

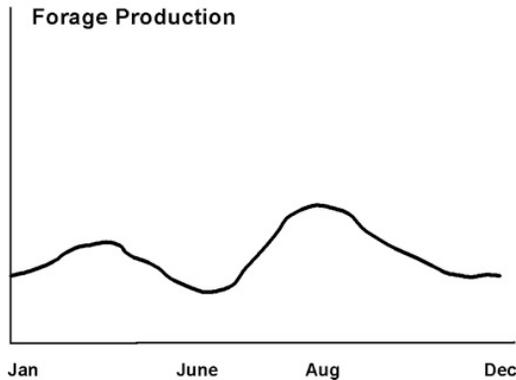
# PROTEIN SUPPLEMENTATION

Jim E. Sprinkle

## Introduction

Much of Arizona can be characterized as having a bimodal (occurring twice per year) pattern of forage production which accompanies the seasonal summer monsoons and winter rains or snows. Forage quantity and quality decreases during the winter dormant season and the "summer slump" preceding summer rains (Figure 1). However, forage quality during any

Figure 1. Forage Production in Arizona



given month can be quite variable, depending upon the timing, frequency, amount of moisture, and the forage type selected. This is illustrated in the following table.

Table 1. Range in Crude Protein by Month  
Blue Grama in Arizona

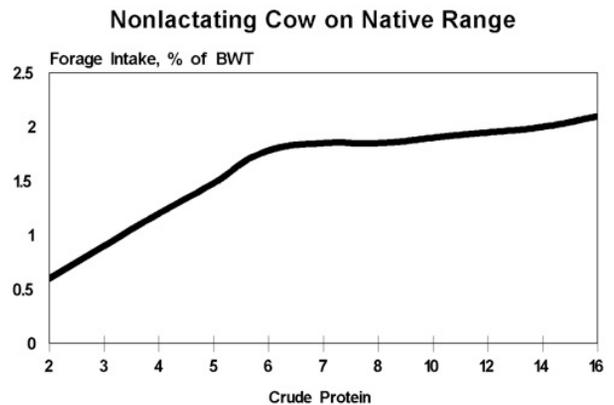
Month of Year	Number of Observations	Crude Protein, %
January	2	3.94 - 7.55
February	5	1.58 - 6.9
March	3	2.57 - 7.3
April	3	4.55 - 7.9
May	5	1.92 - 9.3
June	3	5.59 - 9.0
July	4	4.45 - 8.6
August	6	4.42 - 9.43
September	4	4.76 - 12.5
October	2	6.0 - 7.4
November	7	3.03 - 6.7
December	2	4.5 - 7.13

1979, 1980-81, 1995-96

## Determining When to Supplement Protein

Generally speaking, crude protein content required in the forage to meet the requirements of ruminal microbes which digest fiber is around 7%. When crude protein in forage is below around 6.25%, forage intake for the nonlactating cow drops sharply (Figure 2).

Figure 2. Effect of Crude Protein on Forage Intake



Adapted from: Cochran, 1995 KSU Range Field Day

Providing supplemental protein when crude protein is less than 6.25% can increase forage intake and sometimes forage digestibility, reduce weight loss before calving, and ultimately increase conception rate and profitability.

If the Total Digestible Nutrients (TDN) of forage is around 52 to 55%, forage intake required to maintain a nonlactating cow is around 1.8 to 2.1% of body weight or 18 to 20 lbs. **This is true whether protein requirements are being met by the forage or by feeding supplemental protein.** If protein is deficient in the diet, severe weight loss can occur because the cow must break down body tissue to supply the necessary protein. It takes 6.7 lbs. of lean tissue to supply 1 lb. of protein (Berg and Butterfield, 1976). Conversely, if the diet is deficient in energy (TDN), this only requires 1 lb. of body weight loss for each 1 lb. of TDN (NRC, 1989). As shown in the graph above, when forage fails to meet protein requirements of the microbes in the rumen, intake decreases. This is because microbe numbers and(or) microbe activity decrease, reducing forage digestibility

and increasing exit time from the rumen for fiber. When the forage only contains 4% crude protein, the above graph projects forage intake of only 1.2% of body weight. Forage intake at this level would cause extreme weight loss. Ignoring deficient protein and only considering the energy deficit, weight loss in the above example could exceed 4 lbs. per day.

