Feeding Ethanol By-Products in Colorado

PRINT

Gerald Poppy, DVM MBA
Chris Van Anne, MBA

Intro

The purpose of this paper is to describe what some of the current practice is with ethanol by-products use in CO at the present time and provide producers and nutritionists some information that might aid you as you utilize these products in rations. Ethanol by-products are becoming more and more important in cattle nutrition. A year ago when I agreed to give this talk, although there was a lot of talk of the increasing impact of distillers, few thought that we would be seeing $3.00 to $4.00 per bushel corn price, and the impact that would have on milk production and beef cattle prices. The information I have compiled for this talk are from a number of sources and articles. I would like to thank the nutritionists that filled out survey forms for me, the farms that donated samples, Alan Catterson from Cargill Nutrition for slides, Brad Olson from Pacific Ethanol for the tour of their dry grind ethanol plant in Windsor CO, and Matt Gibson PhD from Dakota Gold for the slides and information.

Why look at Ethanol byproducts?

From American Coalition for Ethanol, their official website Ethanol.org we see the following statistics updated Dec 2006 for the US.

Ethanol plants currently operating: 111
Total annual capacity: 5.15 billion gallons
States with ethanol production: 18
Ethanol plants currently under construction: 72
States with plants under construction: 19
2004 production: 3.4 billion gallons
2005 production: 4 billion gallons
2006 production is expected to reach or be close to 5 billion gallons
Ethanol & the corn crop

In 2004, 12% of the nation's corn crop was used for ethanol production.
In 2005, 14% of the nation's corn crop was used for ethanol production.
For the '06 crop, it is expected that 20% of America's corn will be used for ethanol production
Clearly as corn prices and other starch values change we need to understand better the opportunities for utilizing ethanol by products in the ration. Also it is important to understand some of their potential problems and interactions.

Understanding the different corn by- products

There are three different groups of corn by-products fed in Colorado and the surrounding areas, each with their own characteristics and values. Dry Milling, broken into two categories, ethanol and potable or drinkable alcohol, and Wet Milling. It is important to understand where these products come from and how they differ to take full advantage of them in the dairy rations.

Dry Milling

The first category we will discuss is what is called Dry Milling. This is the category of corn milling that is growing the fastest. The American Coalition for Ethanol report that there are currently 111 ethanol plants in production and another 72 under construction in the US. What is the process for dry milling? (See Figure 1) “Simplistically, whole corn is ground into meal, water is added, the resulting mash is cooked (to gelatinize the starch), enzymes are added to cleave free glucose from the starch, yeast is added, and the mix is allowed to ferment. During this fermentation, two main products are formed: ethanol and CO_2. The CO_2 is (usually) scrubbed and vented to the atmosphere. The fermented mash is distilled to recover the ethanol. The resultant whole stillage is dried into the feed product Dried Distillers Grains with Solubles (DDG/S)". What is important in this process is that the starch is fermented by yeast into alcohol. It goes through several stages and the by-products are the stillage (the spent grains) and the solubles or syrup. The solubles can be processed into Corn Condensed Distillers Solubles (CDS). These might be made into lick blocks for beef cattle. The syrup can be mixed back in with the stillage to make Distillers Grains with Solubles (DDG/S). The amount of syrup can vary in the amount added back to the grains. The grains can be sold wet or dried. The variance in the amount of syrup added back to the stillage as well as variation in drying leads to some of the variation seen in the final products. The syrup is higher in fat and phosphorous than the grain portion.

