into amino acids which are used to build protein. The primary site of nitrate reduction in the corn plant is green leaves. The highest concentrations of nitrates are normally found in the stalks and other conductive tissues. A summary of nitrate levels in different parts of the plant, from drought-stressed corn in Wisconsin, is presented in Table 1.

**Table 1. Nitrate-Nitrogen Levels in Drought-Stressed Corn Plants**

| Plant Part | Parts/Million Nitrate Nitrogen |
|---|---|
| Leaves | 64 |
| Ears | 17 |
| Upper 1/3 stalk | 153 |
| Middle 1/3 stalk | 803 |
| Lower 1/3 stalk | 5524 |
| Whole plant | 978 |

Nitrate and nitrite are contained in different forms within plants and may be reported differently among laboratories. Table 2 contains a list of nitrate and nitrite forms and conversion factors to place them on a nitrate equivalent. Percent nitrate can be converted to parts per million by multiplying the percentage by 10,000 (e.g. 2% Nitrate × 10,000 = 20,000 ppm Nitrate).

**Table 2. Methods of Expressing Nitrate and Nitrite Contents of Feeds, and Multiplication Factors for Conversion to Nitrate**

| Nitrogenous Substances | Chemical Formula or Designation | Multiplication Factor |
|---|---|---|
| Nitrate | $NO_3$ | 1 |
| Nitrite | $NO_2$ | 1.35 |
| Nitrate nitrogen | $NO_3$-N | 4.43 |
| Nitrite nitrogen | $NO_2$-N | 4.43 |
| Sodium nitrate | $NaNO_3$ | .73 |
| Potassium nitrate | $KNO_3$ | .61 |

Table 3 places nitrate concentrations in a cattle feeding context.

**Table 3. Toxicity of Nitrate-Nitrogen**

| Nitrate Nitrogen ($NO_3$-N) Content, ppm | Nitrate ($NO_3$) Content, ppm | Feeding Guide |
|---|---|---|
| less than 1,000 | 4,400 | Not toxic |
| 1,000-2,000 | 4,400-8,800 | Limit feed to less than 50% or ration *dry matter* |
| 2,000-4,000 | 8,800-17,600 | Limit feed to less than 25% of ration *dry matter*, do not feed to pregnant animals |
| more than 4,000 | more than 17,600 | Do not feed |

## Ensiling Reduces Nitrate Concentration

Typically, drought-stressed corn ensiled at the proper dry matter content and packed well should not require testing for nitrates. Cutting drought-stressed corn for silage is a preferred method of utilization because ⅓ to ½ of the nitrate accumulated in the plant material can be reduced to ammonia during fermentation. Because fermentation takes 2 to 3 weeks for completion, drought-stressed corn silage should not be fed for at least 3 weeks after the silo has been filled. Drought-stressed corn plants should not be green chopped and fed directly to cattle without first testing for nitrates.

The percent dry matter of the corn plant at harvest influences the time required for fermentation. The optimum dry matter for adequate fermentation is 30-35%. The maximum dry matter percentage for ensiling corn suspected of high nitrate is 45 percent. Corn ensiled at more than 45 percent dry matter results in reduced fermentation activity, and less breakdown of nitrate. Dry matter levels below 30 percent will result in seepage losses and can result in the production of a sour smelling silage which will not be consumed as readily by livestock as normal silage.

## Nitrate Toxicity

Nitrate toxicity is actually caused by nitrite ($NO_2$), rather than nitrate ($NO_3$). After forage is eaten, rumen bacteria rapidly reduce nitrates to nitrites. Normally, the nitrites are converted to ammonia and used by rumen microorganisms as a nitrogen source. If nitrate intake is faster than its breakdown to ammonia, nitrate levels will increase. Nitrite is rapidly absorbed into the blood stream, where it oxidizes hemoglobin to methemoglobin. Red blood cells containing methemoglobin cannot transport oxygen, and the animal dies from asphyxiation.

Symptoms of nitrate toxicity in animals are increased pulse rate, quickened respiration, heavy breathing, muscle tremble, weakness, staggered gait, and blindness. If these symptoms occur, change the feed source.

