Using By-Product Feeds in Beef Supplementation Programs[1]

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Supplements are often fed to heifers and steers after weaning until winter pasture is ready for grazing. Grain supplements such as corn will improve gains of calves grazing residual pasture or fed hay. Many producers feed four to six lb/day of a corn ration fortified with protein and minerals. Reducing supplemental feed costs without reducing performance may be possible with by-product feeds.

Several by-product feeds are also available in Florida and often are lower-cost sources of energy and other nutrients than corn and other grains. Feeds such as molasses, whole cottonseed, citrus pulp, soybean hulls, wheat midds and hominy are available in many areas of the state. Prices will vary with each feed but all of these feeds make effective supplements for beef cattle. Many of these feeds are by-products of grain processing or other agriculture production. Each feed has different energy, protein and other nutrient concentrations (Table 1) that can alter the levels that should be fed and/or the balance with other nutrients. Many of these feeds do not require processing but may have limitations for handling, storage and feeding. This paper will give a description of each byproduct, discuss handling, storage and feeding, and give the limitations of several byproduct feeds available to cattle producers in Southeast U. S.

By-product Feeds

Molasses

Description. Blackstrap molasses (mill run, heavy) is a byproduct of the sugar industries in south Florida and Louisiana. It is high in energy mostly from residual sugars, and most Florida molasses is grown on organic soils resulting in a molasses higher in protein compared to sugarcane grown on soils low in organic matter. Most molasses is produced during the fall and winter and price is determined on the world market. Over 500,000 tons of molasses is produced annually in south Florida, and Florida is a net exporter of molasses. Blackstrap molasses from south Florida typically contains 22% moisture, 60% TDN and 7% crude protein (as fed). Molasses-based liquid feeds containing 12, 16, 20 and/or 32% crude protein are marketed by many feed manufacturers. These are made by adding urea, water, phosphoric acid, trace minerals, vitamins and other ingredients to

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blackstrap molasses. The TDN concentrations in molasses-based liquid feeds are usually lower than in blackstrap molasses.

Storage and Feeding. Heavy molasses is a liquid that flows or is pumped. Standard molasses (higher moisture (25%) than heavy) is usually preferred during colder weather due to the high viscosity of mill-run molasses. It is usually hauled and stored in large tanks and is stable during storage. It can be hauled on the ranch with a tank mounted on a truck or trailer and allowed to flow by gravity into bathtubs, plastic troughs or other containers. Cattle may limit their consumption of molasses-based feeds, but under many situations, consumption will be higher than desired and it will need to be limit-fed. It can be effectively fed three days/week and cattle allowed to run out between feedings. An advantage is that it is eaten more slowly than concentrate feeds and less bunk space is required for all cattle to have an opportunity to consume the molasses that is offered. Blending with other dry ingredients to make molasses slurries is common on many Florida ranches.

Limitations. It is low in protein, and supplemental protein is needed in many situations. It requires specialized storage and feeding equipment, increasing the initial handling and feeding costs.

Whole Cottonseed

Description. Whole cottonseed is a by-product of cotton production and acreage is expanding in the Southeastern U.S. Whole cottonseed can be fed to ruminants or processed for its oil content, and an increasing proportion has been fed in recent years. Cottonseed is high in TDN (94%) and crude protein (23%) and is a good feed for cattle. Supplies are seasonal and prices tend to be lowest during harvest in the fall.

Storage and Feeding. Cottonseed is light, with a weight of 20 to 25 lb/cubic foot. It is usually hauled in dump trailers or trucks with a bottom conveyor. It can also be hauled and stored in peanut drying wagons. Cottonseed must be dry or it will mold during storage. Cottonseed does not need to be processed and can be mixed in diets or fed in feedbunks or on a clean sod. Cattle usually will eat cottonseed after they are adapted to it. At first offering, whole seed may need to be mixed with other ingredients, but after adaptation cattle usually consume it readily. Feeding cottonseed at a level to meet the supplemental protein needs of growing cattle and beef cows is a common feeding system. Higher levels can be fed if whole seed is priced competitively as an energy supplement.

