



Protein Supplements for Cattle

*Johnny Rossi and Ronnie Silcox
Extension Animal Scientists - Beef Cattle*

Introduction

Feed is a major portion of the annual production costs of beef cow herds. Cattlemen can normally grow enough forage to meet most of the nutritional needs of the cow herds. However, additional protein and energy are often required to properly balance a ration for growing animals and lactating beef cows. High protein supplements cost more than grains or forages used in feeding the cow herd. Proper selection and efficient use of protein supplements can reduce production costs.

Beef cattle are ruminants, which means they have four stomach compartments. The largest compartment (rumen) contains microorganisms that digest feed. These microorganisms can convert non-protein nitrogen compounds to proteins. This allows cattle to utilize a wide range of feedstuffs to meet protein requirements.

Role of supplemental protein for improving forage intake and digestibility

Forage intake and digestion can be influenced by the crude protein content and the amount of supplement fed each day. High crude protein supplements can stimulate forage intake when the protein content of the forage is less than 7 percent. When crude protein is below 7 percent, rumen bacteria that digest the forage cannot maintain adequate growth rates. Thus, forage intake and digestibility will be decreased. In many cases, forages in Georgia will have protein levels greater than 7 percent and providing supplemental protein will not increase forage intake. Most likely, there will be a substitution effect where forage intake decreases as supplement intake increases. Substitution effects occur when supplements are fed at approximately 0.3 percent of body weight or greater, and the crude protein in the forage is greater than 7 percent.

Designing a protein supplement

Forage testing

A well-designed feeding program starts with forage analysis. Submit a sample to the UGA Feed and Environmental Water Lab. County extension agents have the information and sample forms needed for forage testing. Upon request, an extension animal scientist will also custom balance a ration based on analyses of the forage and feedstuffs available.

Protein requirements and grouping cattle

Cows require protein for normal body maintenance, for growth of hair, horns, hooves, and for pregnancy and milk production. In addition, young cows require protein for growth. Protein deficient diets can dramatically reduce reproduction in young cows. One study showed that first calf heifers fed a protein deficient diet (7 percent CP) before and after calving had a 32 percent rebreeding rate compared with 74 percent in heifers fed a protein adequate diet. A protein deficient diet prior to calving can result in weak calves at birth and decreased production of colostrum. Inadequate colostrum intake can result in decreased calf vigor, decreased growth, and increased death loss.

Symptoms of protein deficiency are weight loss, poor growth, poor reproductive performance, reduced milk production, and decreased appetite. When cattle are fed low-quality forages, total feed intake will usually increase when a high protein supplement is fed with the forage.

The amount of protein required by a cow depends on the stage of reproduction and level of milk production. A dry cow requires less protein than a lactating cow. The highest demands for protein occur shortly after calving, when increased protein is required for milk production and for reconditioning the reproductive tract. Requirements for protein and total digestible nutrients (TDN) are given in Table 1 for mature beef cows. Supplemental protein and energy is often required for cows fed harvested feeds.

Heifers and young cows have higher requirements for protein than mature cows since these animals are

still growing. Table 2 lists requirements for yearling heifers and lactating first-calf heifers. To feed a well-balanced ration and keep costs to a minimum, it is best to group cattle by nutritional requirements. The most efficient feeding program consists of four groups: mature dry cows, mature lactating cows, first-calf heifers, and replacement heifers. With the same base forage, each group will require a different supplementation program.

Table 1. Nutrient Requirements for Mature Beef Cows (Dry Matter) ¹

| Body Weight (lb) | Daily Dry Matter Intake (lbs) | (lbs/day) | TDN ² | | Total Protein | |
|--|----------------------------------|-----------|------------------|-------------|---------------|-------------|
| | | | (lbs/day) | (% of diet) | (lbs/day) | (% of diet) |
| <i>Dry Pregnant – Middle third of pregnancy</i> | | | | | | |
| 1000 | 21.1 | 9.47 | 44.9 | 1.26 | 5.98 | |
| 1200 | 24.2 | 10.87 | 44.9 | 1.45 | 5.99 | |
| 1400 | 27.2 | 12.24 | 45.0 | 1.63 | 6.00 | |
| <i>Dry Pregnant – Last third of pregnancy</i> | | | | | | |
| 1000 | 21.0 | 10.92 | 52.0 | 1.61 | 7.66 | |
| 1200 | 24.1 | 12.60 | 52.3 | 1.86 | 7.73 | |
| 1400 | 27.0 | 14.2 | 52.6 | 2.11 | 7.80 | |
| <i>Cows nursing calves – first 3-4 months after calving – Average milk</i> | | | | | | |
| 1000 | 25.0 | 15.23 | 60.9 | 2.80 | 11.18 | |
| 1200 | 27.8 | 16.65 | 59.9 | 2.97 | 10.69 | |
| 1400 | 30.5 | 18.03 | 59.1 | 3.14 | 10.31 | |
| <i>Cows nursing calving – first 3-4 months after calving – Superior milk</i> | | | | | | |
| 1000 | 27.8 | 17.93 | 64.5 | 3.58 | 12.86 | |
| 1200 | 30.6 | 19.34 | 63.2 | 3.75 | 12.25 | |
| 1400 | 33.3 | 20.71 | 62.2 | 3.92 | 11.77 | |

¹ From: **Nutrient Requirements of Beef Cattle**, seventh revised edition, 1996

² Total Digestible Nutrients

Table 2. Nutrient requirements of pregnant replacement heifers (Dry Matter Basis) ¹

| BodyWt. (lbs) | DailyGain (lbs) | Dry Matter Intake (lbs) | TDN ² | | Total Protein | |
|------------------|--------------------|----------------------------|------------------|-------------|---------------|-------------|
| | | | (lbs/day) | (% of diet) | (lbs/day) | (% of diet) |
| 1000 | 0.73 | 20.7 | 11.76 | 56.8 | 1.81 | 8.74 |
| 1100 | 0.80 | 22.3 | 12.60 | 56.5 | 1.92 | 8.63 |
| 1200 | 0.88 | 23.7 | 13.32 | 56.2 | 2.02 | 8.53 |
| 1300 | 0.95 | 25.2 | 14.11 | 56.0 | 2.13 | 8.45 |
| 1400 | 1.02 | 26.6 | 14.84 | 55.8 | 2.23 | 8.38 |

¹ From: **Nutrient Requirements of Beef Cattle**, seventh revised edition, 1996

² Total Digestible Nutrients

Determining supplementation rates and costs

There are many different and satisfactory ways to supplement protein to beef cows. Since cost, crude protein (CP), and dry matter (DM) content differ with supplement types, base your buying decisions on price per pound of protein or energy, not price per pound of supplement. Cottonseed meal (CSM) at \$190 per ton seems cheaper than soybean meal (SBM) at \$200 per ton. However, calculate the protein value before you decide which to purchase. Use the protein content and percent dry matter of protein supplements listed in Table 3 to determine the cost per unit of protein from the sources. An example would be to compare CSM and SBM at the prices quoted above.