DDG/S Analysis and Variation

Often nutritionists are reluctant to utilize large amounts of DDG/S in rations due to the variation. Several papers describe surveys of DDG/S components. Kaiser reported in his paper at the 4-State Dairy Nutrition & Management Conference in 2005 seven data sets of various nutrient compositions for DDG/S both dry and wet. Table 1 and Table 4. One important aspect of looking at variation is the population that is sampled. There is going to be more variation in a large sample from across many sources of product. We will discuss variation more later in the paper. Typical values for DDG/S as represented in the NRC are DM=90.2 SD 1.8, CP=29.7 SD 3.3, EE=10 SD 3.4, NDF= 38.8 SD 7.8 P=.8 SD .1, CA=.2 SD .1 K=1.1 SD .2, Mg=.3 SD .1 Ash=5.2 SD 1.1. As you can see from the nutrient components, DDG/S is a good source of protein and with the high EE values (fat) there is a lot of energy. The NDF is highly digestible which makes it possible for the nutritionist to shift the ruminate from a high starch digestion to a more digestible fiber. To compare a broader sampling of DDG/S to our local Colorado feeding practices this fall we conducted a survey of several farms to sample the corn by-products that were being feed. We drew samples of wet and dry distillers, and brewers grain from the Budweiser and Coors. The relevant data for all these components are included in Table 5. The key numbers for the combined wet and dry product are DM=62.03 SD 27.88, (high variance because this is both the wet and dry samples) CP=30.94 SD 1.03, EE=13.42 SD 1.7, NDF=31.37 SD 2.88 P=.79 SD .11, CA=.05 SD .02 Mg=.29 SD .05, Ash=4.05 SD .76. One aspect that you should notice is the decrease in SD for most values as compared to a larger population sampling as shown in the NRC samples. As the break out is made between wet and dry the variation decreases more. The table shows the wet and dry samples, and the resultant decrease in SD.

Feeding Rates

From our survey of nutritionists that work on dairies in CO it is clear that there is no standard usage of distillers. The range was from 0 to around 6 pounds. (or 0% to 10% of DM) The largest reason for not feeding more was due to the possibility of having depression of butterfat because of the levels of unsaturated fat in the distillers. From the sampling reported here, it appears that the distillers in Colorado tend to be higher in fat than NRC reports. Several authors report feeding rates 10% to 15% of the rations as normal with no depressions seen. Schingoethe in the 2006 California Nutrition Conference proceedings reports recommended amounts up to 20% of rations. (This would be 10.4# in a 52 # DM ration.) In the paper "Can We Feed More Distillers Grains?" at the 15th Tri State Nutrition Conference, Schingoethe summarizes several papers and reports "the 20% of DM figure may be actually conservative." He reported no changes unless forage to concentrate dropped below 50:50. Kleinschmit reported in 2006 in a trial comparing control versus 3 different DDG sources at 20% of the ration an increase in milk yield, 4% FCM, ECM and feed efficiency. One key aspect of the rations fed was that all the rations were at 55:45 forage to concentrate ratio.

Issues with Distillers

Some facts to keep in mind on feeding distillers. All the components of corn are essentially multiplied by 3X in the dry milling process that produces distillers grains. We can see that in the protein. (31% in DDG/S vs. 9.4% in ground corn) The things that increase that might not be as obvious are the P. (.8% on DDG/S vs. .3% in ground corn) If you are limited in the amount of P that can be put on the ground or you think it could be an issue in the future, avoiding over supplementation is critical for you to work with your nutritionist on. For beef cattle we often see sulfur as an issue. DDG/S has .44% sulfur where ground corn has .1%. Polioencepholmalcia type symptoms are seen with over feeding of sulfur to cattle so this is an area to be aware of with high feeding rates. Another aspect that is not often thought of is mycotoxins. The mycotoxins in the feed are not destroyed in the heating process according to Dr. Gibson of Dakota Gold. Although their mills are reported to have a process to identify batches of corn with high mycotoxin levels prior to milling and channeling them outside their branded product, the DDG/S does enter the feeding channels. Other DDG/S manufacturers may not have a branding system in place to limit this. In most years probably the levels are ok, but one could speculate in certain weather conditions this could be an issue. Another issue that is relevant to the feeding of distillers is the value of the protein. Distiller grains are high in methionine and represents a potential source for aid in the balancing of the amino acid profile for rations. Shingoethe reports that distiller grains are high in RUP protein. An appropriate figure to use would be around the value of 55% of the CP. Wet and dry products both appear to be similar although wet distillers is slightly lower in RUP. Another issue in looking at the protein and RUP fraction of the distiller grains is the amount that is heat damaged during the drying process. The ADF protein % (bound protein) in the Colorado samples have a mean of 15.1% of the crude protein. This can lead to under feeding of protein in the ration if not accounted for. Ergul reported in 2003 that there is a correlation between the color of the distillers and the digestible lysine, cystine, and threonine. Lighter color and more yellow color were associated with product averaging .65% digestible lysine while a darker color and less yellow was associated with product averaging .38% digestible lysine. The bottom line is make sure the distillers you buy is light yellow in color to have the best chance at high quality RUP. Darker color is often cheaper but may not be worth the savings. One other issue to mention that is relevant to the Brewers Grains in the next section is that many type of grains may be used in the process of ethanol production. AAFCO 2006 requires that the majority grain to be declared on the label of DDG/S. That is DDG/S resulting from the fermentation of a mixture of 49% grain sorghum and 51% corn will be labeled exactly the same as DDG/S from 100% corn fermentation.1