Limitations. High fat content (18%) and gossypol limit the level of cottonseed that can be fed. Whole cottonseed should be limited to 25% of the total dry matter intake of beef cattle. A practical feeding limit would be three lb/day for a stocker calf and five lb/day for a beef cow. Gossypol has been shown to reduce the reproductive performance of cattle, and the bull appears to be more sensitive than the female. Gossypol levels will vary in whole cottonseed, but feeding the amounts listed above has not resulted in gossypol toxicity problems.

Citrus Pulp

Description. Citrus pulp is a by-product of the orange- and grapefruit-processing industries, with over 500,000 tons produced annually in Florida. Citrus pulp has a 79% TDN and 8% crude protein concentration, making it a good energy supplement for cattle. Most citrus pulp is dried, and much of the supply was exported to Europe during the 1980s. Supplies are available during the citrus-processing season with prices fluctuating with the international market. Wet citrus pulp is available seasonally during periods of heavy harvest and may be an economical supplement for cattle within 30 miles of the processing plant.

Storage and Feeding. Most dried citrus pulp is ground and pelleted, which nearly doubles its bulk density and improves its handling characteristics. It is sensitive to moisture and needs to be dry when stored. Pelleted citrus pulp will usually flow in storage bins and self feeders and can be mixed with other feed ingredients. Citrus pulp is very palatable to cattle and will improve the intake of some rations. Wet citrus pulp (15 to 20% dry matter) is acid and can be stored for short periods. Most wet citrus pulp is fed by dumping piles in pastures and allowing cattle to consume it, which results in some spoilage and wasted pulp.

Limitations. Citrus pulp should be limited to 50% or less of the total daily intake. It is high in calcium and low in protein and phosphorus. Additional protein and phosphorus need to be added to the diet when higher levels are fed.

Soybean Hulls

Description. The soybean hull is the seed coat removed during oil extraction. It is usually toasted and ground after removal and may be added back to the meal. Soybean meal with 48% crude protein does not have the hulls added back after processing, and 44% soybean meal contains the hulls. Soybean hulls are high in fiber that is highly digestible by ruminants. Soybean hulls contain 77% TDN, 12% crude protein and 14% starch. The low starch concentration results in a lower rate of fermentation and reduces problems with acidosis. Demand and prices of soybean hulls are usually lower during the summer months.

Storage and Feeding. Unpelleted soybean hulls are light and bulky with a weight of 20 lb/cubic foot. Pelleted soybean hulls have a higher bulk density and are available from some sources. They are usually stored in flat-bed storage and loaded with a front-end-loader. They are very palatable to cattle and are a good feed for newly weaned calves. The protein, calcium and phosphorus is usually adequate and nearly balanced, making soybean hulls a commodity that can be fed without mixing with other feeds. They have also been used to supplement bulls since soybean hulls are palatable and their low starch concentration reduces the chance of acidosis and founder. When used as a supplement with forage, soybean hulls have less of a depressing effect on forage intake and digestibility, and usually result in better cattle gains than cattle fed similar amounts of TDN from grains.

Limitation. Soybean hulls can be fed at high levels to growing cattle, and storing and handling characteristics may limit their use in some situations.

Wheat Midds

Description. Wheat middlings are a byproduct of milling wheat for flour. They are high in TDN (82%), protein (18%) and phosphorus (1.0%). Wheat midds are available from flour mills in Florida and across the United States. They are routinely used in commercial feeds. Their price is often attractive when higher protein content is needed in the ration.

Storage and Feeding. Wheat midds are light and bulky with a weight of 20 lb/cubic foot. They are usually stored in flat-bed storage and loaded with a front-end loader. Wheat midds are moderately palatable to most cattle but some animals may not readily consume them unless mixed with other feeds. Pelleting improves their palatability to cattle. They make an excellent supplement for grazing cattle since they are high in energy, protein and phosphorus, and their moderate levels of starch result in less depression in intake and digestibility of forage.

Limitations. Palatability may limit their use in some situations and levels should be limited to 50% of the total dry matter intake. At higher levels of feeding the high phosphorus concentration needs to be balanced by adding calcium.

Hominy

Description. Hominy is a by-product of corn processing for human consumption. It contains corn bran, corn germ, and part of the starch. Hominy is higher in energy, protein, fat, and fiber than corn grain. The fat concentration can range from 5 to 12%, which will alter the TDN concentration and the maximum levels that can be added to the ration. It is often used in rations as a replacement for corn.