Testing for nitrate content of drought-stressed corn should be done before green chopping or grazing. If drought-stressed corn is ensiled at the proper moisture content and other steps are followed to provide good quality silage, testing should not be necessary. Forage can be tested for nitrates at most commercial forage testing laboratories or at the Soil and Plant Nutrient Laboratory at Michigan State University. The Michigan State University laboratory's address is:

Soil and Plant Nutrient Laboratory
Room A81, Plant and Soil Science Building
Michigan State University
East Lansing, MI 48824
Phone: 517/355-0218

Care must be taken in sampling to ensure a representative sample. Grab samples should be taken from chopped forage from various locations in the field which represent all levels of plant stress. Mix these samples in a bucket, air dry briefly, and place approximately one pint of material in a paper bag. Time between sampling and arrival at the laboratory must be as short as possible. Refrigeration of samples is beneficial, especially when the lag extends beyond one day. Green or wet samples allowed to stand at room temperature or higher temperatures may lose nitrate through action of denitrifying bacteria and enzyme action.

## Silo Gases

Forage containing nitrate results in production of various forms of nitrogen oxide gas during fermentation. These gases, which are poisonous to humans and livestock may occur within 12 to 60 hours after silo filling begins. These gases are heavier than air and will accumulate above the silage in a tower silo, in the chute of a tower silo, in the silo room, and flow out with the silo effluent.

The first lethal gas to form is nitric oxide which is colorless and odorless. Nitric oxide is then converted to nitrogen dioxide which is yellowish-green in color and smells like some laundry bleaches. Further oxidation of nitrogen oxide forms nitrogen tetroxide which has a reddish-brown color and carries an odor characteristic of some laundry bleaches. These gases will leave a characteristic yellowish-brown stain on wood, silage or any other material it contacts. *It is important to inform your family and workers of this potentially hazardous situation*.

No one should enter a tower silo without first running the blower for 10 to 15 minutes to completely ventilate the silo, chute, and silo room. It is wise to do this during filling, and whenever anyone enters the silo for 2 to 3 weeks after completion of filling. Also, leave the chute door open at the surface of the silage to prevent accumulation in the silo.

Call a doctor immediately if anyone is exposed to nitrogen oxide gases from silage. Medical treatment may prevent death and minimize injury.

## III. STORAGE OF SILAGE

### Storing the Silage

Upright silos in good condition that are designed for storing high moisture crops can be used in the normal way. If the dry matter content of silage is lower than the desired 30-35%, leaching of silage effluent can be expected unless harvest is delayed until after a killing frost. Though the ears and leaves may be brown after a frost, there is a generally adequate moisture in the stalks for proper fermentation to occur.

Temporary storage facilities can be utilized if more permanent structures are unavailable. As temporary storage, the above ground stack, plastic bags, and the below ground unlined trench siles are suitable alternatives. Select a well-drained site for a stack, plastic bags or trench to exclude surface water and provide best access under wet weather conditions. The stack should be 20-25 feet wide, 6-7 feet high and 80-90 feet long. A cubic foot of silage in a stack or trench will average about 40 pounds. With stacks or trenches, continuous packing with a weighted wheel tractor is necessary to exclude oxygen and ensure a favorable fermentation. Good compaction will reduce storage losses. Better compaction can be obtained with a wheel tractor than with a crawler type. Because of the greater exposed surface, the shallow depth, and the difficulty of packing; losses of dry matter during storage of corn silage will be greater for stacks (20%-30%) and trenches (15%-25%) than conventional storage facilities (10%-20%). A tight cover of polyethylene plastic sealed with soil around the edges and held down with dirt or old automobile tires is effective in minimizing losses.

## IV. FEEDING

### Nutrient Characteristics

Corn silage made from plants that are in good condition, but poorly pollinated with no ears or partially filled ears, has 85-90% of the energy value of normal corn silage. Table 4 is a summary of the results from six trials where normal and drought-stressed corn silage was fed to growing steers. The diets were supplemented with protein. The corn plants comprising the drought-stressed corn silage would have yielded less than 20 bu of corn/acre in all trials.