New Process in Dry Milling

On the horizon are several advances in the production of ethanol that will lead to substantial changes in the distillers' by-product. According to a paper by Pritchard, one technique is the fractioning of the corn prior to the starch entering the fermentor. Broin Industries the makers of Dakota Gold call their process BFRAC. (see figure 2). "This involves separating the bran and germ and starch prior to fermentation. This improves the fermentation process but also substantially alters the composition of the distillers grains produced. The CP content is elevated while NDF, fat and P content are lowered (Dakota Gold HP)" included in this paper as Table 7. We are seeing this product in some rations in Colorado and care should be taken to make sure that you are using the updated analysis.

Brewers Grains

The process for the "potable ethanol" or alcohol for human consumption is in some ways similar to the process for fuel ethanol but with very different outcomes. The by-product that is produced is different as well. First the grain is not usually all corn. According to Stengel from Anheuser-Bush the primary ingredient used in their process is barley, with rice and corn as cereal adjuncts. Second, the point of grain fermentation takes place at a different place in the process. As can be seen in Figure 6 at the end of this paper, the barley is mashed and the adjuncts added at the mash level. The grain that will be made into the brewers' grains at this point are removed and the yeast fermentation that is going to take place on the wort proceeds without what will become the by-product grains. There is some confusion in the market place as nutritionists and producers look for products with yeast fermentation end products in it as an aid in ruminant digestion. The products in the ethanol production do have the yeast fermentation products, although as I will discuss later in this paper, not enough active metabolites to substitute for commercial yeast culture. In brewers' grain, these products are not present.

Colorado Brewers Grains

In Colorado the main source of brewers' grains are the Coors plant and the Budweiser plant. Many dairies get product from one plant or the other and a few from both that we sampled. Compared to DDG/S the brewers grains are lower in CP, higher in NDF and lower in energy. The mean data analyzing both products together are: DM=24.7 SD 5.6, CP=26.46 SD 6.45, ADFPRO=4.15 SD 1.23, ADF=21.6 SD 2.07, NDF=46.94 SD 3.05, Lignin=5.94 SD .6, Fat=9.4 SD .71, NFC=16.45 SD 3.67, TDN=74.15 SD.97, NEL=.79 SD .97, Ash=4.9 SD .57, CA=.28 SD .03, P=.66 SD .05, Mg=.23 SD .03 K=.18 SD .06. The break out between the Coors and Bud products is seen in Table 6 below. The most striking difference is the difference in protein. The Coors has a mean of 19.17 and the Bud 32.11. This difference could be partially the result of the sample size for the Coors was n=4. This leads to the question of variability. By utilizing a single source for the brewers' grains a producer is able to substantially reduce the variation in their product.

Brewers Feeding Rates

Although there is some limitation on the feeding of such a wet product (mean DM=24.66) for the potential for limiting intake, in a study by Dhiman, et al. in 2003 didn't see any difference in feed intake, FCM, or milk composition when fed either the wet or dry product at 15% DM of the ration when the ration dry matter was kept similar.

Dealing with Variation in By-Products

One of the key reasons that many nutritionists are reluctant to utilize high levels of by-products in their rations is because of the variation in the feeds. In the paper Randomness Rules, Dr. Weiss makes the statement that "the mean of a normal distribution is not the absolute right answer, but rather it is the value that has the lowest probability of being substantially wrong." Another quote in this paper says "Variation in feed composition increases risk and that has a cost. If a specific feed has a large load to load variation, diets either have to be over supplemented to avoid a deficiency (i.e., increased feed costs) or production may decrease because at times the diet does not provide adequate nutrients. Feeds with large variation in nutrient composition are worth less than feeds with less variation." This is illustrated in Table 8
In this example if a product such as brewers' grains has a sample CP of 23.8% with a SD of 5.7. This means that 16% of the loads will have a high probability of having a CP of 18.1% or less and 16% of them will have a high probability of being 29.5% of higher. If the ration is formulated for 23.8, then when a load with low CP is received if the product is being fed at 10% DM of the diet, the ration is .3# of protein deficient or a 24% error. The interesting fact is if we double the inclusion rate to 20% feeding for the average of 2.52 # of CP, 16% of the time the animals will be fed1.92# of protein or .6# CP error. So the error amount increased by 4X when the feeding rated doubled. The way to deal with the error rate is to feed small amounts of product with high SD of samples, or find a source with low variation. Dr. Weiss has a very good paper and I would recommend it to anyone feeding by-product feeds.