Use the following formula:

$$1. \text{ Unit wt.} \times \frac{\% \text{ DM}}{100} \times \frac{\% \text{ CP}}{100} = \text{lbs. CP/unit}$$

$$2. \frac{\text{Cost/Unit}}{\text{lbs. CP/Unit}} = \text{Value/lb. CP}$$

For a ton of CSM:

$$1. 2000 \times \frac{91}{100} \times \frac{45.2}{100} = 822.6 \text{ lbs. CP/ton CSM}$$

$$2. \frac{\$190/2000 \text{ lbs.}}{822.6 \text{ lbs. CP/2000 lbs.}} = \$0.23/\text{lb CP}$$

For a ton of SBM:

$$1. 2000 \times \frac{90}{100} \times \frac{49}{100} = 882 \text{ lbs. CP/ton CSM}$$

$$2. \frac{\$200/2000 \text{ lbs.}}{882 \text{ lbs. CP/2000 lbs.}} = \$0.227/\text{lb CP}$$

In this example, although CSM is cheaper per ton, SBM is more economical, since cost per pound of protein is less for SBM (\$0.227) than for CSM (\$0.230). Since the dry matter content of the feedstuffs in Table 3 are similar, the as-fed crude protein content can be used to decide which supplement will be the most economical. In addition to considering the price per pound of protein or energy, consider the labor and processing involved with using various supplements. The cost of mixing and feeding sometimes outweighs the difference in value. Computerized ration balancing programs are available through your county Extension agent. A computer program can quickly and accurately compare various protein supplements for meeting requirements at the lowest cost.

Table 3. Composition of Some Common Protein Supplements

| Feed | Dry Matter | Crude Protein | | TDN ¹ | | Calcium | | Phosphorus | |
|-------------------|------------|---------------|-----------------|------------------|------|---------|------|------------|------|
| | | As-fed | DM ² | As-fed | DM | As-fed | DM | As-fed | DM |
| Corn gluten feed | 90 | 18.9 | 21.0 | 72.0 | 80 | 0.06 | 0.07 | 0.77 | 0.85 |
| Cottonseed meal | 91 | 41.1 | 45.2 | 65.5 | 72 | 0.18 | 0.20 | 1.06 | 1.16 |
| Whole cottonseed | 92 | 22.0 | 23.9 | 88.3 | 96 | 0.15 | 0.16 | 0.57 | 0.62 |
| Distillers grains | 90 | 26.6 | 29.5 | 79.2 | 88 | 0.14 | 0.16 | 0.72 | 0.80 |
| Soybean meal, 44% | 90 | 44.9 | 49.9 | 75.6 | 84 | 0.36 | 0.40 | 0.64 | 0.71 |
| Soybean meal, 49% | 90 | 48.6 | 54.0 | 78.3 | 87 | 0.26 | 0.29 | 0.64 | 0.71 |
| Whole Soybeans | 92 | 39.4 | 42.8 | 83.7 | 91 | 0.25 | 0.27 | 0.60 | 0.65 |
| Urea | 100 | 287.0 | 287.0 | ---- | ---- | ---- | ---- | ---- | ---- |

¹ Total Digestible Nutrients

² Dry Matter

Urea use in cattle supplements

Urea is included in beef cattle diets to economically replace a portion of the protein content. Urea is used in many commercial protein supplements and is sometimes used in mixing feed on the farm. If properly used, urea is an inexpensive protein source. It can be toxic to cattle if used improperly.

Urea is best utilized in well-balanced high energy rations with crude protein levels of less than 12 percent. Urea is not well utilized for supplementing low quality forages such as wheat straw, fescue hay or bermudagrass hay. Research summary shows that cows on poor quality winter forages do not perform as well with urea-containing supplements as with cottonseed or soybean meal supplements. Urea can be used as the only source of supplemental protein when cows are wintered on corn silage.

Urea is used most frequently and efficiently in high grain diets because starch in the grain is rapidly digested once it enters the rumen. Bacteria must have sufficient amounts of carbohydrates available in the rumen to make protein. Energy from roughages is digested too slowly for efficient use of urea. Thus, higher levels of urea can be used when cattle are fed grain versus forage-based diets.

In grain-based rations, urea should be fed at no more than 0.25 lbs per day or no greater than 1 percent of the diet. Urea will not be used effectively above this level and the animal must use energy to excrete the excess urea, which will decrease performance. Calves smaller than 400 pounds or younger than 120 days do not use urea effectively. Supply another source of protein to these calves. In addition, do not feed urea-containing supplements to newly received cattle that may have been off feed for a few days. Cattle must be started on feed before introducing urea supplements into their diet.

Mature cows should consume no more than 0.25 pounds of urea per day. Mature cows are consuming roughage and thus cannot use the urea as efficiently as feedlot cattle. However, if forages are extremely low in crude protein (< 5 percent), urea is beneficial in stimulating intake of the forage and improves animal performance. When protein is this low in the forage, there is not enough ammonia released from digestion of the forage to maintain growth of the rumen bacteria. Urea will provide ammonia, which increases growth rates of bacteria. In most situations, cattle are consuming forages that contain enough protein to provide an adequate level of rumen ammonia. Thus, urea is usually a poor source of supplemental protein when fed with most forages grown in Georgia.

