SUCCESSFUL USE OF HIGH QUALITY CORN SILAGE FOR DAIRIES IN THE WESTERN UNITED STATES

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ABSTRACT

This paper presents a number of applied management practices, based on data and research, necessary for dairies in the western United States to produce, store and fed high quality corn silage. These management practices include hybrid selection, growing a quality crop, proper harvest timing, chopping, packing, inoculating and feed out of the stored corn silage.

Key Words: corn silage, management

INTODUCTION

Corn silage is one of the two (alfalfa being the other) most important forages on modern dairies in the western United States today. The trend over the past ten years has been for corn silage to represent a higher percentage of the forages fed. If selected, grown, harvested, stored and fed properly, corn silage has several positive features. These include:

- High dry matter yields
- High-energy content
- Consistent, palatable feed
- Reduces total feed cost
- Forage that can be stored directly at time of harvest
- Forage that allows rapid harvest
- Requires less water than crops such as alfalfa

From this list of advantages, the two most important are **High-energy content** and **Consistent, palatable feed.**

PRODUCING HIGH QUALITY CORN SILAGE

The goal of a premier dairy producer feeding corn silage in dairy rations should be to deliver to the rumen bacteria at every feeding, a high-energy forage, or to be more correct, a forage-grain mixture, which is as consistent as possible across every bite consumed. To do this, the producer must have in place, a complete management program that focuses on every aspect of the corn silage production, storage and feeding. These would include:

- Proper hybrid selection
- Superior planting, watering, fertilization, weed and pest control practices

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- Harvesting silage at the correct plant maturity/moisture content
- Correct chopping/kernel-processing practices
- Use of a beneficial, research proven additive or bacterial inoculant
- Superb bunker packing practices
- Excellent bunker covering management
- Proper feed out practice

Each of these silage management areas is critical to a highly successful corn silage program. For example, the first four could be excellent and yet a poor quality feed could be presented to the cows if any of the remaining practices listed do not receive proper attention. Or, a dairy may have excellent corn silage harvest, storage and feed bunk management practices. If, however, a poor hybrid selection was made or the crop was grown poorly, the result will be a feed with far less than the maximum energy density potential. All too often, one or more of these critical management decisions does not receive adequate attention resulting in less than optimum corn silage feed quality. That dairy is then forced to utilize the resulting corn silage for the entire next year. Every bite consumed during that year represents lost income potential. My philosophy to producing high quality corn silage is very simple. You are growing or buying a valuable amount of feed, which you must use, after it is produced. **The producer selecting the hybrids and growing the crop, the person harvesting the crop and the feeder must pay strict attention to every detail!** On some dairy operations, this may involve a number of individuals. Each must have a correct working knowledge of what is required to produce high quality corn silage.

In the western United States, successful dairy operations are applying improved corn silage management over every aspect of corn silage production and feeding. The results are truly significant. How dramatic can the differences be? Table one shows observed variation in nutrient values of corn silage grown in the nine western states. The difference in the observed range of NeL equates to the corn silage containing 70 percent moisture with the higher energy value being able to support 400 more pounds of milk for every ton fed [.22 x (2000lb x 30% DM) divided by .33 Mcal (amount required to produce 1 pound of milk].

Table 1. Nutrient Variation Observed in Corn Silage. All values expressed on a dry matter basis.

Nutrient	**Average Value**	**Observed Range**
Crude Protein (%)	8.0	7.0 - 9.5
Acid Detergent Fiber (%)	26.5	17.0 – 35.0
Net Energy Lactation*****	.68*****	.78***** – .56*****

*****Mcal/lb. = [0.996 – (0.0126 x % ADF)] … New Hampshire Equation.

There can be significant variations in acid detergent fiber levels, which in turn, influence net energy lactation values. In one manner or another, corn silage energy density values are influenced by each of the corn silage management practices listed previously.