Ethanol By-Products Interaction with Rumen Modifiers such as Diamond V Products

One question that frequently comes up when feeding by-products of the ethanol process is "can we not feed yeast culture because of the yeast byproducts that come through in the ethanol process. In the brewers' grain process, the grain is removed from the process before the yeast is added to the wort. Therefore the brewers' grains do not have the spent yeast product. In the DDG/S process the grain is fermented early in the process. With the feeding of DDG/S it is noted that the fermentation residues and yeast biomass are contained in the product. It must be remembered, the end product desired in this controlled fermentation is ethanol. The included yeasts in DDGS/S are "spent" having completed their designated goal of efficient fermentation of starch to alcohol. Additional metabolites may be present but have not been researched to determine beneficial effects on dairy rumen function. Sanchez et. al. , in an early lactation study with Diamond V yeast culture in a diet with DDG/S at 8.5% of the DM post calving saw 91.9# FCM vs. 86.1 FCM in the control diet with no Diamond V yeast culture. (Table 9) . Harris, in a study in a diet containing both brewers' grains at 14.8% DM and distillers at 3.8% of DM, on a diet with Diamond V yeast culture vs. control the diet with Diamond V produced 31.7 kg vs. 30.9 kg FCM per day as well as a significant increase in BF. Diamond V Mills has a process called DV Ram which is a replication of an artificial rumen that can measure the difference between products for VFA production. In 2006 a study was conducted in Diamond V's laboratory with Dakota Gold Distillers (DDGS and Dakota Gold HPTM (DDG) alone vs. with Diamond V XPC. The results (Table 10) show a significant increase in VFA production when Diamond V XPC is fermented with both products vs. without Diamond V XPC. DDG Total VFA=59.02 vs. DDG plus XPC VFA=64.18, and DDGS Total VFA=62.13 vs. DDGS plus XPC VFA=64.95. Further studies are on going to better define the yeast metabolite interactions with other ethanol by-products and their impact on milk production.

Wet Milling

The wet milling process will not be covered in depth in this paper. I will include the way this differs from the Dry Milling process. The last new wet milling facility was built in 1995, so this is not increasing at the speed the dry milling process is. The wet milling process is for production of corn oil, corn starch, and high-fructose corn syrup. The largest difference in this process is that the corn is broken into various fractions, bran, starch, protein and oil at the beginning of the process. The main feed products from wet milling are steep liquor, bran, germ meal, gluten meal, and gluten feed. One of these products from Cargill, wet corn gluten feed, called SweetBran shows promise for high milk production when fed up to 36% of the DM in the ration. Brouk, M.J. et. al.
The process for wet milling is outline in Figure 6. The nutritional components for the wet-milling process included for reference in Table 11.

Summary

There are many products in the marketplace, all being sold under the heading of ethanol by-products. Wet milling and dry milling, which can be broken down between alcohol and ethanol production, yield considerable variation in products, as well as potential variation from different sources even within a product line. The challenge with dealing with variation will become more difficult in the future for nutrition consultants, allowing their expertise to bring additional benefit to the dairy or beef producer. With the tremendous increase in ethanol for fuel production and the corresponding increase in starch prices, we will need to become better at efficiently utilizing these products in production agriculture to generate profitable enterprises.