As a general rule, do not supplement protein when the forage contains greater than 6.25% crude protein (Caton et al., 1988). However, benefits will be gained by protein supplementation when crude protein in forage is low. This principle is illustrated by the tables below. In the first example (Table 2), forage intake and overall nutrient intake increased by 27% when steers on a 6% crude protein hay diet received additional protein. In the second example (Table 3), supplementing steers grazing tobosa grass was only beneficial when the forage contained less than 7% crude protein.

Obviously, the only way to decide whether you need to supplement crude protein is to test forage for protein content. Your local Extension office can provide a list of commercial labs that perform this service. The cost for crude protein and TDN analyses totals around \$25. Alternatively, near infrared spectroscopy (NIRS) analyses can be performed on fecal samples, provided the cow's diet does not exceed 30% browse. This service is provided by Texas A&M University Grazingland Animal Nutrition Lab at Temple, TX (phone 254-774-6134; <http://cnrit.tamu.edu/ganlab/>.)

It should be mentioned that protein supplementation is only effective when an adequate quantity of forage is available. The strategy when supplementing protein is to feed the microbes enough protein to enable the cow to more effectively process and harvest cheap low-quality forage. When forage utilization (removal of available quantity by livestock, wildlife, and insects) exceeds 50% of the total mass, protein supplementation may be ineffective and expensive. In this scenario, it would be more advantageous to feed a combination protein/energy supplement. The next two graphs support this point. In the first graph, (Figure 3) researchers found that maximum animal gain per acre was achieved when forage utilization was 40 to 50%. Animal performance dropped sharply when forage

**Table 3. Protein Supplementation with Cottonseed Meal Steers Grazing Tobosa**

Amount CSM, lbs.	Cost/Day (.114¢/lb.)	ADG	Extra Gain with CSM	Profit/Day (70¢/lb. calf)
<b>1985*</b>				
*(Crude protein below 7% in July)				
0	0	0.84		
0.75	0.09	0.97	0.13	0
1.5	0.17	1.48	0.64	0.28
<b>1986</b>				
0	0	1.43		
0.75	0.09	1.45	0.02	-0.07
1.5	0.17	1.57	0.14	-0.07
<b>1987</b>				
0	0	2.16		
0.75	0.09	2.38	0.22	0.07
1.5	0.17	2.36	0.20	-0.03

Adapted from Pitts et al., 1992: Journal Range Mgmt. 45:226-231.

utilization reached the 60% level. The standard rule of range management for plant health is "to take 1/2 and leave 1/2". This is also good animal management. In the second graph (Figure 4), an experiment was conducted with protein supplementation on mid-grass prairie at two different stocking rates. In the heavy stocking rate regimen, protein supplementation was not economically sound.

The ideal time to supplement protein in terms of a cow's physiological cycle is 60 to 90 days before calving. This is the time period when maintenance requirements are low and you receive the biggest "bang for your buck" in preventing weight loss and increasing conception rate. In most of Arizona with traditional spring calving, this accompanies the forage winter dormancy period. It is an expensive proposition to try to put on weight after calving as Mother Nature is working against you. The demands of early lactation induce weight loss, which is almost impossible to reverse until after about day 45 to 60 of lactation. It is a more cost-effective practice to have the cow maintain or put on weight before calving to provide a safety cushion for weight loss. The table below illustrates the importance of having cattle in good body condition at calving.

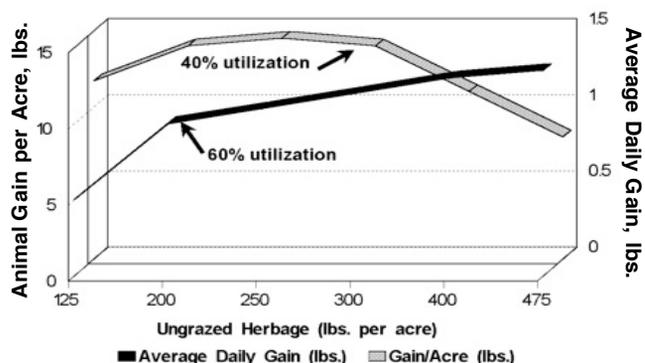
**Table 2. Cottonseed Meal Supplementation**

Steers Fed 6% Crude Protein Prairie Hay

Experimental Group	Rumen Digestibility	Forage Intake Increase	Net Effect
Supplemented	57 %	+ 27%	+ 9% increase in nutrient utilization
Control	48.8%		