**Table 4. Impact of Drought-Stressed vs Normal Corn Silage on Feedlot Performance**

| Measure | Corn Silage | | Standard Error of the Mean |
|---|---|---|---|
| | Normal | Drought Stressed | |
| No. of cattle | 170 | 262 | |
| Daily gain, lb | 2.17 | 1.97 | .20 |
| Dry matter intake, lb/day | 16.1 | 15.5 | 1.16 |
| Feed/gain | 7.41 | 7.86 | .72 |

The steers receiving drought-stressed silage required 6.1% more feed per lb gain than steers receiving normal corn silage. Gain/day (ADG) was less for cattle receiving drought-stressed silage, partly because dry matter intake (DMI) was about 4% less. Thus, the price of drought-stressed corn silage would have to be discounted relative to the price of normal corn silage if the cattle feeder's objective was to price the silages to yield equivalent cost of gain. The performance data suggest the price discount necessary to give equivalent cost of gain would be modest.

Table 5, adapted from the *1996 NRC Nutrient Requirements of Beef Cattle*, is consistent with the data presented in Table 4 and describes typical nutrient characteristics of normal and immature corn silage. We'll use these nutrient values for drought-stressed corn silage in ration formulation and pricing. As we noted in the introduction, whole corn plants with crude protein concentrations that are substantially larger than shown in Table 5 will typically have much lower energy values.

**Table 5. Nutrient Values of Normal and Drought-Stressed Corn Silage**

| Measure | Drought-Stressed (barren) | Normal (Grain formed) |
|---|---|---|
| Energy measures: | | |
| TDN, % of DM | 64 - 66 | 71 |
| $NE_m$, Mcal/lb DM | .62 - .70 | .74 |
| $NE_g$, Mcal/lb DM | .40 - .45 | .48 |
| NDF (fiber measure), % of DM | 58 | 44 |
| Crude protein, % of DM | 8.8 | 8.0 |
| Calcium, % of DM | .40 | .25 |

| | | |
|---|---|---|
| Phosphorus, % of DM | .27 | .22 |

To accommodate the altered nutrient characteristics of drought-stressed or immature corn silage, consider the following changes in feeding systems:

- Feed poorer quality silage to cattle on medium energy diets.
- Corn silage that has been through significant drought stress should not be supplemented with NPN since the NPN component of crude protein will be significantly higher than normal.
- Since immature corn silage is high in nitrates and NPN, limit the use of nonprotein nitrogen products, such as urea, in the total ration.
- If high silage rations are fed initially, the cattle should be finished on a high concentrate diet for the last 60-90 days before slaughter as to meet market specifications for USDA quality grade.
- Balance rations to minimize stress on animals. See nutritional guidelines for feeding corn silage including Michigan State University Extension Bulletin E-1660, *Feeding Corn Silage to Beef Cow Herds*, and E-1139, *Protein-Mineral Supplements for Growing and Finishing Cattle fed Corn-Corn Silage Rations*.

### Nitrate Toxicity

To avoid nitrate toxicity:

- Test the forage for nitrates.
- Limit corn plant forage initially if it is green chopped or pastured to avoid the risk of animals going off-feed or nitrate toxicity. Provide other feeds before pasturing or limit pasturing time.
- Make silage from corn that experienced drought-stress near silking time.
- Supplement with other forages to avoid excess intake and dilute potentially dangerous silage.
- Feed a small number of animals and observe carefully before feeding a large number of animals.

## V. ECONOMIC VALUE OF IMMATURE CORN SILAGE

### Concept

There is no clear-cut “right” economic value / price for drought-stressed and immature corn silage. However, we can establish the *maximum price* that a cattle feeder or cow-calf operator can afford to pay for immature stressed corn silage delivered to the cattle *feedbunk* in comparison to prices for substitute feeds that can be used to accomplish the same feeding objectives. We can also establish the price the corn grower needs to have to warrant harvesting the corn for use as silage or as grain — call that the seller's *minimum price*. The range between the minimum and maximum price give the *price range for negotiation* between potential buyers and sellers. Supply–demand conditions in local areas will determine whether the price is closer to the seller's minimum or the buyer's maximum.

The purpose of this section is to develop a method for estimating: (1) the cattle feeder and cow-calf operators maximum bid price; (2) the corn grower's minimum sale price; and (3) how to get from the price of corn silage in the feedbunk to the price of the corn plant standing in the field.