Figure 1 Dry Grind Process for Ethanol production

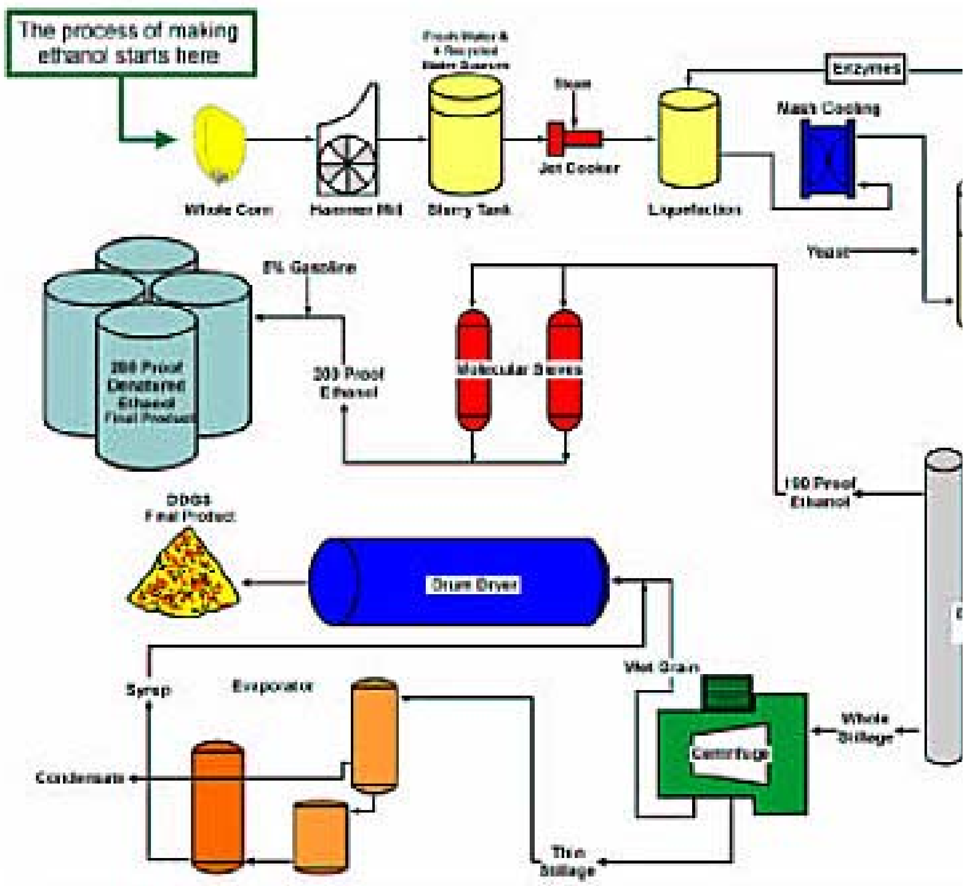

Table 1. Organic nutrient composition of DWGS by total population and ethanol pl

Organized for Within population or plant comparisons

	DM	CP	EE Mars	EE UW	FA	NDF	NDF-CP
	%	---	---	--% DM--	---	---	---
Population (n=51)	35.6	26.7	10.6	16.4	13.2	30.2	8.9
SD	7.4	1.6	1.0	1.2	0.8	2.9	3.4
Min Value	28.0	23.0	7.8	13.7	11.4	24.7	3.0
Max Value	53.2	29.0	13.0	19.0	15.5	39.7	15.9
Plant 1 (n= 9)	32.6	27.5	10.6	16.0	12.7	31.4	6.7
SD1	0.9	1.6	0.9	1.1	0.8	2.0	3.2
Min Value 1	31.4	24.2	9.1	14.5	11.4	28.7	3.7
Max Value 1	33.7	29.0	11.7	18.0	14.2	34.9	13.4
Plant 2 (n=11)	49.3	25.6	10.9	17.5	13.8	30.4	5.9
SD2	2.3	1.5	1.0	0.8	0.9	3.1	2.5
Min Value 2	44.9	23.5	9.6	16.5	12.3	26.6	3.0
Max Value 2	53.2	27.2	13.0	19.0	15.5	36.3	11.2
Plant 3 (n=31)	31.6	26.8	10.5	16.1	13.2	29.7	10.5
SD3	1.2	1.5	1.0	1.2	0.5	3.1	2.6
Min Value 3	28.0	23.0	7.8	13.7	12.1	24.7	7.1
Max Value 3	33.9	28.6	12.0	18.2	14.7	39.7	15.9

Table 4. Nutrient means and standard deviations of distillers grains with solubles from sev