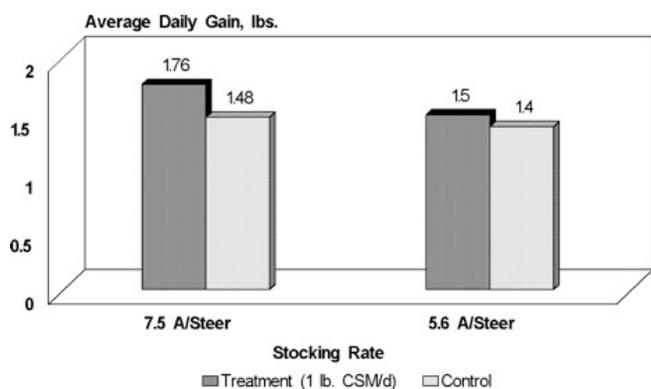
McCollum and Galyean, 1985 Journal Anim. Sci. 60:570.

**Figure 3. Animal Performance & Stocking Rate Upland Blue Grama Range in Colorado**



Adapted from: Bement, 1969 Journal of Range Mgmt. 22:83-86.

**Figure 4. Effect of Stocking Rate Upon Cottonseed Meal Supplementation**



McCollum et al., 1992 Marvin Klemme Range Res. Sta. Report, OK

This research was done with two-year-old cows in LA, OK, and SC, but the results are similar to those in other states. If in spite of your best efforts, cattle are thin at calving, opportunities may exist to “flush” British and Continental cross cattle with better quality pastures and(or) supplements following peak lactation (around 60 to 70 days). This stage of lactation would accompany the forage “summer slump” time period for many Arizona ranching operations. If cattle have sufficient body fat reserves at calving they may safely coast through the summer slump and maintain acceptable conception rates. However, if cattle are below a body condition score of 4 at breeding time, it may be time to consider using a protein supplement if forage quality is low. Unfortunately, flushing thin cattle following peak lactation does not seem to work for Brahman cross cattle. Research in Australia has shown that lactating Brahman cattle often put the energy obtained from supplements into milk production instead of body fat (Hunter, 1991). This would suggest that the only opportunity one has for increasing fat stores for grazing Brahman cross cattle is before calving.

**Table 4. Pregnancy % by Body Condition Score**

Body Condition at Calving	Day 40 of Breeding Season	Day 60 of Breeding Season
4	43 ± 5	56 ± 5
5	65 ± 4	80 ± 4
6	90 ± 9	96 ± 8

Spitzer et al., May 1995. Journal of Animal Science

## How Much Supplement to Feed

The most cost effective method in feeding protein supplements is to supplement what is deficient in the forage (amount of protein required by animal - amount contained in forage). Guidelines for doing this are contained in University of Arizona Cooperative Extension Publication az9523 (Sprinkle, 2011). The maintenance requirements for a 1,000 lb. cow are listed in Table 5, but requirements will differ for different size cows and for different milk production. As an example in calculating the amount of protein to supplement, forage crude protein was tested and found to be 4%. For a 1,000 lb. nonlactating cow, the amount of protein that needs to be fed is 2.32 lbs. per day, which is calculated below.

1. Find the daily requirement for crude protein, which is 1.6 lbs.
2. Determine the amount contained in forage. If we estimate forage intake to increase to 1.7% of body weight for the supplemented cow, then crude protein in the forage is .68 lbs. (1,000 x .017 = 17 lbs; 17 x .04 crude protein in forage = .68 lbs. of protein)
3. Subtract the amount contained in forage from the daily requirement, which gives .92 lbs. of protein that need to be supplemented. (1.6 - .68 = .92 lbs. of protein needed)
4. Determine the amount of supplement to feed by dividing the amount of protein needed by the protein content of the supplement. If we feed cottonseed meal (44% crude protein), then 2.09 lbs. cottonseed meal would need to be fed on a dry matter basis (.92 lbs. protein ÷ .44 crude protein/lb csm = 2.09 lbs. cottonseed meal)
5. Because most protein supplements contain about 10% water, convert feed on a dry matter basis to an “as fed” basis. This would require the feeding of 2.32 lbs. of cottonseed meal per day to meet protein requirements. (2.09 ÷ .9 = 2.32 lbs. cottonseed meal)

The protein could be fed once a week (7 times the daily rate) without harming the cow (Huston et al., 1999). Ruminant animals have an ability to recycle some of the excess nitrogen contained in protein back to the rumen after it is consumed the first time