Urea is sometimes marketed in a slow release form such as biuret in an attempt to synchronize availability of the urea with availability of carbohydrates from the slowly digested forage. Performance is usually not improved by the use of the slow release products because cattle have the ability to recycle the urea for

use later on. Ammonia that escapes the rumen goes to the liver where it is converted back into urea and is then available for use primarily through the saliva.

One of the biggest obstacles to using urea is the need for thorough mixing. Few producers have the mixing equipment needed to safely mix urea-containing supplements. It is safest to buy a urea containing supplement and then blend the supplement with the remainder of the ration. Do not topdress urea over feed in a bunk.

Urea is toxic to cattle if fed at high levels. When urea enters the rumen, it is rapidly converted into ammonia. This ammonia can be used by microorganisms along with a readily available energy source to produce proteins. If an energy source is limited or if too much urea is consumed, a large proportion of the ammonia enters the blood system. If ammonia enters the blood faster than the liver can remove it, cattle develop ammonia poisoning (urea toxicity). This can result in death in less than 30 minutes. Urea toxicity occurs most frequently due to improper weighing or poor mixing of urea-containing rations. In some cases, urea poisoning occurs when hungry cattle over consume liquid molasses-based supplements containing urea. Cattle will have excessive salivation, tremors, rapid breathing, and tetany prior to dying from urea poisoning. As an emergency treatment, administer one gallon of vinegar as a drench. The acid in the vinegar can help neutralize the ammonia and prevent absorption into the blood.

Follow these precautions when using urea as a feed supplement:

1. Mix feeds thoroughly when urea is used.
2. Do not feed to starving cattle.
3. Feed in conjunction with readily available energy sources, such as grain or molasses.
4. Never offer a feed containing urea to cattle that have access to raw soybeans. Raw soybeans contain urease, which breaks down urea into ammonia, causing a potential ammonia toxicity problem.
5. Do not feed to calves under 400 pounds.

Commercial protein supplements

Several types of commercial supplements on the market such as range cubes, protein blocks, and liquid supplements work well, but usually there are less expensive supplements available. However, for some producers, the convenience of feeding or savings in labor are worth the added cost.

The protein and TDN content of these supplements varies from one manufacturer to another. Base your buying decisions on cost per pound of protein rather than price per pound of supplement. Look for the percent protein on the product label. The label should also indicate how much of the protein is from non-protein nitrogen (urea).

Various methods are used to restrict the intake of blocks and liquid supplements. Intake varies with the type of supplement and availability of forage. Check on the expected consumption before you buy. Some products will supply too little or too much of the required nutrients.

Range cubes or pellets

Several feed companies market range cubes or pellets. These cubes usually contain a mixture of grain, oilseed meal, and mineral by-products, and may or may not contain urea. Protein and TDN content vary with manufacturers, but the TDN content is usually not very high. Cubes are usually scattered on the ground for feeding. Range cubes are usually fed daily, which creates advantages and disadvantages. The advantage is that it gives the producer a chance to check the cows each day; however, daily feeding does require more labor than some other supplementation programs.

Cubes that contain urea should be fed daily. Feeding larger amounts two to three times a week should not be done when cattle are on low quality forage. If done, the urea and energy in the supplement will not be utilized properly by the cattle.

Protein blocks

Protein blocks are a protein supplement compressed into a hardened block which usually weighs from 30 to 500 pounds. Protein blocks are derived from many ingredients and manufacturing processes. The composition of blocks varies, and they may or may not contain urea. Pressed blocks usually contain dry feed ingredients similar to range cubes and are consumed at one to four pounds per day. Chemically hardened blocks are constituted by liquid molasses and dry feed supplements combined in a slurry form and mixed with metal oxides such as calcium and magnesium oxide. The water combines with the metal oxides to form a hard block. The hardness of the block limits intake from one to three pounds per day. Low moisture cooked blocks are widely used and are formed by heating liquid ingredients (molasses) to remove water and then combined with dry ingredients and poured into containers. Low moisture blocks are consumed at the lowest rate among the three types of blocks.

Place blocks in an area of the pasture that cattle use frequently such as the water source. Cows normally take two to three weeks to adjust to blocks. During this period they may consume more or less than desired. If consumption is lower than expected, increase the number of blocks or tubs. Protein blocks rarely supply adequate amounts of supplemental energy for lactating cows fed hay. Closely monitor cow body condition and supplement additional energy as needed.

Liquid protein supplements

Liquid supplements are available from several feed companies and are offered free-choice in a "lick tank."

Liquid supplements are used to provide both supplemental protein and energy. Protein content is usually about 32 percent and varies with suppliers. Consumption is usually restricted by the addition of phosphoric acid.

The major advantage of liquid supplement is that little or no labor is required for feeding. However, cost per pound of protein can be higher than other supplements. Since liquid supplements contain urea, observe precautions for feeding urea. Feed cattle free-choice hay before tanks are placed in the pasture. Once cattle are started on liquid supplements, do not let the tanks run dry. Hungry cattle may consume too much urea from a newly filled tank. Do not feed liquid supplements that contain urea to cows that have access to soybean stubble.

The molasses in liquid supplements provide energy, but this additional energy is usually insufficient for the proper utilization of urea when cattle are consuming low quality pasture or grass hay. Lactating cows may not be able to consume adequate amounts of the liquid supplement to meet energy requirements when consuming a hay diet. Protein requirements are usually met or exceeded when feeding liquid supplements, therefore, additional energy can be supplied by low protein grain such as corn or a by-product feed such as soybean hulls, hominy, or citrus pulp. In addition, liquid supplements can work well in corn silage based rations. Intake of liquid supplements varies considerably among animals. In one study, 17 to 38 percent of cattle did not consume any of the supplement. In a separate study, cows consumed from 0 to 5.6 pounds of liquid supplements per day.