Storage and Feeding. Hominy is finely ground and can be stored, handled and fed similarly to ground corn. It is desirable to feed up supplies in one month or less to avoid the stale smell, as with ground corn.

Limitations. Hominy has a lower starch level than corn but can be used with the same limitations as corn.

Peanut Skins

Description. Peanuts skins are the thin outer coat on the nut after shelling (not the hull). These are a by-product from peanut shellers and are usually available during the winter and spring. They are a good energy supplement for cattle, containing an estimated 60 to 80% TDN (not experimentally determined) and 17% crude protein.

Storage and Feeding. Peanut skins are light, bulky and not likely to flow well in grain handling facilities. They can be blown by wind and need to be hauled in covered vehicles and stored in closed facilities. Experiences indicate they can be stored and rancidity of the fat is not usually a problem. Peanut skins are usually mixed with grains and are readily consumed by cattle.

Limitations. Peanut skins are high in tannin (18%) that will negatively impact protein utilization, and they are high in fat (22%) that contributes to their energy content but limits the levels that can be fed. Research indicates that peanut skins should be limited to 10% of the total intake of cattle to avoid reduced gains. Higher levels (15 to 20% of the diet) of peanut skins may not depress performance if dietary protein levels are increased to overcome the protein binding of tannin.

Cotton Gin Trash

Description. Cotton gin trash contains mostly cotton lint with some pieces of stems, immature seeds, and other cotton plant parts harvested with the cotton. It is a waste product at cotton gins and often is hauled to landfills. Nutrient composition is variable depending on the amount of foreign material in the cotton and the amount of immature seed. Typically cotton gin trash has an energy concentration similar to mature bahiagrass hay and protein is typically 10% or higher. It is best suited as a feed source for mature dry beef cows and is usually available for the cost of hauling from the cotton gin. The supply is seasonal and available during cotton harvest and processing.

Storage and Feeding. Cotton gin trash is bulky and a large truck may contain only 10 to 12 tons. It is often hauled in trucks with live bottoms and unloaded in the fields where it is fed. Baling gin trash in large round bales may be feasible to facilitate handling and feeding. It smells good and is very palatable to cattle.

Limitations. It is limited in energy, and additional supplements may be needed to avoid body condition loss and improve cattle performance. Residues of pesticides typically used in cotton production do not appear to pose problems, but cattle producers need to monitor cotton pesticides used and be aware of the risks. Weed seeds are a contaminate in cotton gin trash and control of weeds near feeding areas may be needed.

Supplemental Purchasing Decisions

Nutrients Needed. The first step in determining which supplements to feed is to evaluate which nutrients are deficient. This requires that you compare the animal's nutrient requirements to the forage nutrient content. Deficiencies of minerals and vitamins can usually be overcome by offering a mineral-vitamin supplement free-choice for a relatively low cost. Protein deficiencies have been shown to limit forage intake and digestibility, therefore supplementing protein in these situations is usually more cost effective than feeding energy supplements. After balancing the animals' diet for minerals, vitamins and protein, the usable energy intake needs to be evaluated. Forage quality will determine the intake and digestibility of the forage and, therefore, the amount of supplemental TDN that is needed.

Cost of TDN. It is essential to select sources of energy and protein that provide the needed TDN and protein at a low cost. The lowest cost sources of nutrients will depend on the cost of ingredients, quantities purchased, handling and storage system, processing and mixing required, feeding system waste and cost, and labor available. The first decision is to narrow the list of ingredients to those that you can use in your system then compare prices based on cost of nutrients from each source.

In recent years, the net energy system of evaluating feeds developed. The net energy system has been shown to be more accurate than TDN, or digestible energy system, for high grain diets using feedstuffs that have little variation in nutrient content. In forage-based diets, however, the forage nutrient concentration is variable and the supplement will affect the forage intake and forage digestibility. The net energy system can be used, but offers little accuracy improvements over TDN in determining the source and level of supplement for forage-based diets.