**Table 5. Maintenance Requirements of Range Cattle**

	Energy TDN	Protein % in diet or lbs.
• Nonlactating, Mid-Pregnancy	9.1 lbs.	7.0 or 1.40
• Nonlactating, Last Trimester	11.0 lbs.	7.9 or 1.60
• Early Lactation, 18 lbs. milk	16.5 lbs.	11.0 or 2.24
• Mid-Lactation, 10 lbs. milk	14.0 lbs.	9.6 or 2.00
• Late Lactation, 7 lbs. milk	12.8 lbs.	9.5 or 1.90

(1000 lb. cow)

(Owens and Zinn, 1988). **Do not feed energy (high grain, protein less than 22%) supplements with less than daily feeding or problems like acidosis and founder can occur.**

## What Kind of Protein Supplement to Use

The greatest benefits for protein supplements are usually obtained with high protein of a natural origin (no protein from urea). These type of supplements are also the most expensive to use. A portion of the protein can be obtained from urea in order to cheapen the protein supplement. Too much urea in the supplement can result in reduced intake of the supplement because of palatability problems or urea toxicity if cattle consume too much of the supplement. Recommendations for urea substitution of natural protein will be discussed later.

It is important to know the ideal composition of protein supplements to feed. Although we know very little concerning the ideal amino acid profiles, research has identified the advantage of using supplements with greater crude protein. When five trials in Kansas were summarized, researchers found that increasing crude protein of the supplement from 15 to 22 to 28% resulted in 49% greater forage intake and 22% greater forage digestion (as cited by Paterson et al., 1996). Kansas researchers also found that cattle fed a 13% crude protein supplement lost 193 lbs. over the winter and cattle fed a 39% crude protein ration lost 97 lbs. over the winter (DelCurto et al., 1990).

In stressful situations in which cattle are losing weight, some benefits have been demonstrated by feeding supplements with approximately 40 to 60% of the protein being ruminally undegradable or bypass protein. Feedstuffs high in bypass protein include feather meal, corn gluten meal, and fish meal. Due to palatability problems, rendered animal products are usually limited to 25 to 30% of the total supplement and are combined with grain products to increase palatability. Petersen et al. (1996) reported that weight loss has been reduced and conception rates increased in several experiments by feeding bypass protein. However, they reported that bypass protein supplementation only seems to be effective when animals are losing weight. The additional cost per ton for adding bypass protein is around \$50 to \$80.

When urea is substituted for natural protein in the supplement, it is recommended that no more than 30% of the crude protein in the supplement come from urea (Köster et al., 1996). The table below from research in Kansas represents a slight decrease in cow performance when the percentage of crude protein derived from urea was 30%. If forage quality is very low and the supply of forage limited (as in drought) avoid the feeding of any urea at all.

Liquid feed supplements can be expected to yield similar results to dry supplements. If the supplement does not contain sufficient protein (less than 22% crude protein) it can be expected to perform as an energy supplement. Usually, energy supplements result in substitution of forage by the supplement and can decrease both forage intake and forage digestibility (Caton and Dhuyvetter, 1997). Urea is often added to liquid supplements to increase crude protein. Modern technology has devised an urea molecule (biuret) that breaks down more slowly than the urea molecule used in past formulations. This has

reduced the danger of urea toxicity for liquid feeds. Assumptions made above for dry feeds on the percentage of urea included in feeds and their effect upon performance are probably also valid for liquid feeds. This is illustrated by the graph below. Incremental increases in pregnancy rate were achieved by increasing protein of the molasses supplement by urea and then by cottonseed meal plus urea.

In a presentation given to the American Feed Industry Association in 1995, J.E. Moore made the following conclusions concerning the use of liquid feeds.

1. When forage quality was low, forage intake and average daily gain (ADG) increased but ADG could still be low or negative.
2. When forage quality was high, forage intake decreased, but ADG increased if supplement contained meal + urea or meal.
3. Forage intake decreased if forage intake was greater than 1.75% of body weight.
4. Forage intake increased if forage intake was less than 1.75% of body weight.
5. Forage intake decreased if supplement intake exceeded .8% of body weight (about 8 lbs. for a 1000 lb. cow).
6. Forage intake increased when crude protein of the supplement was greater than 22%.
7. Liquid feeds acted similarly to dry supplements for forage intake..

## Deciding Which Supplement to Buy

The way to evaluate protein supplement purchases is to calculate the cost of each lb. of protein dispensed. This is illustrated below for one supplement fed once a week at seven times the daily rate vs. another supplement that is self fed.