Oil seeds and meals

The cotton and soybean industries are major sources of protein supplements for cattle. Soybean meal (SBM) and cottonseed meal (CSM), two byproducts of the oil industry, are commonly-used protein supplements. Whole, raw soybeans and cottonseed may also be fed to cattle. Oil seed meals or a combination of CSM or SBM and ground corn can be hand-fed daily. A common way to self-feed SBM or CSM as a protein supplement for cows is in salt-limited mixtures sometimes called "hot meal." Cattle on dry forage, such as fall grasses or hay, will consume approximately 0.1 pound of salt per 100 pounds of body weight daily when it is mixed with a palatable feed. A 900-pound cow, for example, will limit her consumption of salt to about 0.9 pounds per day. Another method of feeding protein supplements to reduce labor costs is to feed the supplements every three days. Research has shown that cow performance is equal when providing a three-day supply of protein on one day versus supplementing a day's supply every day.

Table 4. Daily cottonseed meal (41%) and ground corn required with various quality forages.

| Forage Analysis | | Repl.Heifers ¹ (600 lbs.) | Dry Cows ² (1000 to 1200 lbs.) | | Lactating Cows ³ (1000-1200 lbs.) | |
|-----------------|-------|---|--|-----------|---|-----------|
| CP % | TDN % | Lbs. CSM | Lbs. CSM | Lbs. Corn | Lbs. CSM | Lbs. Corn |
| >11.2 | >56 | 0 | 0 | 0 | 0 | 4.0 |
| 9.5 - 11.1 | >56 | 0 | 0 | 0 | 1.0 | 4.0 |
| | 53-56 | 0 | 0 | 1.0 | 1.0 | 5.0 |
| | 50-53 | 0 | 0 | 2.5 | 1.0 | 7.0 |
| 8.2 - 9.5 | 54-56 | 0.5 | 0 | 1.0 | 2.0 | 5.0 |
| | 51-54 | 0.5 | 0 | 2.0 | 5.0 | 6.0 |
| | <50 | 0.5 | 0 | 4.0 | 2.0 | 8.0 |
| 7.3 - 8.2 | 53-55 | 1.0 | 0 | 1.0 | 2.5 | 6.0 |
| | 51-53 | 1.0 | 0 | 2.0 | 2.5 | 7.0 |
| | <50 | 1.0 | 0 | 4.0 | 2.5 | 8.0 |
| 7.3 | <48 | 1.5 to 2.0 | 0.5 | 5.0 | 2.5 | 8.0 |

¹ Heifers should gain 1.25 to 1.5 lbs/day at this rate of supplementation.

² Dry cows in the last one-third of pregnancy.

³ High (20 lb/day) milking cows during the first three months of lactation.

For example, in Table 4, a 1,000 to 1,200-pound lactating cow fed hay that contains 9 percent CP and 55 percent TDN needs two pounds of cottonseed meal and five pounds of corn per day. A salt-limited feed for a cow in this case should contain a ratio of two pounds CSM: 5 pounds corn: 1.1 pounds salt. Figure the percentage of each ingredient as follows:

1. 2 lbs CSM + 5 lbs corn + 1.1 lbs salt = 8.1 lbs total daily

2. $\frac{2 \text{ lbs CSM}}{8.1 \text{ lbs total}} \times 100\% = 25\% \text{ CSM}$

3. $\frac{5 \text{ lbs Corn}}{8.1 \text{ lbs total}} \times 100\% = 61\% \text{ Corn}$

4. $\frac{1.1 \text{ lbs Salt}}{8.1 \text{ lbs total}} \times 100\% = 14\% \text{ Salt}$

The most common oil seed meals are cottonseed meal and soybean meal. These are available through most feed suppliers. Both are excellent protein supplements for cattle, particularly for cattle consuming low quality forages. Base your choice of CSM or SBM on price per pound of protein.

The amount of protein and energy supplementation required for cows depends on the quality of available forages. Forage quality varies greatly with fertilization rate, maturity, and weather damage. Table 4 contains the amount of cottonseed meal and corn required to supplement animals fed free choice with forages of different quality.

Whole cottonseed

Cottonseed can be bought in the fall at cotton gins in some areas of Georgia. The price of cotton seed varies greatly from year to year and location to location. Whole cottonseed is often used to reduce supplemental feeding costs of lactating cows. Whole cottonseed is a unique feed because it can supply protein, energy, and fiber to a diet. Whole cottonseed is approximately 23 percent crude protein, 95 percent TDN, 18 percent fat, and 40 percent neutral detergent fiber. Whole cottonseed is an excellent supplement to poor quality grass hay for dry

and lactating cows because it supplies both energy and protein in a single feed ingredient. Cottonseed can be used in the diets of cows and stocker calves, but should not be fed to young baby calves.

Feeding directions for whole cottonseed

For cows on low quality grass or grass hay, it is typical to feed two to three pounds of cottonseed per day to dry cows and four to five pounds to lactating cows. A forage analysis allows a better estimate of the true need. Each pound of whole cottonseed will provide approximately 0.2 pounds of crude protein and 0.87 pounds of TDN on a dry matter basis. One pound of whole cottonseed has the same amount of protein and energy as a mixture of 0.35 pounds of cottonseed meal and 0.8 pounds of corn. Cottonseed can be included up to seven pounds per day in mature cow diets. This provides 1.5 pounds of supplemental crude protein and 6.1 pounds of TDN. This would provide sufficient supplemental energy and protein for lactating cows fed a diet containing hay that is at least 9 percent crude protein and 50 percent TDN. If supplementation is required beyond seven pounds per day, other feeds must be blended with the whole cottonseed.

Stocker calves cannot be fed as much whole cottonseed in the diet as mature cows. Whole cottonseed should not exceed 15 percent of diet dry matter for stocker calves. When dietary whole cottonseed exceeds 15 percent of diet dry matter, feed intake, daily gains, and feed efficiency are decreased. A trial in North Carolina showed a reduction in daily gains of 0.2 pounds per day when steers were fed a corn silage based diet containing 24 percent whole cottonseed compared with 24 percent of a corn soybean meal mix. When feeding corn-based diets, additional supplemental protein can be derived from either soybean meal, another high protein byproduct feed, or urea.