HYBRID SELECTION

In the past, many corn silage growers selected silage hybrids based on yield potential alone. While some still select silage hybrids using yield as their primary criteria, more progressive dairy operations now select hybrids based on energy density potential more so than yield potential. At Pioneer Hi-Bred, we feel there are four primary factors which influence energy density in corn silage.

- Dry matter yield potential
- Grain content
- Stover digestibility
- Plant maturity at harvest

If a hybrid has very significant dry matter yield potential, it will likely reduce the percentage of grain in the resulting corn silage. Because grain is so much more digestible than the stover portion of the plant, we now observe some dairy operations selecting hybrids with slightly lower yield potential to increase grain content. These progressive dairy producers realize it is better to plant or buy a few more acres of silage than to lower the energy density. If they are buying the silage from a contract grower, they know they may have to pay a slightly higher price for the silage to compensate the grower for the lower yields. This has not been an easy concept for many dairy operations to accept and adopt. I suggest to you, however, that if all management practices listed previously are performed in an excellent manner, this is a very wise decision, which can pay big dividends.

Grain content of the resulting corn silage should be the major consideration when selecting corn silage hybrids. We have observed that grain content of corn silage, on a dry matter basis, can vary from less than 20 percent to over 60 percent. Variation in grain content can have a dramatic influence of animal performance, animal productivity per acre and total feed costs. If two silage hybrids grown for silage both yield 30 tons per acre at 70 percent moisture but one hybrid produced 30 percent grain while the other 50 percent, the hybrid with higher grain content would yield over 1,000 more pounds of **DIGESTIBLE** material per acre. That represents a considerable economic advantage for little if any higher input costs for growing the crop with the higher grain content.

What is the importance of stover digestibility in the hybrid selected? It can influence the quality of the silage, but not as dramatically as the grain content. On the average, grain is 90 percent digestible while stover may be 60 percent digestible. We at Pioneer, feel most hybrids do not range more than about five percentage units in stover digestibility. That difference, however, can have a significant effect. Hunt and Kezar. (1993) conducted a steer feeding trial in which two hybrids with nearly equal grain content were fed to growing steers at 65 percent of the ration. The two hybrids had stover acid detergent fiber values, which varied by five percentage units (42.7 vs. 37.7). In vitro dry matter digestibility of the stover varied by 5.2 percentage units (61.9 vs. 56.7) between the two hybrids. Using economic values at the time the study was conducted, the hybrid with lower fiber levels (more digestible) was worth $315.00 more per acre than the hybrid it was compared to. While most dairies do not feed anywhere near the level of

corn silage fed in this study, it does point out that stover digestibility can influence animal performance dramatically and should be considered when selecting silage hybrids.
Other criteria that should be considered when selecting corn silage hybrids in a specific area are correct relative maturity to match the environment where the corn will be grown, disease resistance, insect tolerance and in some cases, drought tolerance.

Corn silage crude protein content does not vary a great deal between hybrids. When significant differences do occur, more than a percentage unit or two, it is usually related to poor management practices if low values, less that 6.5 percent, are observed and possible nitrate accumulation if high values, greater than 9.5 percent, are determined. In the Western United States, we at Pioneer Hi-Bred, do not advise corn silage growers to select hybrids based on variation in crude protein value. Other companies may have different recommendations for their customers and we advise checking prior to making purchasing decisions.

GROWING THE CROP

Once the proper hybrid, or set of hybrids, has been selected, the next major challenge is to grow the crop maximizing the full plant genetic potential both in terms of dry matter yield and energy yields per acre. It begins with excellent ground preparation, to produce a uniform seedbed.

Many of the premier corn growers in the world list planting as one, if not the most, critical steps in growing excellent corn. Plant spacing must be even and depth of planting should be correct and consistent. While it seems simple enough, uneven plant stands or reduced populations are two of the most common problems observed when lower than expected grain corn or silage yields are obtained. Our research data indicates that in many parts of the western United States, we can increase corn plant populations up to 37,000 per acre before we reduce dry matter yields or lower grain content of the silage. This assumes all other management practices such as fertilization and irrigation are optimum. Check with local consultants to determine the best plant populations for your area.

