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Calculating Fertilizer Value of Supplemental Feed for Cattle on Pasture

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Most cattle maintained on pasture receive supplemental feed during some portion of the year. Supplements are commonly fed to grazing cattle when pasture forage quality and quantity are below animal requirements. The availability of low-cost grain milling byproducts has encouraged some producers to expand the use of supplemental feeds. Examples of grain milling byproducts that have become popular for use as supplements include condensed distillers solubles (CDS), dried distillers grain with solubles (DDGS), corn gluten feed, and soybean hulls.

The value of grain milling byproducts as cattle feeds is well established (MU publication G2076, *Alternative Feeds for Beef Cows and Stockers*). An often-overlooked aspect of supplementing grazing cattle with hay and grain milling byproducts is the additional mineral nutrients that pass through the animal to the pasture in the manure. The objective of this guide is to help calculate the value of supplemental feeds as a fertilizer for pastures.

Table 1 provides estimates of the fertilizer value of the nutrients fed a cow for 100 days. Capturing the fertilizer value in supplemental feeds is particularly important with rising fertilizer prices and the need to protect water quality by using fertilizer nutrients efficiently. The fertilizer value of these materials also can offset some of the cost of purchasing supplemental feed.

Well-managed, intensively grazed pastures already have lower fertilizer maintenance requirements than hay fields because so many of the nutrients in the forage are redeposited onto the pasture. Nutrients in supplemental feeds can reduce or eliminate the need for maintenance fertilizer applications on pastures. Table 2 summarizes the annual phosphate and potash removal rates for pasture and hay fields. These removal rates for pastures can frequently be met or exceeded with typical supplemental feeding strategies.

Supplemental feeds can provide an important source of nutrients for pastures.

Some typical nutrient concentrations in feedstuffs are reported in Table 3. Cattle do not use the nutrients in feed with 100 percent efficiency. The majority of the nutrients consumed by cattle are redeposited on pasture in the urine and feces. Table 4 summarizes the percentage of consumed nutrients excreted by cattle. Mature cattle use the nutrients in feed to maintain the tissues of their bodies; however, they usually excrete about as much protein and minerals as they consume.

See MU publication G4570, *Reducing Losses When Feeding Hay to Beef Cattle*, for more information on feeding hay in pastures.

Table 1. Estimated fertilizer value of selected supplemental feeds fed to one cow for 100 days.

Feedstuff	Daily intake[1] (lb/day)	Nitrogen[2] (lb/100 days)	Phosphate (lb/100 days)	Potash (lb/100 days)
Fescue hay	30	23	23	67
Alfalfa hay	30	30	20	95
Dried distillers grain with solubles	8	14	7	2
Condensed distillers solubles	6	4	7	4
Wet corn gluten feed	18	8	13	5
Dry corn gluten feed	8	8	13	5
Soybean hulls	8	5	3	11
Wet brewers grain	24	12	9	<1

1 On an "as-fed" basis.
2 Assumes availability of 35 percent for nitrogen excreted by the animals.

Table 2. Estimated annual phosphate and potash removal from cool-season pasture and hay fields.

Forage	Yield goal (tons/A)	Phosphate removal (lb/A)	Potash removal (lb/A)
Pasture	3	10	34
Hay	3	27	102

Calculating the fertilizer value of supplemental feed

There are three steps in determining fertilizer nutrient value of supplemental feeds.

1. Determine the amount of supplemental feed consumed by grazing animals.
2. Determine the amount nutrients in the supplemental feed available for use as fertilizer.
3. Determine the effective nutrient application rate onto a pasture.

Step 1: Determine the amount of supplemental feed consumed by animals.

The most convenient way to estimate the amount of supplemental feed consumed by animals is to estimate the daily intake of the feed by the animals grazing the pasture and the number of days feed was provided to the animals. The amount of supplemental feed *(SF)* consumed, in pounds, is equal to the number of animals fed *(A)* times the amount of feed each animal receives per day (F_d) times the number of days *(D)* the animals are on feed:

$$SF = A \times F_d \times D$$

Table 5 includes typical values for the daily intake (on an "as-fed" or wet basis) of specific supplemental feeds. The number of days animals are fed over the course of a year typically ranges from 90 to 150 days. These values are provided as guidelines; use the actual numbers for your farm.

Step 2: Determine the amount of nutrients available for use as fertilizer.

The objective here is to estimate the amount of supplemental nutrients excreted onto pasture and, therefore, available for use as fertilizer.