### Economic Value At The Feedbunk: Establishing a Maximum Bid Price

One approach to economic valuation at the feedbunk is for the livestock-producer to ask "If I didn't feed immature corn silage, what would it cost me using an alternative ration to get the same performance from my animals?" If immature corn silage is priced so high that it costs more to feed the animal with it than it would with the alternative diet, then corn silage is priced too high! There is no economic advantage to feed it.

If we accept the framework just described, we must start thinking about what feedstuffs immature corn silage can substitute for in beef cattle diets. A bit of reflection leads us to the conclusion that its value will be dependent upon the type of animals (for example, growing beef cattle versus finishing beef cattle versus beef cows) being fed and the alternative feedstuffs that are available. If the immature silage is of very good quality, it could be combined with a protein-mineral mix and used in the grower-backgrounding phase of a cattle feeding program. In a finishing program, a combination of immature corn silage and corn would give equivalent performance to normal corn silage; and, supplemental protein could be reduced slightly to reflect the higher CP in immature corn silage. For beef cows, immature corn silage would be an excellent feedstuff to replace hay.

We will calculate the economic value of immature corn silage under three circumstances: (1) in cattle feeding finishing diets where a combination of immature silage and corn grain substitute for a combination of corn and soybean meal, (2) for beef cows as a substitute for grass hay, and (3) as a substitute for corn and alfalfa hay, primarily relevant for lactating beef cows in the winter prior to going to grass.

The feedstuff nutrient value assumptions used in our case example are presented in Table 6.

**Table 6. Nutrient Characteristics used in Budgeting**

| Nutrient | Drought-Stressed Corn Silage | Normal Corn Silage | Soybean Meal | Corn Grain | 17% CP Alfalfa | Grass Hay |
|---|---|---|---|---|---|---|
| Dry matter, % | 32 | 32 | 90 | 85 | 88 | 88 |
| $NE_m$ (Mcal/lb DM) | .68 | .74 | .93 | 1.02 | .59 | .52 |
| $NE_g$ (Mcal/lb DM) | .44 | .48 | .64 | .70 | .34 | .27 |
| Crude protein (% of DM) | 8.8 | 8.0 | 48 | 9.3 | 17.0 | 10.5 |

### *Economic value of immature corn silage in growing and finishing cattle diets*

Table 7 presents the maximum bid price on immature corn silage — with the nutrient values described in Tables 5 and 6 — for alternative corn prices. These values were calculated by asking “How high does the price of immature corn silage have to be before it's more profitable to simply feed a higher concentrate ration — to feed more corn grain and less immature corn silage? The range in values reflects a range in corn silage energy values.

**Table 7. *Maximum* Bid Price for Corn Silage at the Feedbunk — For Use By Cattle Feeders**

| Corn, $/bu | Immature Corn Silage ($/ton As-Fed) |
|---|---|
| 2.00 | 14.20 to 16.10 |
| 2.25 | 16.09 to 18.11 |
| 2.50 | 17.88 to 20.13 |
| 2.75 | 19.66 to 22.14 |
| 3.00 | 21.45 to 24.15 |
| 3.25 | 23.24 to 26.16 |
| 3.50 | 25.03 to 28.18 |
| 3.75 | 26.81 to 30.19 |
| 4.00 | 28.60 to 32.20 |
| 4.25 | 30.39 to 34.21 |
| 4.50 | 32.18 to 36.23 |
| 4.75 | 33.96 to 38.24 |

To calculate the price of immature corn silage at which costs of gain would be comparable between feeding systems, we used the relative net energy values of corn compared to immature corn silage. Also, an adjustment was made for the higher CP content of immature corn silage versus normal corn silage and an adjustment was made for potential differences in non-feed costs associated with use of higher levels of corn silage.

### *Economic value of immature corn silage for beef cows*

Corn silage is fed to beef cows primarily for its energy content, and should be priced accordingly. Because of the high energy value, it must usually be limit-fed to mature dry beef cows. If not, winter feed costs will escalate, and the cows will usually become fat causing reproductive problems. The energy content of corn silage makes it a good feedstuff for developing bulls and heifers and meeting the high energy requirements of the lactating cow. The protein content of corn silage alone is marginal for mature dry cows, and is inadequate for growing and lactating cattle.