Irrigation is the next key management consideration. It is important to remember that the corn plant is determining ear girth at the six-leaf stage of maturity and corn should not be water stressed during this period. Pioneer agronomists also emphasize early water stress can reduce both dry matter and grain yields. They advise growers to avoid any water stress during the period two weeks before silk formation until two weeks following. Knowing when to stop irrigating is also critical. Pulling water away from a growing crop too early can be a serious mistake. Timing of the last irrigation may range from early dent to 3-4 days before harvest. The timing of the last irrigation is greatly influenced by soil type and environment. Consult local experts for the proper advice.

Eliminating competition from weeks in corn is essential. One of our agronomists always tells growers “kill them all – it is critical”. While weeds may contribute to total yields, they will significantly reduce the quality of corn silage, largely through reduction of grain content. We have some growers who recently have adapted their operations to allow them to grow narrow row corn. This is usually on 22-inch rows but occasionally 15-inch. Many claim they are

increasing moisture adjusted yields by about seven percent but another advantage they point to is faster canopy closure, about 7-10 days, which in turn helps control weeds.

Corn plants do not produce maximum yields without proper nutrients. Proper fertilization is essential. Determine realistic yield goals for corn silage and then plan a fertilization program to meet those goals. The rule is 7.5-8 pounds of nitrogen for every ton harvested at 70% moisture. If manure is being applied, make sure it is spread evenly across fields. Avoid heavy manure loads year after year. Excessive manure can create salinity problems and exceedingly high nitrogen levels, which may cause excessive plant growth and lodging. Phosphorus, potassium and other nutrients should be applied as indicated by a soil test.

Insect control is generally beneficial if significant leaf loss is likely. Contact local consultants to determine if you need to be concerned with insect control in the area where your corn silage is being grown.

MATURITY OF CORN SILAGE PLANT AT HARVEST

Plant maturity at corn silage harvest is an important management decision and should receive careful consideration.

Late in the life of a corn plant, there are two physiological changes occurring we must consider. First, the plant is working hard to incorporate as much highly digestible starch into the ear as possible. At the same time, the stover portion of the plant is increasing in cell wall components. This reduces the digestibility of the stover portion of the plant. The question then becomes: "At what point do I have the plant maturity which maximizes yield and whole plant digestibility?"

Harvesting corn silage too early can result in silage with reduced grain content. There is also the increased chance of effluent (run-off) occurring because of higher plant moisture content at earlier harvest. This silage effluent, should it occur, carries valuable nutrients. Research tells us silage run-off typically contains 20 percent nitrogen compounds, 25 percent minerals and 55 percent organic material, primarily in the form of organic acids. This, for the most part, is highly digestible material we do not want to lose.

If corn silage is harvested too late, it may result in lower total digestible nutrients because of higher cell wall components in the stover. The grain contained in the silage harvested at later stages of maturity, if not being harvested using a kernel processor will have a greater chance of passing through the cow without being digested. Hunt, Kezar and Vinande (1989) conducted a study looking at six hybrids harvested at three different maturities, grown at two locations, Idaho and California. The results of that study led Pioneer to the recommendation that if kernel processing is not being utilized at harvest, the best plant maturity for corn silage harvest is between 1/3 starch line and 2/3 starch line.

CHOPPING/PROCESSING

Excellent chopping practices should be followed when harvesting corn silage. Sharp knives are essential. Theoretical chop length recommendations are typically between 3/8-1/2 inch and have

been largely dictated by the desire to break up as many kernels and cobs as possible. This has been especially true, as plant maturity has gone beyond the 3/4-starch line stage of maturity. The recent practice of using rollers when harvesting corn silage (often referred to as kernel or corn silage processing) has allowed some producers to increase theoretical length of chop to 3/4 inch and still break up most kernels and cob sections. I believe the use of kernel processors has been very beneficial to many dairy operations in the western United States. In recent years, this highly effective new corn silage management tool has surfaced and has been rapidly adapted. Make sure you ask the producer if they are processing their corn silage. Actually, you should be able to tell by examining the silage. Look for most of the kernels to be cracked or broken and for only very small sections of cob. This will tell you it has been processed. Processing occurs through the use of two rollers set very close together, which further process the silage after it has gone through the knives. This new technology is available on many of the newer, larger self-propelled harvesters as well as in at least one pull type model. The primary function of the processor it to crack or break open the kernels contained in the silage. In addition, the cob sections will be broken into smaller pieces. The stover portions of the silage will not appear significantly different.