The high oil content (18 percent) in whole cottonseed can cause digestive problems. The high fat content is the primary limiting factor for inclusion in beef cattle diets. Supplementing cottonseed at the maximum recommended feeding rate (seven pounds per day) will provide 1.1 pounds of supplemental fat, which is the maximum amount that should be fed to prevent significant reductions in fiber digestion.

Cottonseed is difficult to grind and does not mix well for salt-limited feedings. Over-consumption of cottonseed can cause diarrhea. Limiting intake to a maximum of seven pounds per day for mature cows should eliminate diarrhea.

Feeding too much whole cottonseed can potentially cause reproductive problems due to the gossypol contained in the seed. Gossypol is a yellow pigment that is found throughout the cotton plant but the highest concentrations of gossypol are found in the seeds. Gossypol is toxic to cattle if consumed in sufficient quantities. The most common concern of gossypol toxicity is gossypol-induced reproductive failure of the bull. Young developing bulls are more affected than

mature bulls. However, no decline in semen quality was noted when young Brahman bulls were fed a diet that contained 41 percent whole cottonseed (Chase et al., 1994). Females appear to be more resistant to gossypol-induced reproductive failure than bulls. There is no reported data showing impaired fertility caused by recommended feeding levels of cottonseed or cottonseed meal to bulls. Even feeding at twice the recommended level of gossypol showed little negative effect, however, this would be above practical levels of feeding and would reduce growth rates of bulls.

Storage and handling

Grinding cottonseed does not improve digestibility, and this by-product should be fed whole. Hand feeding whole cottonseed in a trough each day prevents over consumption and is the most ideal method of feeding. In dry weather, whole cottonseed may be fed on sod under a temporary electric fence with little wastage. However, feeding in a trough will minimize waste, particularly in damp weather. Cottonseed is very bulky and will not flow through an auger system, and it should not be stored in a grain bin. Whole cottonseed is most easily handled with a scoop or front-end loader. Whole cottonseed should be protected from rain and stored under a shelter that provides good ventilation to prevent moisture accumulation and molding of the cottonseed. Do not feed moldy cottonseed because it may contain aflatoxin, which is toxic to cattle. Allow at least two feet of trough space per head. Cattle producers with large cattle operations should consider building a commodity shed with a concrete floor to store cottonseed and other by-products. Producers with small herds can pick cottonseed up directly from the gin and store the cottonseed in a peanut wagon or any type of gravity flow wagon. The wagon can then be placed near the feeding area and the required amount scooped into a trough each day.

Soybeans

Whole soybeans are usually too expensive to use as a cattle feed, but damaged or immature soybeans are sometimes available. Soybeans are good supplemental sources of both energy and protein for cattle fed hay-based diets and may replace all of the protein supplement in a complete ration. Follow a few precautions when feeding raw soybeans. Soybeans are 94 percent TDN, 40 percent crude protein, and 18 percent fat. The high fat content of soybeans limit their inclusion in the ration because fat can decrease fiber digestion and cause scouring.

Soybeans can be fed raw without any depression in protein digestion. Soybeans must be roasted prior to feeding to swine or poultry to inactivate an inhibitor that depresses protein digestion. However, cattle have rumen microbes that can deactivate the inhibitor and allow the protein to be digested normally. Raw soybeans should not be fed to calves less than four months old because they may not have a fully functional rumen that can deactivate the inhibitor.

The protein in soybeans is used as efficiently as the protein in soybean meal. There is no nutritional advantage to cooking or roasting the soybeans prior to feeding to cattle. Raw soybeans should not be fed to animals that are fed supplements containing urea. Soybeans contain the enzyme urease that rapidly breaks down urea into ammonia. An overload of ammonia can result in toxicity and death of the animal. Remove all liquid supplements, protein blocks, cubes, or mixed feed that contain urea before cattle are fed raw soybeans. The enzyme is destroyed by heat used in processing soybean meal, so feeding soybean meal with urea supplements is not a problem.

Mature raw soybeans can be fed whole with little depression in digestion compared to ground. However, grinding is necessary when feeding small immature beans that were damaged by drought. Soybeans that are ground should be fed within one week because the ground beans become rancid very quickly.

Raw soybeans should be limited to no more than five pounds per day for mature cows. This would supply 1.8 pounds of protein and 4.2 pounds of TDN per day. This is enough supplemental protein for a lactating cow fed hay that is 52 percent TDN or greater. An alternative feed source low in protein such as corn should be fed if more TDN is required. In stocker calf diets, raw soybeans should be limited to no more than 10 percent of the diet dry matter.

Corn by-products

The quantity of corn by-products is rapidly increasing primarily because of increasing ethanol production. Corn by-products are becoming more prevalent sources of feed for beef cattle. Corn gluten feed and distillers grains are two corn co-products that can be used to provide supplemental protein. The composition of these two feeds and unprocessed corn are listed in Table 3. They are both high in protein, energy, and phosphorus and low in starch, which makes them excellent supplements for hay-based diets. Distillers grains are also high in fat, which increases the energy content but limits the amount that can be fed because excess fat can decrease forage digestibility. Starch is the component of corn that is used in the industry to produce ethanol and sweeteners. Therefore, the remaining components (protein, minerals, vitamins, fiber, fat) are concentrated in the corn gluten and distillers grains. Because of the high starch content of corn, depressions in forage intake and digestibility occur when corn is a component of a forage-based diet. Corn gluten feed and distillers grains contain little or no starch, and the depression in forage intake and digestion are much less than for unprocessed corn.

Corn gluten feed

Corn gluten feed is a by-product of the wet milling industry. The wet milling industry isolates starch from corn, which is used to make sweeteners. Gluten feed is

what is left of the corn kernel after the removal of the starch, oil, and gluten. Corn gluten feed consists of bran, germ meal, and solubles that are produced when the grain is soaked during the initial stages of processing. It is produced in a wet form (60 percent water) and dry form (10 percent water). Corn gluten feed is usually pelleted to increase bulk density and decrease transportation costs. Producers in Georgia use the dry form of corn gluten feed.