	DM	SD	CP	SD	EE	SD	EE UW	SD	NDF
NRC, DDGS	90.2	1.8	29.7	3.3	10.0	3.4			38.8
Kaiser, DWGS	35.8	1.5	26.6	1.6	10.5	1.0	16.4	1.2	30.1
Robinson, DDGS	90.1	1.6	30.1	2.6	11.5	3.5			33.7
Robinson, Dakota Gold™	88.2	0.9	30.7	1.2	11.9	0.7			28.1
Hardy, DDGS	92.7	1.0	30.1	1.5	10.5	1.2			48.8
DePeters, DDGS			31.2	0.6	13.0	1.3			35.6
Belyea, DDGS			30.6	1.4	7.4	0.9			33.0
Spiehs, DDGS	89.0	1.1	30.2	1.0	10.9	0.5			42.0

	P	SD	Ca	SD	K	SD	Mg	SD	Ash
NRC, DDGS	0.8	0.1	0.2	0.1	1.1	0.2	0.3	0.1	5.2
Kaiser, DWGS	0.9	0.2	0.1	0.1	1.2	0.1	0.4	0.0	5.6
Robinson, DDGS	0.9	0.1	0.1	0.0	1.0	0.2	0.3	0.1	4.9
Robinson, Dakota Gold™	0.7	0.1	0.0	0.0	0.9	0.1	0.3	0.0	4.6
Hardy, DDGS									4.3
DePeters, DDGS	0.8	0.0	0.1	0.0	1.0	0.1	0.4	0.0	4.7
Belyea, DDGS	0.7	0.0	0.0	0.0	0.9	0.1	0.3	0.0	3.1
Spiehs, DDGS	0.9	0.1	0.1	0.0	0.9	0.1	0.3	0.0	5.8

Table 5 Distiller sample from Colorado Dairies Wet and Dry Fall 2006

	Distillers Grains		Wet DDG		Dry
n=	10		5		5
	MEAN	Stand Dev	MEAN	Stand Dev	MEAN
DM	62.03	27.88	35.59	0.44	88.47
CP	30.94	1.03	31.31	1.23	30.58
ADFPRO	3.64	1.24	2.67	0.33	4.61
ADFPR%PRO	11.8%	4.1%	8.5%	0.9%	15.1%
ADF	14.80	2.96	13.30	2.92	16.29
NDF	31.37	2.88	29.67	0.56	33.06
LIGNIN	2.84	0.59	2.39	0.17	3.30
FAT	13.42	1.70	13.89	2.19	12.95
NFC	23.60	1.95	23.70	2.38	23.49
TDN	90.61	3.78	92.76	3.64	88.46
NEL	0.98	0.05	1.01	0.05	0.96
ASH	4.05	0.76	3.89	0.32	4.22
CA	0.05	0.02	0.04	0.01	0.07
P	0.79	0.11	0.77	0.06	0.81
MG	0.29	0.05	0.28	0.03	0.30
K	1.00	0.15	1.00	0.10	1.00
NA	0.13	0.06	0.15	0.03	0.12
FE	127.48	89.13	83.25	9.30	171.71
MN	22.80	11.18	16.79	1.50	28.80
ZN	65.61	13.73	58.84	5.60	72.37
CU	6.71	2.31	5.04	0.86	8.38

Table 6 Brewers Grain Simples from Colorado Dairies Fall 2006
Poppy Van Anne Colorado Nutrition Conf 2007

	Wet Brewers		Coors		
n=	13		4		7
	MEAN	Stand Dev	MEAN	Stand Dev	MEAN
DM	24.66	5.63	30.65	3.08	20.10
CP	26.46	6.45	19.17	1.03	32.11
ADFPRO	4.15	1.23	3.08	0.09	5.16
ADFPR%PRO	15.6%	1.9%	16.1%	0.5%	16.1%
ADF	21.60	2.07	22.17	1.62	21.39
NDF	46.94	3.05	49.87	0.96	44.45
LIGNIN	5.94	0.60	5.48	0.58	6.35
FAT	9.40	0.71	8.75	0.83	9.55
NFC	16.45	3.67	20.54	3.01	14.23
TDN	74.15	0.97	72.99	0.79	74.67
NEL	0.79	0.01	0.78	0.01	0.80
ASH	4.90	0.57	4.74	0.65	4.82
CA	0.28	0.03	0.30	0.05	0.27
P	0.66	0.05	0.65	0.07	0.64
MG	0.23	0.03	0.25	0.03	0.22
K	0.18	0.06	0.21	0.01	0.15
NA	0.02	0.01	0.02	0.00	0.02
FE	167.19	25.53	152.35	24.08	165.70
MN	52.17	4.94	49.84	5.15	53.09
ZN	92.25	9.57	88.21	11.26	94.45
CU	17.20	6.19	19.40	6.13	15.96