One advantage of processing has been it has allowed producers to do a better job of breaking up cob sections in the silage. This has reduced sorting by the cows and resulted in a more consistent feed being consumed. Processing has also allowed much better corn silage to be harvested if the ideal window of harvest (1/3-2/3-starch line) has passed. Instead of the resulting kernels passing through cows in this late harvested silage, they now have a chance to be utilized. Additional advantages to processing corn silage are:

- Improved packing characteristics of the silage.
- Improves the digestibility of the starch portion of the silage!
- Improves the digestibility of the stover? Researchers have not fully answered this question yet but data exists that suggests it may reduce stover digestibility

One disadvantage of processing corn silage is that it will likely increase harvest costs.

In recent years, we, at Pioneer Hi-Bred Int. have assisted a small number of innovative dairy producers, working with excellent growers to experiment with cutting corn silage at heights 6 to 18 inches higher than normal. The basic idea has been to leave the portion of the plant that is less digestible in the field, thus concentrating the more digestible portions. Initial results in Idaho have been very promising and the idea is beginning to gain more attention. These dairy operations are combining the practice of high cut silage with that of maximizing grain content by using excellent grain hybrids for silage. They are also kernel processing at harvest, inoculating with a research proven inoculant, and utilizing excellent management practices in all phases of corn silage growing, storing and feeding. The resulting silage is what they have coined as “super silage”. The thumb rule is that one ton is lost (at 70 percent moisture) for each six inches the cutting height is raised. The material being left in the field is nearly 50 percent ADF so the quality of what is being left is poor from a feeding standpoint. By not harvesting the poor quality material, the resulting corn silage is higher in quality (lower in percent ADF).

One of the difficulties of producing super silage, if the end user is not growing their own silage, is that of resistance from growers to leaving that many tons in the field not harvested. To overcome this objection, some end users are paying the grower for the tons they are leaving. The resulting "super silage" has been so good, and the animal performance so superior, they feel they can justify doing so. One way many of these growers are looking at "high cut" corn silage is: Why haul this poorly digestible material in, handle it twice, and then haul it back out as manure?

USE OF SILAGE INOCULANTS

The area of silage additives is one that still can be very confusing to many dairy operations. The idea of a producer paying a significant amount of money for something they may find very difficult to understand not to mention difficult to observe, has made the decision to use a silage inoculant difficult for many dairy producers. I am very confident there are a few additives being sold that do have a very positive effect on corn silage fermentation, improved silage stability on re-introduction to oxygen, reduced dry matter loss, improved animal performance and in general improve the quality of the silage being fed. These few products have been proven to be effective through extensive research trials conducted at university research stations around the world. There are, however, a significant number of products being sold that have not expended the money required to conduct adequate research to prove their products are effective. Instead, they claim to be just like the products that have done adequate research. These non-researched products usually, but not always, cost less. With respect to bacterial inoculants, there are millions of bacteria strains that could be used to produce a silage additive. It is critical to have the correct numbers and combinations of strains for the product to be effective during all phases of silage fermentation and storage. The research proven products have usually patented the strains and combinations they utilize so there will not be identical effective products on the market. The bottom line is simply this. Each product being sold is totally different and unique. There are both effective and ineffective inoculants being sold. On the labels, they may look very similar. Each one must be proven on its own merits through extensive research. Silage additives do represent a significant investment. The producer must know the inoculant they are considering is a wise use of their money. If you are considering using one, **demand to see the research data. Make sure it is good data and that there is an adequate amount of it.** Do not, for example, just accept data that shows rapid pH drop. Make sure it is solid data that shows positive animal performance. If you are not sure it is good data, take the time to get opinions from professionals who work with such products. Get more than one opinion. A company selling a silage additive, willing to take your money for their product, should be accountable and willing to spend money to prove that product will be cost effective. If they have not made that commitment, look for another product to purchase