Distillers grains

Distillers grains are a product of the dry milling industry and are produced primarily from the production of ethanol. In ethanol production, corn is fermented to produce ethanol, carbon dioxide, and spent grains. Liquid is removed from the spent grains, and the grains are then dried to produce dried distillers grains. If the liquid is added to the spent grains before drying, the product produced is dried distillers grains + solubles. There is little difference between the composition and feeding value of the two by-products. Distillers grains have a very small particle size and are usually fed in the loose form. Distillers grains should be stored out of the wind to avoid large storage losses.

Feeding directions for corn by-products

The low starch content and high protein and energy levels make these ideal supplements for poor quality hay. For example, a diet based on low quality bermudagrass hay containing 7 percent crude protein could be balanced by feeding 5.5 pounds per day of corn gluten feed to a dry cow and 8 pounds per day to a lactating cow. Likewise, the same low quality hay would require 5 pounds per day of corn gluten feed for a dry cow and 7.2 pounds for a lactating cow. Distillers grains require less total feed to balance the diet than corn gluten feed because they contain higher levels of protein and energy. However, feed costs may not be reduced because the price is usually greater for distillers grains than for gluten feed.

Winter annuals

Winter annuals such as oats, rye, wheat, and ryegrass are high in energy and protein. When properly managed, they range from 17 to 22 percent crude protein and 70 to 75 percent digestibility (dry matter basis). Establishment of winter grazing is expensive; however, limited grazing of these forages can be an economical supplement for low quality forages.

Rye will usually produce more total forage than other winter annuals. Rye can be planted earlier in the fall and is more drought and cold tolerant than other small grains. Wheat and oats produce forage later in the spring than rye. Ryegrass produces most of its growth in late winter and spring, as do arrowleaf and crimson clover. These winter annuals have different growth characteristics; therefore, mixtures are often planted.

A cow can consume 1.5 to 2 times the amount of protein and energy needed in a day with continuous access to pasture. To avoid overfeeding the cow, most producers limit-graze the winter pasture and feed lower quality hay to meet the cow's nutrient needs. In addition to decreasing hay needs, the need for protein supplements should be eliminated, which reduces winter feeding costs. The most popular method of grazing cows on winter pasture is limit-grazing a few hours every day. However, satisfactory results can be obtained by grazing as little as every other day or just two or three days per week. Research has shown that grazing lactating cows for seven hours per day for either two or three days per week eliminates the need for a protein supplement and decreases hay needs by 15 to 25 percent. This system will only work if forage availability is adequate; otherwise, cow condition will suffer. Rye, oat, and wheat pastures may not provide enough grazing beyond the first of April to continue using this system. Ryegrass may extend the spring grazing season beyond rye to oats. Irrigation or rainfall becomes critical to length of time ryegrass can be grazed in spring. If your breeding season is in the spring, high quality hay and/or supplemental feeds must be used if permanent pastures are not yet ready for grazing. Pregnancy rates will likely be decreased if cows are grazing depleted winter pasture and fed poor quality hay. Limiting the time that cows graze the winter annual pasture decreases trampling and reduces the amount of grazing required per cow.

One acre of winter pasture should provide enough forage for three or four cows. This will vary with the weather, cow size, forage type, and management. Keep in mind that establishing winter pasture is very expensive. Winter pasture costs about \$100 per acre, which results in \$25 to \$30 per cow in winter feeding costs. Reductions in hay consumption and supplemental feed should be \$40 to \$50 per cow. Therefore, winter pasture can reduce winter feeding costs by about \$25 per cow.

Continuous grazing of winter annuals is rare, but has been tested in some research trials. In one study, cows were wintered using 1.25 acres of winter rye and wheat plus hay or wintered with hay and supplemental grain only. Allowing cows to graze winter pasture reduced the amount of hay fed by 30 percent, and reduced the supplemental grain by 22 percent. However, the feed savings were not enough to overcome the high costs of pasture establishment. Continuous grazing of mature cows on winter pasture is seldom, if ever, an economical way to utilize this high quality forage. The best results have been with limit grazing cows at about three cows per acre.

New research has shown that high levels of protein in winter annual forages can reduce reproductive efficiency (Beck et al., 2005). Most winter annual pastures (wheat, rye, ryegrass) are very high in protein. When protein is degraded in the rumen, it is degraded into ammonia that is then transported to the liver where it is converted into urea. This will increase the blood urea nitrogen (BUN) levels. When BUN is elevated, reduced reproductive efficiency has been observed. It

has been shown that the high levels of urea in the blood will reduce the pH in the uterus causing poor fetal survivability in early pregnancy. This has only been documented when cows have continuous access to lush pasture. Reductions in pregnancy rates of approximately 20 percent have been observed mostly in dairy cows with high levels of BUN. A study conducted at the University of Arkansas compared the reproductive efficiency of heifers grazed on either wheat and ryegrass pastures or fed a drylot ration of 75 percent grain and 25 percent hay (Beck et al., 2005). Heifers were grazed or fed the grain-based ration for five months prior to breeding. Daily gain of the heifers was approximately 1.22 lb/day for each group. Heifers were synchronized and artificially inseminated (AI) once and then clean-up bulls were placed with the heifers for 56 days. There were no statistically significant difference in either AI or overall pregnancy rates between the two groups. However, some trends were noticed in pregnancy rates as overall pregnancy rates for grain fed heifers was 88 percent and pregnancy rates for heifers that grazed wheat and ryegrass pastures was 69 percent. Heifers that grazed the winter annuals calved 14 days later than heifers fed the grain-based diet during development. Conceiving early in the breeding season is especially important for heifers as this will allow them more time to breed back after having their first calf.

The reduced pregnancy rates from grazing winter annual pastures have only been observed when animals had continuous access to the pasture. Often, cows are limit grazed a few hours a day and supplemented with hay. There should be little or no problems with reproduction when using this feeding strategy. If animals are allowed to graze continuously during the early part of the breeding season then do not feed any supplemental protein. There may be some alleviation of the problem if low protein grains such as corn is fed during this time to increase the use of nitrogen in the rumen, which should lower BUN levels.