### Deciding Which Supplement to Buy

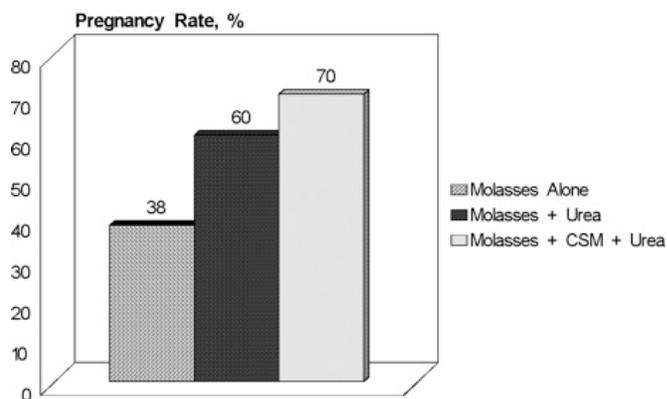
Supplement A: Fed once/wk (2 lbs./d x 7 = 14 lbs/ feeding)

Supplement B: Self fed (2.5 lbs/day)

1. Determine protein content of supplements:
  - Supp. A: 44% CP x 2000 lb. = 880 lb. protein
  - Supp. B: 36% CP x 2000 lb. = 720 lb. protein
2. Determine the cost/lb. protein:
  - Supp. A: \$228/T or  $228 \div 880 \text{ lb.} = \$ .26/\text{lb. protein}$
  - Supp. B: \$260/T or  $260 \div 720 \text{ lb.} = \$ .36/\text{lb. protein}$
3. Determine the cost of dispensing supplements:
  - Supp. A: \$70/T or  $70 \div 880 = \$ .08/\text{lb. protein}$
  - Supp. B: \$20/T or  $20 \div 720 = \$ .03/\text{lb. protein}$
4. Determine protein each cow eats each day:
  - Supp. A: 2 lbs. x .44 = .88 lb. protein
  - Supp. B: 2.5 lbs. x .36 = .90 lb. protein
5. Determine the cost/cow/day:
  - Supp. A: .88 lbs. protein x (.26 + .08) = \$ .34/day
  - Supp. B: .90 lbs. protein x (.36 + .03) = \$ .35/day
6. Determine the cost for the herd:
  - Supp. A: \$ .34 x 60 d x 100 cows = \$ 2040
  - Supp. B: \$ .35 x 60 d x 100 cows = \$ 2100

**Figure 5. Molasses Supplements**

**3-Yr-Old Cows Fed Stargrass Hay (4 - 6% CP)**



Pate et al., 1990 Journal Anim. Sci. 68:618-623.

In the above example, costs are similar, so a management decision needs to be made. If the producer desired to look at his herd more often, then he might opt for Supplement A. Otherwise, he may wish to use the self-fed supplement.

**Conclusions**

1. The purpose of protein supplementation is to feed microbes so the cow can harvest more cheap forage.
2. Adequate available forage is required for protein supplementation to be effective.
3. Forage should be tested to determine if supplementation is needed.
4. Young cows respond more favorably to protein supplementation than do older cows.
5. If forage is less than 6.25% crude protein (CP), protein supplementation typically increases forage intake, decreases weight loss, and increases conception.
6. The optimum time to supplement is 60 to 90 d before calving.

**Table 6. Substitution of Urea for Natural Protein**

**Cows Grazing Winter Tallgrass Prairie**

Item	0% CP from Urea	15% CP from urea	30% CP from urea
Supplement Intake, lbs.	4.8	4.8	4.8
Wt. gain (28 Nov - 7 Feb)	48	42	14
Wt. gain {28 Nov - 21 Mar (Calving)}	-97	-107	-130
Wt. gain {28 Nov - 27 Apr (Breeding)}	-152	-152	-172
Wt. gain {28 Nov - 5 Oct (Weaning)}	52	62	27
Pregnancy Rate, %	92.6	100	86.2

Koster et al., 1996 KSU Cattlemen's Day

7. As a general rule, forage with 4% CP requires about 2 lbs. of cottonseed meal or soybean oil meal per cow per day.
8. To avoid hurting animal performance, keep CP supplemented by urea less than 30% of the total CP of the supplement.
9. Liquid feeds function much like dry protein supplements.
10. It is advisable to keep CP in supplements greater than 22% with low-quality forage.

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