BUNKER PACKING AND COVERFING

When are fermented feeds the most valuable? Truth of the matter is, they are the most valuable the day they are brought to the bunker. From that time on, feed quality will only deteriorate. The degree to which that feed quality will be reduced is dependent on the management practices being incorporated.

One fact all good silage managers must know well is that oxygen is not the friend of silage. During silage harvest, storage and feeding, this important fact should be kept in mind by **all** those involved in these important phases. Oxygen causes silage to deteriorate and loose the most digestible components. Rapid filling of bunkers is critical because the sooner the job is finished the faster we reduce the exposure of the silage to oxygen. It must be balanced, however, with adequate packing at the bunker. **The person(s) on the silage-packing device is the critical link to success. They must be aware of what they are attempting to do and why it is so critical. They must be aware their mission is to eliminate as much oxygen as possible from the silage and the serious negative results if this is not achieved.** A poor job here means extensive respiration occurring in the silage, excessive heat being produced and **lower energy silage values**. Make sure this critical phase receives adequate attention!

Some producers choose not to cover bunkers. Most often, the reasons given are they do not want to have to constantly hassle with the plastic and tires. Many times in the west, the top 18 inches of the bunker do not look too bad for not having been covered. The existing data, however, on covering is so powerful it cannot be ignored. McLaughlin et al. (1978) reported dry matter losses of 60 percent from the top 25-cm of a bunker and 22 percent in the 25-50 cm depth. Table 2 shows corn silage data collected in 1992-93 comparing covered Vs non-covered bunkers and how it can influence feed quality.

Table 2. Effects of Sealing Treatment and Depth from Surface on Dry Matter and Organic Matter Recoveries, In Situ Digestibility, pH and Lactic Acid Content

Sealing Treatment	Depth From Surface (cm)	Dry Matter Recovered %	Org. Matter Recovered %	In Situ Digestibility %	pH	Lactic Acid %
Unsealed	25	24.7	24.4	37.1	7.11	.07
	50	75.0	76.9	63.1	3.84	.97
	75	76.7	77.6	65.7	3.86	5.21
Sealed	25	90.0	90.2	72.4	3.92	2.16
	50	92.4	92.7	71.2	3.79	4.23
	75	93.6	93.3	71.9	3.88	4.31

Source: Bolsen (1997).

If one does not cover a silage pile or bunker, in reality, at feeding time, they have two totally different feeds they are using. The top two feet of silage represent a feed, which is significantly lower in energy density. If a dairy cow is receiving corn silage one feeding which by chance has a much higher percentage of material from the top of the bunker and the next feeding receives material primarily from the lower portion, **that is not consistent feed quality.** No nutritionist is good enough to formulate a good dairy ration around that type of variation.

REMOVING CORN SILAGE FROM A PILE OR BUNKER

Keep the amount of silage that must be disturbed to a minimum. When excess silage is broken loose and not fed immediately, the oxygen penetrating that material will immediately allow aerobic microbial activity to begin. This process utilizes the most digestible portions of the silage. The loss of these valuable nutrients reduces feed value and reduces animal performance. Make sure the person who is responsible for removing silage at feeding time understands the negative effects of oxygen! Have them place their hand in loose material, which has been lying on the ground for several hours. Explain to them that the heat they feel represents lost energy, which will never be consumed by the cows they are feeding. Make them understand that how they feed effects how the cows milk. The more progressive dairy operations in the western United States are taking the time, and making the effort to educate the key people working with the crops and feeds which will be fed to their cows. These are efforts, which can pay significant dividends.

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