Protein supplementation of cows

Generally, cows will only require supplemental protein when lactating and fed low protein hay or silage. The first step in supplementing the lactating cow is to conduct a forage test to determine the crude protein of the forage. A protein supplement can then be chosen that is both economical and consumed at a level that will deliver the correct amount of supplemental protein to the cow. Even though protein requirements are low for pregnant cows, some hay may require protein supplementation when fed to gestating cows. Protein deficiency in late gestation can lead to poor health of the newborn calf, reduced body condition of the cow, and reduced conception rates. It is recommended to test all hay that is fed to the cow herd and to feed the lowest protein hay to the early-gestating cows. Cows are sometimes allowed to graze bermudagrass in the late

fall and early winter that has been stockpiled for two to three months prior to grazing. When the bermudagrass was fertilized prior to stockpiling, research has not shown any benefit to feeding a protein supplement to gestating cows when grazing these pastures. Producers should use caution when using stockpiled bermudagrass for lactating cows, as energy and protein will likely be deficient and significant supplementation may be required. Stockpiled bermudagrass pasture is generally lower in TDN and quality than stockpiled tall fescue pastures.

Protein supplementation for creep feeds

Creep feeds should be at least 15 percent crude protein or greater. Research on varying levels of protein is limited but high protein creep feeds may offer an advantage. An Illinois study compared creep feed protein levels of approximately 10, 20, and 30 percent using corn and soybean meal in varying amounts. Composition of diets are shown in Table 5, and performance is shown in Table 6. Daily gain of creep-fed calves averaged 0.94 pounds per day greater than non-creep-fed calves. Daily gains increased as protein level in the diet increased. However, the more soybean meal added to the ration, the more expensive the ration. Another option is to limit intake of a high protein creep feed to about 1 pound per day. Intake of the creep feed is limited by adding 8 to 10 percent salt to a high protein feed such as cottonseed meal. Research has shown that creep-fed calves gain about 30 pounds more than non-creep-fed calves with a cost of about \$0.25 per pound of added gain. This option is best used when there is an abundant supply of forage available since protein feed (cottonseed meal or soybean meal) improves forage intake and digestibility. On the other hand, high energy creep feeds are best used when forage availability is limiting such as during a drought. When feeding the salt-limited creep feeds, the salt level should be 0 to 5 percent until calves begin eating the creep feed. This will take two to three weeks. The salt level can then be increased to keep consumption around 1.0 lb per day.

Table 5. Composition of creep feed rations.

| Creep diet | Crude protein, % | | |
|--------------|------------------|------|------|
| | 10 | 20 | 30 |
| Cracked corn | 97 | 72 | 47 |
| Soybean meal | — | 25 | 50 |
| Molasses | 3 | 3 | 3 |
| % CP | 9.1 | 18.8 | 28.5 |

Table 6. Performance of creep-fed calves.

| Item | Crude protein, % | | | |
|--|------------------|------|------|------|
| | No-creep | 10 | 20 | 30 |
| Initial wt, lb | 312 | 315 | 324 | 322 |
| Final wt, lb | 366 | 403 | 436 | 438 |
| Gain, lb | 54 | 88 | 112 | 116 |
| Summer gain, lb/d | 0.88 | 1.45 | 1.84 | 2.17 |
| Creep intake, lb/d | 0 | 5.2 | 5.7 | 5.7 |
| Creep conversion (lbs creep/lb added gain) | — | 9.1 | 5.7 | 4.4 |

Protein supplementation of stocker calves

Summer pastures

Bermudagrass is the predominant warm-season perennial grass that is used to stocker calves during the summer months. Tifton 85 is a hybrid bermudagrass that has greater yields and digestibility than Coastal bermudagrass. Calves require supplementation with a highly digestible grain source when grazing bermudagrass pastures to gain at an economical rate. Without supplementation, stocker calves usually gain about 1.0 lb per day when grazing Coastal bermudagrass, but gains increase to 1.5 pounds or greater per day when grazing Tifton 85 bermudagrass. Research has shown that calves should be fed a high protein (> 20 percent) supplement when grazing bermudagrass pastures. Several research studies have examined the effects of feeding high protein supplements to stocker calves grazing Coastal and Tifton 85 bermudagrass.

A study was conducted at Texas A&M University to evaluate stocker calf gains on Coastal and Tifton 85 bermudagrass with or without supplementation. Fall-born steers and heifers weaned in June started grazing Tifton 85 bermudagrass pastures (three head/acre) on July 3. Calves in the supplement groups were fed 2 pounds per day of a 28 percent crude protein supplement that consisted of a 1:1 ratio of soybean meal to ground corn containing an ionophore (Rumensin®). Results of the experiment are shown in Table 7. Calves grazing Tifton 85 bermudagrass gained approximately 0.75 pounds per day more than calves grazing Coastal bermudagrass. Supplementation increased gains by one-third of a pound and feed conversions (pounds of supplement per pound of added gain) were 6.1 pounds of feed for calves grazing Tifton 85 bermudagrass and 6.9 pounds of feed for calves grazing Coastal bermudagrass. This study clearly shows that Tifton 85 is superior to Coastal bermudagrass for stocker calves.

A second study was also conducted at Texas A&M University to evaluate supplement level for stockers grazing Tifton 85 bermudagrass. Fall-born steers and heifers were weaned in June and started grazing Tifton 85 bermudagrass pastures on July 1. Calves weighed 760 pounds when the trial started. Calves were stocked at 3.6 head per acre and fed a supplement at either 0, 0.2, 0.4, or 0.8 percent of body weight for 90 days. The supplement was 36 percent crude protein and consisted of a 2:1 ratio of soybean meal to corn. The supplement contained an ionophore (Rumensin®) and calves were implanted prior to the start of the experiment. Results of the experiment are shown in Table 8. Daily gains increased with increasing supplement level. Efficiency of supplementation was not reduced when fed up to 0.8 percent of body weight. Thus, supplement cost per pound of gain was similar among supplement treatments.

Both trials showed that feed efficiency was six to seven pounds of feed per pound of gain for calves fed the high protein supplements. These supplements would cost \$0.08 to \$0.10 per pound in most years. This would result in supplement cost of gain between \$0.50 and \$0.70 per pound of gain. You must account for both supplement cost of gain and the value of additional weight when deciding how much supplement to feed. When grazing Tifton 85, stocker calves should be fed supplement at 0.25 to 0.5 percent of body weight to achieve gains of 1.8 to 2.2 pounds per day. Supplementation rates of 0.5 to 1.0 percent of body weight should yield gains of 2.2 to 2.6 pounds per day. Adequate forage must be available at all times for calves to achieve these gains.