As an example, if you need an energy supplement for your heifers after weaning, and corn and soybean hulls cost $120/ton and $105/ton respectively, which is the lower-cost source of TDN? The cost of TDN can be calculated if you know the TDN concentration in each feed. The TDN in corn is 87% in the dry matter (Table 1), and the dry matter constitutes 88%. The TDN in soybean hulls is 77% in the dry matter, and the dry matter constitutes 91%. With this information, you can determine the cost of TDN from each source. I usually prefer to calculate the cost of 100 lb of TDN, and the first step is to convert the cost/ton to cost/100 lb by dividing by 20 — or corn costs $6.00 for each 100 lb. The next step is to determine how much 100 lb of corn dry matter will cost, and this is done by dividing $6.00 by the dry-matter fraction in corn (.88), to get $6.82(6/.88=6.82). Each 100 lb of corn dry matter contains 87%, or 87 lb (100*.87=87) of TDN, and the cost of 100 lb of TDN from corn is determined by dividing $6.82 by the TDN fraction in corn (.87) to get $7.84 (6.82/.87=7.84), which is the cost of 100 lb of TDN in corn that costs $120/ton. Similar calculations for soybean hulls show that 100 lb of hulls cost $5.25 ($105/ton divided by 20=$5.25), 100 lb of soybean hull dry matter costs $5.77 ($5.25/100 lb, divided by .91 dry matter fraction = $5.77), and 100 lb of TDN from soybean hulls costs $7.49 ($5.77/100 lb dry matter, divided by. 77 fraction of TDN = $7.49). In summary, for $120/ton corn, the TDN will cost $7.84/100 lb and for $105/ton soybean hulls, the TDN will cost $7.49, therefore soybean hulls are 5% cheaper than corn as a source of TDN. If the storage and feeding costs and losses are similar, then this will be a realized savings in supplement cost. It will require more pounds of soybean hulls to provide the same level of supplemental TDN compared to corn, therefore the level of supplement feeding should be adjusted.

Associative Effects. Supplements with high grain content have high TDN levels and high levels of starch. High levels of starch and sugar are rapidly fermented, resulting in a lower rumen pH. This results in lower intake and digestibility of forage when starch intake reaches a critical level. The effects of the supplement on the forage intake, digestibility, and utilization are called the associative effects.

Research using by-product feeds that have low levels of starch and sugars, but relatively high TDN (such as soybean hulls) has shown these feeds may have less negative effect on forage intake and digestibility, resulting in a better response than expected from the level of TDN in these feeds. A comparison of corn, wheat middlings, and soybean hulls (Garces-Yepez et al., 1996), fed at approximately .5% or 1% of body weight to growing steers offered good quality bermudagrass hay free-choice, showed that gains, forage intake and NDF digestibility were similar for all three concentrates fed at approximately .5% body weight (Table 2). However, cattle fed corn at .94% of body weight had lower gains, reduced forage intake and a lower NDF digestibility than cattle fed soybean hulls at 1.16% body weight (supplemental TDN from soybean hulls and corn were similar). Cattle fed wheat middlings had responses intermediate to corn and soybean hulls. Additional research comparing these feeds and others has also shown that by-products with high digestibility and lower starch and sugar concentrations will have less of a depressing effect on forage intake and digestibility than those with higher levels of starch and sugars when fed at intermediate levels (Brown, 1994; Brown and Weigel, 1993).

Feeds such as soybean hulls, citrus pulp and wheat middlings are highly digestible but contain 35% or less of starch plus sugars, compared to corn that contains 75% starch (Table 1). Several experiments indicate that when sum of the starch plus sugars are fed at levels above .4% of body weight, the forage intake and digestibility may be reduced. In these situations when a forage is being supplemented, choosing a highly digestible supplement such as soybean hulls compared to a high starch supplement such as corn appears to give 15 to 30% better performance per unit of supplemental TDN. When comparing the cost of TDN in these situations, this suggests you can pay 15 to 30% more per unit of TDN and still get the same performance. This is offered as a guideline and will depend on the situation.

Feed Brokers. By-product feeds are available from many different sources and having an information source that has current prices, availability, and will arrange for trucking and delivery can be invaluable when evaluating your alternatives. Feed brokers supply this service for many dairy producers and cattle ranchers in Florida. A few feed brokers are listed below for your information. This list is not inclusive nor an endorsement. It is provided for your convenience.