Nutrient availability in supplemental feed is affected by the concentration of nutrients in the feed, the percentage of those nutrients excreted by the animals and the availability of the manure nutrients as a fertilizer source. For the amount of supplemental feed *(SF)* calculated in Step 1, use values in Tables 3 and 4 to calculate the amount of nitrogen, in pounds, available as fertilizer (N_a) as follows:

$$N_a = (SF \times \text{protein concentration (\%)}/100) \quad \textit{(see Table 3)}$$
$$\times \text{ excreted nitrogen (\%)}/100 \quad \textit{(see Table 4)}$$
$$\times \text{ 35\% fertilizer availability}/100$$
$$\times \text{ 1 lb nitrogen fertilizer/6.25 lb protein}$$

Similarly, the amounts of available phosphate (P_a) and available potash (K_a) can be calculated as follows:

$$P_a = (SF \times \text{phosphorus concentration (\%)}/100)$$
$$\times \text{ excreted phosphorus (\%)}/100$$
$$\times \text{ 100\% fertilizer availability}/100$$
$$\times \text{ 2.3 lb phosphate fertilizer/lb phosphorus}$$

$$K_a = (SF \times \text{potassium concentration (\%)}/100)$$
$$\times \text{ excreted potassium (\%)}/100$$
$$\times \text{ 100\% fertilizer availability}/100$$
$$\times \text{ 1.2 lb potash fertilizer/lb potassium}$$

Use Table 3 to estimate the nutrient concentration in the supplemental feed. Use Table 4 to estimate the percentage of nutrients excreted by the animal. Note that phosphate and potash in manure are 100 percent equal to fertilizer nutrients. However, nitrogen in manure is substantially less available than fertilizer nitrogen. An estimated 35 percent of the nitrogen in excreted urine and feces is available as fertilizer. The rest is lost to the atmosphere as ammonia or tied up in unavailable forms in the manure.

Step 3: Determine the effective nutrient application rate for a pasture.

The rate (R_a) at which nutrients are applied to a pasture is affected by the availability of nutrients in the manure (calculated in Step 2), the proportion of the supplemental feed fed in a particular pasture and the size of the pasture:

$$R_a = \frac{\text{available nutrients (lb)} \times \text{\% of feed fed on that pasture}/100}{\text{pasture size (acres)}}$$

Table 3. Nitrogen, phosphorus and potassium concentration of selected feedstuffs. All values are reported on an "as-fed" basis.

Feedstuff	Dry matter, %	Protein[1], %	Phosphorus, %	Potassium, %
Fescue hay	100	12.5	0.3	1.7
Alfalfa hay	100	18	0.3	2.6
Dried distillers grain with solubles	90	32	0.4	0.2
Condensed distillers solubles	35	12	0.5	0.6
Wet corn gluten feed	40	8	0.3	0.3
Dry corn gluten feed	90	18	0.7	0.6
Soybean hulls	90	11	0.2	1.1
Wet brewers grain	30	9	0.2	0.03

[1] To convert from protein to nitrogen, divide by 6.25.

Table 4. Percentage of consumed nutrients (nitrogen, phosphorus and potassium) excreted by cattle.

Animal type	Nitrogen (% excreted)	Phosphorus (% excreted)	Potassium (% excreted)
Growing cattle	50–70	65–75	65–85
Mature cattle	100	100	100

Table 5. Typical daily intake (on an "as-fed" basis) for selected supplemental feeds.

Feedstuff	Typical daily intake (lb/animal/day)
Fescue hay	30
Alfalfa hay	30
Dried distillers grain with solubles	6–10
Condensed distillers solubles	3–9
Wet corn gluten feed	13–23
Dry corn gluten feed	6–10
Soybean hulls	6–10
Wet brewers grain	17–30

Unrolling hay is one strategy for increasing the distribution of nutrients on pasture.

Example 1: Feeding fescue hay

A farmer feeds 100 cows *(A)* 30 pounds fescue hay per day (F_d) from mid-December to early April (D = 110 days). The winter pasture is 100 acres. What is the fertilizer value of the imported hay to this pasture?

Step 1:

Amount of supplemental feed *(SF)* = 100 cows × 30 lb hay/cow/day × 110 days = 330,000 lb feed

Step 2:

Available nitrogen (N_a) = (330,000 lb feed × 12.5% nitrogen/100) × 100% excreted/100 × 35% available/100 × 1 lb nitrogen fertilizer/6.25 lb protein = 2,310 lb nitrogen

Available phosphate (P_a) = (330,000 lb feed × 0.3% phosphorus/100) × 100% excreted/100 × 100% available/100 × 2.3 lb phosphate fertilizer/lb phosphorus = 2,280 lb phosphate

Available potash (K_a) = (330,000 lb feed × 1.7% potassium/100) × 100% excreted/100 × 100% available/100 × 1.2 lb potash fertilizer/lb potassium = 6,730 lb potash