Winter annual pastures

Stocker calves are often allowed to continuously graze winter annual pastures. The protein level of these forages can be greater than 20 percent crude protein, which far exceeds the animals requirement. However, most of the protein in winter annual forages is highly soluble and does not reach the small intestine for absorption. There is too little energy available in the rumen for the bacteria to convert the nitrogen into protein that can be used by the animal. Research has shown that feeding protein supplements that escape rumen degradation and are absorbed in the small intestines can increase daily gains of calves grazing winter annual pastures. In a Georgia trial, calves grazing wheat pasture were fed a supplement that supplied 3.25 pounds per day corn, or a supplement that supplied 2 pounds of corn, 0.8 pounds of distillers grains, and 0.5 pounds per day fish meal per day. Calves fed the high-protein supplement gained 0.3 pounds per day more than calves fed only corn. Since protein is more expensive than energy, cost of the protein supplement should be the determining factor when considering which supplement mix to use.

Table 7. Daily gain, gain per acre, and supplement efficiency of stocker calves grazing Tifton 85 or Coastal bermudagrass and fed 2 pound per day supplement.

| Pasture | Daily gain | Gain per acre | Lb feed per lb of gain |
|--------------------------|------------|---------------|------------------------|
| Coastal, no supplement | 1.11 | 279 | — |
| Coastal + supplement | 1.43 | 360 | 6.9 |
| Tifton 85, no supplement | 1.85 | 465 | — |
| Tifton 85 + supplement | 2.21 | 550 | 6.1 |

Adapted from Rouquette et al., 2002

Table 8. Performance, supplement intake, and supplement efficiency of stocker calves grazing Tifton 85 bermudagrass.

| Item | Supplement, % of body weight | | | |
|--|------------------------------|------|------|------|
| | 0.0 | 0.2 | 0.4 | 0.8 |
| Daily gain, 90 days | 1.55 | 1.79 | 2.02 | 2.44 |
| Supplement intake, lb/day | — | 1.64 | 3.22 | 6.44 |
| Supplement efficiency, lb feed/lb added gain | — | 6.83 | 6.85 | 7.24 |

Adapted from Woods et al., 2004

Summary

Purchased feeds represent a major cost in beef cattle production. There are several types of supplemental protein available for beef cows. Prices on these feeds vary greatly. There are several ways to reduce the cost of feeding the cow herd. An analysis of available forages will allow for proper balancing of the ration and can prevent overfeeding. Group cattle and feed according to nutritional requirements. Purchase supplements based on price per unit of protein or energy. In addition, consider the cost of labor and additional processing. With self-fed supplements, adequate forage needs to be available to prevent costly over-consumption of supplements. Protein supplements are used for the cow only during the winter feeding period to supplement poor quality hay or low protein silages. Stocker calf gains when grazing summer pastures can be increased by feeding high protein supplements. For more information contact your local county Extension agent.

Literature cited

- Beck, P.A., S.A. Gunter, J.M. Phillips, and D.L. Kreider. 2005. Development of beef heifers using programmed feeding. *The Prof. Anim. Sci.* 21:365-370.
- Blecha, F., R.C. Bull, D.P. Olson, R.H. Ross, and S. Curtis. 1981. Effects of prepartum protein restriction in the beef cow on immunoglobulin content in blood and colostrum whey and subsequent immunoglobulin absorption by the neonatal calf. *J. Anim. Sci.* 53:1174.
- Brown, W.F. 1991. *Hay ammoniation and energy/protein supplementation for heifer development*. In: 40th Annual Florida Beef Cattle Short Course Proceedings; Gainesville, Fla. University of Florida (Gainesville): Animal Science Department. pg.196.
- Chase, C.C., Jr., P. Bastidas, J.L. Ruttle, C.R. Long, and R.D. Randel. 1994. Growth and reproductive development in Brahman bulls fed diets containing gossypol. *J. Anim. Sci.* 72:445-452.
- Machen, R., J. Drouillard, and J. Harris. *Block and tub supplements for grazing beef cattle*. Texas Cooperative Extension. E-178.
- M. A. McCann, R. S. Donaldson, H. E. Amos, and C. S. Hoveland. 1991. Ruminal escape protein supplementation and zeranol implantation effects on performance of steers grazing winter annuals. *J. Anim. Sci.* 69: 3112-3117.
- Nutrient requirements of beef cattle*. 1996. Washington, D.C. National Research Council.
- Rouquette, F.M., Jr., J.L. Kerby, G.H. Nimr, and W.C. Ellis. 2002. Tifton 85, Coastal bermudagrass, and supplement for backgrounding fall born calves during the summer. *Beef Cattle Research in TX.* pg. 62-66.
- Sasser, R.G., R.J. Williams, R.C. Bull, C.A. Ruder, and D.G. Falk. 1988. Postpartum reproductive performance in crude protein restricted beef cows: return to estrus and conception. *J. Anim. Sci.* 66:3033-3039.
- Woods, S.A, F.M. Rouquette, Jr., G.E Carstens, J.L. Kerby, G.H. Nimr, T.D.A. Forbes, and W.C. Ellis. 2004. Effects of level of protein supplement intake on performance of crossbred calves grazing Tifton 85 bermudagrass. *Beef Cattle Research in TX.* pg. 75-78.



Replaces C807

The University of Georgia and Ft. Valley State University, the U.S. Department of Agriculture and counties of the state cooperating. Cooperative Extension, the University of Georgia College of Agricultural and Environmental Sciences, offers educational programs, assistance and materials to all people without regard to race, color, national origin, age, gender or disability.

**An Equal Opportunity Employer/Affirmative Action Organization
Committed to a Diverse Work Force**

Bulletin 1322

January 2007

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, The University of Georgia College of Agricultural and Environmental Sciences and the U.S. Department of Agriculture cooperating.

J. Scott Angle, Dean and Director