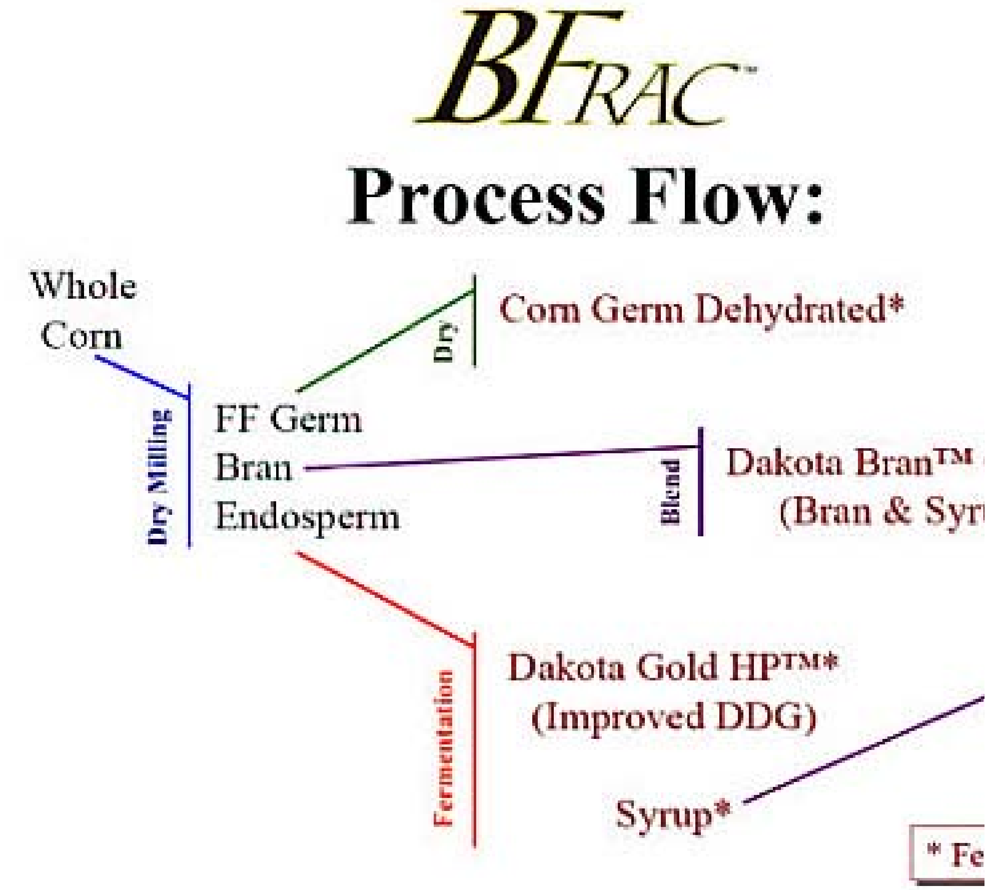

Figure 2 Diagram showing new process that produces the higher protein
Dakota Gold
From Dakota Gold website.

DAKOTA GOLD® HP
Dried Distillers Grains

PROTEIN, FAT, ENERGY, FIBER		
ITEM	VALUE[1,2]	ITEM
Dry Matter, %	91.9	NE_L, Mcal/cwt[3]
Crude Protein, %	46.8	NE_M, Mcal/cwt[3]
Crude Fat, %	3.3	NE_G, Mcal/cwt[3]
Crude Fiber, %	7.52	ADF, %
ME – Swine, Kcal/lb[4]	1842	NDF, %
ME – Poultry, Kcal/lb[4]	1328	Ash, %

MINERALS		
ITEM	VALUE[1,2]	ITEM
Calcium, %	0.01	Sulfur, %
Phosphorus, %	0.40	Copper, ppm
Sodium, %	0.16	Iron, ppm
Potassium, %	0.34	Manganese, ppm
Magnesium, %	0.10	Zinc, ppm