*Laboratory analysis of corn silage will allow more accurate diet formulation, reduce feeding costs and reduce the chances of reduced performance if nutrient values are below expectations.* This is critical with immature corn silage since protein contents are borderline for meeting requirements. For detailed information regarding feeding of corn silage to beef cow herds see MSU Extension Bulletin E-1660.

Tables 8 and 9 present the maximum bid price on immature silage — with the nutrient values described in Table 6 — for alternative corn prices. The prices were calculated, as they were for the growing and finishing cattle, based upon the substitution of immature corn silage for hay. Since immature corn silage has 10% to 15% more protein than normal corn silage; and the hays included in the analysis contain adequate protein to meet the protein and energy requirements for non-lactating and lactating cows of low milking ability, the substitution was done strictly on an energy basis. We asked, "How many pounds of immature corn silage are required to give the same amount of energy per day as would be consumed from hay?"

Because of its higher crude protein level, the economic values for immature silage would be greater in circumstances where supplemental protein in the ration was required. That would occur early in lactation for most beef cows and early and mid lactation for cows with superior milking ability.

**Table 8. Maximum Bid Price ($/ton) for Immature Corn Silage On an As-Fed Basis at the Feedbunk — For Use by Non-Lactating and Low Milking Ability Lactating Beef Cows**

| Price of 0.55 $NE_m$ Grass Hay $/ton | Price of Corn Silage ($/ton) |
|---|---|
| 20 | 8.99 |
| 40 | 17.98 |
| 50 | 22.48 |
| 60 | 26.98 |
| 70 | 31.47 |
| 80 | 35.97 |
| 90 | 40.46 |
| 100 | 44.96 |
| 110 | 49.45 |
| 120 | 58.18 |

**Table 9. Maximum Bid Price ($/ton) for Immature Corn Silage On an As-Fed Basis Feedbunk — For Use by Non-Lactating and Low Milking Ability Lactating Beef Cows**

| Price of 0.60 $NE_m$ Alfalfa Hay $/ton | Price of Corn Silage ($/ton) |
|---|---|
| 40 | 14.55 |
| 50 | 18.18 |
| 60 | 21.82 |
| 70 | 25.45 |
| 80 | 29.09 |
| 90 | 32.73 |
| 100 | 36.36 |
| 110 | 40.00 |
| 120 | 43.64 |

## Economic Value the Field

Let's continue with our examples on maximum bid price. We projected the maximum bid price for drought-stressed corn silage to someone valuing it as a substitute for $2.50/bu corn in cattle feeding at $17.88/ton to $20.13/ton delivered to the feedbunk. For purposes of discussion, lets say that the negotiated price is $19.00/ton. What is $19.00/ton corn silage at the feedbunk worth standing in the field?

Worksheet 1 was developed to answer that question. The costs of storage, including storage losses, must be subtracted along with the costs of harvesting, hauling and packing.

For our example, $7.30/ton silage harvesting and storage costs are projected to be incurred. That leaves $11.70/ton for corn in the field. The harvesting, hauling, etc., costs were adapted from S.B. Nott, et. al., 1995 *Crop and Livestock Budgets*, Michigan State University, Agricultural Economics Report 508; and G. Schwab and Marcelo E. Siles, Custom Work Rates in Michigan, Cooperative Extension Service Bulletin, E-2131, September 1994.

**Worksheet 1. Maximum Bid Price for Corn Standing in the Field for Use As Corn Silage**

| | Item | Example $/Ton | Your Farm |
|---|---|---|---|
| (1) | Corn silage @ feedbunk | $19.00[a] | ________ |
| (2) | - Storage losses (10% to 30%)<br>(**Example** @ 20%) | $3.80 | ________ |
| (3) | - Storage cost (zero for existing storage;<br>Amortized cost if new facilities added) | 0.00 | ________ |
| (4) | - Harvesting (chopping) | $2.00 | ________ |
| (5) | - Hauling and packing (depends upon distance) | $1.50 | ________ |
| (6) | Total<br>(Line 2, 3, 4, and 5) | $7.30 | ________ |
| (7) | Maximum bid price/ton for corn standing in field<br>(line 1 minus line 6) | $11.70 | ________ |

[a] Adapted from Tables 7 and 8.