- Central States, Orlando, FL, (800) 935-3503
- Columbia Grain, Lake City, FL, (800) 323-1594
- Furst McNess, Trenton, FL, (800) 562-0480
- Archer Daniels Midland (ADM), Valdosta, GA, (800) 841-9612

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Table 1. Nutrient concentration and bulk density of feed ingredients (NA = Analysis Not Available).

Feed	Dry Matter	Concentration in dry matter									Bulk Density
		TDN %	NEm mcal/lb	NEg mcal/lb	Starch-Sugars %	Fat %	Crude Protein %	Bypass Protein % CP	Ca %	P %	lb/ft^3
Grains											
• Corn	88	87	0.96	0.64	75	4.2	10	65	0.02	0.30	48
• Oats	89	76	0.81	0.52	47	4.6	13	21	0.09	0.40	25
• Rye	89	81	0.88	0.58	NA	1.7	12	20	0.07	0.39	45
• Wheat	89	88	0.98	0.65	69	2.0	12	NA	0.06	0.40	48
High energy feeds											
• Citrus pulp, pellet	90	79	0.85	0.55	25	3.9	8	37	1.80	0.15	20
• Cotton gin trash	91	45	0.44	0.05	NA	2.0	11	NA	1.70	0.25	NA
• Hominy	90	92	1.03	0.70	52	5.3	11	44	0.04	0.45	28
• Molasses, heavy	78	78	0.79	0.50	60	0.0	9	0	1.10	0.10	78
• Peanut skins	92	70	NA	NA	NA	20.0	17	NA	0.19	0.20	20
• Rice bran	91	66	0.68	0.38	27	15.8	14	34	0.08	1.68	20
• Soybean hulls, grnd	91	77	0.82	0.53	14	2.5	12	30	0.63	0.22	20
• Wheat middlings	89	82	0.89	0.59	35	4.6	18	24	0.14	1.04	20
Medium protein feeds											
• Brewer's grains	92	84	0.92	0.61	14	7.4	30	56	0.30	0.60	15
• Cottonseed, whole	90	94	1.06	0.72	8	18.0	23	39	0.16	0.62	25
• Corn gluten feed	90	82	0.89	0.59	30	3.3	24	25	0.20	0.85	30
• Distiller's grains	92	87	0.96	0.64	12	9.0	27	47	0.30	0.75	15
High protein feeds											
• Blood meal	91	66	0.66	0.37	NA	1.3	92	82	0.29	0.23	38
• Corn gluten meal	91	89	0.99	0.67	19	2.4	67	60	0.05	0.51	42
• Cottonseed meal	91	76	0.81	0.52	12	2.0	47	41	0.21	1.18	42
• Feather meal	92	69	0.71	0.43	7	5.0	88	72	0.40	0.60	15
• Fish meal	90	72	0.75	0.47	2	8.0	66	63	6.40	3.60	40
• Meat & bone meal	93	71	0.74	0.46	NA	10.4	55	53	9.95	5.00	37
• Peanut meal	91	77	0.82	0.53	25	4.5	48	28	0.20	0.52	29
• Soybean meal	91	87	0.96	0.64	10	1.2	55	30	0.28	0.70	42
• Soybeans, whole	88	93	1.04	0.71	10	18.5	40	30	0.27	0.64	48

Table 2. Corn, wheat middlings (WM), and soybean hull (SH) supplements for growing cattle fed hay.[a]

	None	Supplements					
		Low - 25% TDN			High - 50% TDN		
		Corn	WM	SH	Corn	WM	SH
Daily gain, lb	0.67	1.40	1.43	1.34	1.67	1.97	2.09
BCS change[b]	-0.57	0.65	-0.23	0.23	0.34	0.13	0.61
Intake, % BW							
• Supplement		0.43	0.49	0.53	0.94	1.09	1.16
• Hay	2.20	2.16	2.19	2.07	1.76	1.83	1.83
• Total	2.20	2.59	2.68	2.60	2.70	2.92	2.99
Digestibility, %							
• Organic matter	51.9	57.1	55.4	58.3	63.1	57.1	63.8
• NDF[c]	56.2	55.0	55.0	59.1	52.3	52.3	63.0

[a]Garces-Yepez et al., 1997.
[b]Body condition score change.
[c]Neutral detergent fiber.