Table 7 From Dakota Gold website

Figure 6 Process for the formation of Brewers Grains from the alcohol ind

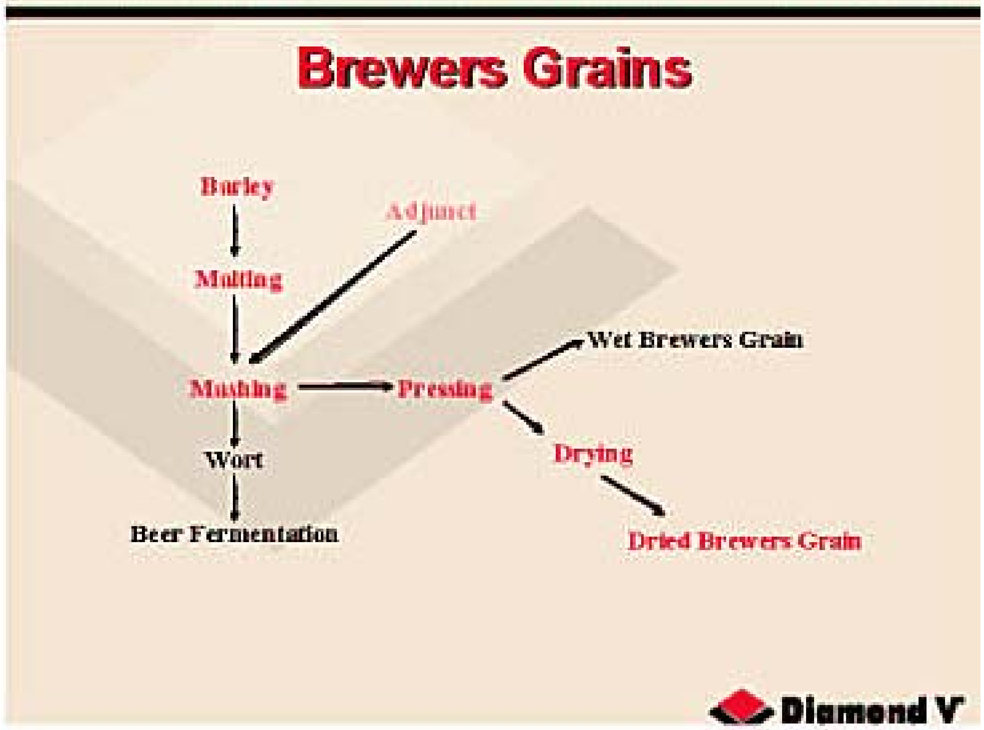

Table 8 Example of error from variation

		Low	Normal amount fed
Sample CP	23.8		
Sample SD	5.7		
16% of samples are at least this low	18.1		
16% of samples are at least this high	29.5		
Diet DM Intake	53		
In a diet containing this amount of feed	10%	0.96	1.2
	20%	1.92	2.5
	30%	2.88	3.7

Influence of yeast culture on lactational performance of high producing dairy cows

Item	30 weeks			15 week	Y
	Control	Yeast Culture	SE	Control	Y
Milk, lb/d	91.9	93.3**	0.5	93.8	
Fat, %	3.34	3.50	0.08	3.29	
Fat, lb/d	2.94	3.20**	0.09	2.93	
Protein, %	3.36	3.42	0.03	3.31	
Protein, lb/d	2.97	3.14**	0.06	2.99	
SNF, %	8.96	9.02	0.03	8.91	
SNF, lb/d	7.95	8.31*	0.15	8.09	
3.5% FCM, lb/d	86.1	91.9**	2.0	86.9	
Energy corrected milk, lb/d	88.5	94.3**	1.9	89.3	
Dollar corrected milk, $/cwt (based on solids)	12.08	12.26*	0.07	11.98	
Dollar corrected milk, $/cwt (based on protein)	12.28	12.67*	0.11	12.09	

** P<.05 * P<.10

Table 9 Diamond V addition to DDG/S

Table 10 Diamond V DV Ram VFA test with DDG

Treatments:

1. DDG with XPCGB
2. DDG with XPC
3. DDGS with XPCGB
4. DDGS with XPC

Chemical composition

Sample	DM %	Protein, % DM
XPC	90.48	16.56
XPCGB	89.73	11.78
DDG	92.26	48.41
DDGS	89.90	32.04

Table 10 Diamond V Ram VFA continued

Last Updated (Wednesday, 09 May 2007)