## VI. SHOULD YOU HARVEST YOUR CORN AS SILAGE OR AS GRAIN—ASSUMING IT IS WORTH HARVESTING?

Worksheet 2 asks the question on a $2.50/bu corn market, "Will you generate more net income harvesting corn as grain or as silage?" Your pre-harvest expenses are sunk costs — they have already been committed and are irrelevant to the decision. Moisture in harvested corn grain is assumed to be 30 percent and is dried to 15 percent at a cost of 2 cents per point.

Let's consider Example I in Worksheet 2. Suppose a corn field will yield 50 bu/acre if harvested for corn grain and 9 ton/acre if harvested for corn silage. For those *relative* yields, corn silage nets more dollars. Corn silage *returns $95.48/acre above unallocated costs* as compared to $82.50 for corn for grain.

We can also explore *break-even relationships*. For example, what are the corn grain and corn silage yields at which returns above unallocated costs are equivalent? Consider Example II. If corn grain yields were projected at 100 bu/acre, not 50 bu/acre as in the example I, then the returns per acre above unallocated costs would be $185.00. In comparison, the corn field if harvested as silage yielding 14 ton per acre provides a return of $151.30 above unallocated costs. The breakeven yields to make equal the net returns between corn grain and corn silage are between these two scenarios for this hypothetical situation. The relative yields are important in this comparison. How much do corn silage yields increase as the corn grain yield increases?

The *relative* prices for corn and corn silage are critical. Typically, the corn grain price will be better established; the corn silage price may offer significant opportunities, but will require more work to achieve.

**Worksheet 2. Partial Budget for Comparing Net Returns[a] to Unallocated Costs From Corn Harvested As Grain vs. Corn Harvested as Silage**

| | Item | Unit | Example No. I | Example No. II | Your Farm |
|---|---|---|---|---|---|
| **Corn Grain** | | | | | |
| | Revenue: | | $/Acre | | |
| (1) | Yield | bu/acre | 50 | 100 | ________ |
| (2) | Price, (no. 2 corn adjusted for test weight ...) | $/bu | 2.50 | 2.50 | ________ |
| (3) | Gross revenue (Line 1 × Line 2) | $/acre | 125.00 | 250.00 | ________ |
| | Harvest cost: | | | | |
| (4) | Combining | $/acre | $20.00 | 20.00 | ________ |
| (5) | Grain Hauling @ $0.15 | $/bu | 7.50 | 15.00 | ________ |
| (6) | Drying @ $0.30 | $/bu | 15.00 | 30.00 | ________ |
| (7) | Total (Line 4 + Line 5 + Line 6) | | $42.50 | 65.00 | ________ |
| (8) | Net above harvesting costs from harvesting corn as grain (Line 3 - 7) | | $82.50 | $185.00 | ________ |
| **Corn Silage** | | | | | |
| (9) | Yield | ton/acre | 9.0 | 14.0 | ________ |
| (10) | Price in field (Value from Line 7, Worksheet 1) | $/ton | 11.70 | 11.70 | ________ |
| (11) | Gross from harvesting corn as silage (Line 9 × Line 10) | $/acre | 105.30 | 163.80 | ________ |
| (12) | Additional fertilizer equivalent removed with corn plant above corn grain removal | | | | |

| | Lbs/ bu[b] | Lbs/ ton[b] | Added lb/ acre for silage | | Added lb/ acre for silage | |
|---|---|---|---|---|---|---|
| Phosphate @ .25/lb | .37 | 3.3 | 11.20 | $2.80 | 9.20 | $ 2.30 |
| Potash @ .12/lb | .27 | 8.0 | 58.50 | $7.02 | 85.00 | $10.20 |

| | Item | Example No. I | Example No. II |
|---|---|---|---|
| (13) | Net above harvesting and nutrient removal costs for harvesting corn as silage (Line 11 - Line 12) | $95.48 | $151.30 |

[a] These are returns to all costs that have been committed up to the time of harvest.

[b] "Tri-State Fertilizer Recommendations for corn, soybeans, wheat and Alfalfa," E-2567, Michigan State University, The Ohio State University and Purdue University, May 1995.