Step 3:

$$\text{Nitrogen application rate} = \frac{2{,}310 \text{ lb nitrogen} \times 100\% \text{ on field}/100}{100 \text{ acres}} = 23 \text{ lb nitrogen/acre}$$

$$\text{Phosphate application rate} = \frac{2{,}280 \text{ lb phosphate} \times 100\% \text{ on field}/100}{100 \text{ acres}} = 23 \text{ lb phosphorus/acre}$$

$$\text{Potash application rate} = \frac{6{,}730 \text{ lb potash} \times 100\% \text{ on field}/100}{100 \text{ acres}} = 67 \text{ lb potash/acre}$$

Note that the phosphate and potash application rate is more than double the annual removal rate for most pastures, so soil test levels for these nutrients will increase over time if this pasture is used annually for winter pasture. The available nutrients in the manure are worth $2,967, or $29.50 per acre or $18/ton of hay if one assumes fertilizer value of $0.40/lb nitrogen, $0.30/lb phosphate and $0.20/lb potash.

Example 2: Feeding dried distillers grain with solubles

A farmer feeds 40 cows *(A)* 8 pounds of dried distillers grain with solubles (DDGS) per day (F_d) from January to early March (D = 60 days) in a 25-acre pasture. What is the fertilizer value of the imported feed to this pasture.

Step 1:

Amount of supplemental feed *(SF)* = 40 cows × 8 lb DDGS/cow/day × 60 days = 19,200 lb feed

Step 2:

Available nitrogen (N_a)	= (19,200 lb feed × 32% protein/100) × 100% excreted/100 × 35% available/100 × 1 lb nitrogen fertilizer/6.25 lb protein	= 344 lb nitrogen
Available phosphate (P_a)	= (19,200 lb feed × 0.4% phosphorus/100) × 100% excreted/100 × 100% available/100 × 2.3 lb phosphate fertilizer/lb phosphorus	= 176 lb phosphate
Available potash (K_a)	= (19,200 lb feed × 0.2% potassium/100) × 100% excreted/100 × 100% available/100 × 1.2 lb phosphate fertilizer/lb phosphorus	= 46 lb potash

Step 3:

Nitrogen application rate	= (344 lb nitrogen × 100% on field/100) ÷ 25 acres	= 14 lb nitrogen/acre
Phosphate application rate	= (176 lb phosphate × 100% on field/100) ÷ 25 acres	= 7 lb phosphorus/acre
Potash application rate	= (46 lb potash × 100% on field/100) ÷ 25 acres	= 2 lb potash/acre

Note that the nitrogen application rate is close the spring nitrogen needs of many pastures and the phosphate application rate is nearly the annual removal rate for most pastures. The available nutrients in the manure are worth $194, or $7.75 per acre or $20/ton of DDGS if one assumes fertilizer value of $0.40/lb nitrogen, $0.30/lb phosphate and $0.20/lb potash.

Barriers to using feed nutrients as a fertilizer

With manure nutrients, cattle are the fertilizer spreader. Urine typically contains more than 50 percent of the total nitrogen and potassium excreted by cattle. Conversely, feces contain 80 percent of the total phosphorus excreted by cattle.

The nutrients in supplemental feed are only valuable as a fertilizer if you take steps to ensure that they are spread evenly around the whole field. Animals typically do a poor job of distributing nutrients around a pasture; nutrients tend to concentrate near feeders, water and shade areas. The bulk of the pasture often gets only limited benefits from manure nutrients unless steps are taken to improve manure distribution by grazing animals.

Through management farmers can improve nutrient distribution in pastures. Managing animals so they do a better job of distributing manure in a pasture makes their manure more valuable as a fertilizer. Recommended steps include:

- Regularly move feeders and feeding areas around the pasture.
- Increase the stocking density of animals but move animals from area to area more frequently to prevent over use of areas in the pasture.
- Do not use the same pasture for supplemental feeding every year. Instead move the supplemental feeding area to distribute the nutrient benefits around the farm.
- Maintain a setback area of at least 100 feet between supplemental feeding areas and streams. Avoid placing feeding areas where runoff will easily move into surface waters, particularly in winter when frozen and saturated soil promotes the movement of manure nutrients in runoff.

Missouri research shows that moving the hay feeding area every two days resulted in higher pasture yield and higher phosphorus and potassium soil test levels in the field. Feeding hay in one spot resulted in similar yields in most of the pasture as importing no hay.

These results emphasize that capturing the fertilizer benefit of nutrients in supplemental feed requires moving feeding areas on a regular basis. You cannot fertilize a field with a manure spreader by just running the spreader in a corner of the field. Similarly, you cannot benefit from the fertilizer nutrients in your feed supplements if you always put the feeder in the same spot in a pasture.

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