Section F

Giving credit for non-fertilizer nitrogen sources

Mineralization of nitrogen from soil organic matter

Soil organic matter is a major soil component. It consists of plant and animal residue in various stages of decay and holds large amounts of nitrogen in organic forms. This nitrogen is unavailable to the crop until it is mineralized by soil microorganisms. Mineralization transforms organic nitrogen into ammonium, which the crop can use.

Soils in Nebraska typically range from 0.5 to 3.0% organic matter and occasionally higher. A soil with 2% organic matter has almost 20 tons/acre of organic matter in the top 6 inches. This much organic matter contains roughly 2,000 lb of nitrogen in organic form. About 70 to 80% of the total organic matter decays very slowly. The remaining 20 to 30%, the humus, is in a stable advanced state of decay. Thus, only 1 to 2% of the organic N (20-40 lb N/ac) is mineralized per year. *Table F-1* shows the minimum estimated amount of N made available annually by mineralization, according to the organic matter content of the soil.

Table F-1. Minimum estimated nitrogen contributed to the crop from mineralization of soil organic matter.

Soil Test Organic Matter (%)	Nitrogen Contributed to Crops From Mineralization (lb/acre/yr)
1	20 - 30
2	40 - 55
3	60 - 70

Mineralized nitrogen is available for crop use while the crop is growing. The actual amount of nitrogen coming from mineralization will vary due to temperature and moisture conditions, and can be different from the values in the table. However, the amount mineralized is related to the amount of organic matter in a soil. Therefore, the minimum nitrogen expected to become available for crop use can be reliably estimated. The nitrogen credit for mineralization is already included in the nitrogen fertilizer calculation in Section E by including organic matter (OM) as part of the equation.

Previous legume crop credit

Legumes fix nitrogen from the air and store it in root nodules. This nitrogen becomes available when the plant dies and decays. If the previous crop was a legume, a credit should be used when calculating fertilizer needs. This is one of the “other credits” in the N fertilizer need algorithm discussed in Section E.

Figure F-1. Large round bale in an alfalfa field. Alfalfa is a legume that provides soil N due to the decay of plant roots, stems, and leaves.

Legume nitrogen starts with the formation of a root nodule. Each nodule represents an invasion by specific soil bacteria into the root. The bacteria multiply and result in enlarged or mature nodules. The bacteria in the nodules can fix enough nitrogen gas from the soil air to meet a substantial part of the plant's nitrogen needs. The amount actually fixed depends on the amount of nitrogen in the soil. The legumes will use the available soil nitrogen first, before they fix enough nitrogen to meet the rest of their needs. This is why soil nitrates are usually low following a legume crop.

When a legume crop is killed or dies, the plant residue decays easily because of the high nitrogen content in the legume leaves and stems. The amount of nitrogen the decaying legume residue contributes to the next crop varies. *Table F-2* shows the expected nitrogen credit when a grain crop follows a legume.

Table F-2. Estimated nitrogen credit when the previous crop is a legume.

Legume Crop	Medium and Fine Textured Soils	Sandy Soils
	(lb/acre nitrogen credit)	
Alfalfa 70 - 100% stand (More than 4 plants per sq ft)	180	100
Alfalfa 30 - 69% stand (1.5 to 4 plants per sq ft)	120	70
Alfalfa 0 - 29% stand (Less than 1.5 plants per sq ft)	90	40
Sweet clover and red clover	80% of credit allowed for alfalfa	
Soybean	45	35
Dry edible beans	25	25

Irrigation water credit

Nitrate-nitrogen in irrigation water is available to a growing crop and is another credit to include in the fertilizer need equation. Each ppm will add 2.72 lb N/ac to the soil with each 12-inches of irrigation water applied (or 0.23 lb N/acre with each inch of irrigation water applied).

When irrigation water contains 10 or more ppm of nitrate-nitrogen, the amount of N fertilizer added to a crop should be reduced to credit the nitrogen coming from irrigation water. *Table F-3* shows how much nitrogen is added for different amounts of irrigation water. *(Note: Some water analyses give nitrate-nitrogen concentrations in parts per million [ppm] and others give values in milligrams per liter [mg/l]. They are the same.)*

Table F-3. Crop available nitrogen in irrigation water.

Water Applied (inches)	Nitrate-Nitrogen concentration (ppm or mg/l)								
	5	10	15	20	25	30	35	40	45
	(lb of nitrogen added per acre)								
6	7	14	20	27	34	41	48	54	61
9	10	20	30	41	51	61	72	82	92
12	14	27	41	54	68	81	95	109	122
15	17	34	51	68	85	102	119	136	153
20	23	45	68	91	114	136	159	182	204
25	28	57	85	114	142	170	199	227	255

The timing of irrigation application in relation to the period of rapid nitrogen uptake by the crop affects the value of the nitrogen in the water to that year's crop. Rapid N uptake is illustrated in *Figure G-1* and extends from about V6 to after pollination, but N is taken up all season. Nitrogen in irrigation water applied during the rapid uptake period is just as useful to the crop as the same amount of nitrogen fertilizer. Nitrogen in water applied late in the growing season, after the crop has already taken up most of its nitrogen needs, is of limited value. Care must be taken to reduce drainage below the root zone since nitrogen will leach with the water. The sections on irrigation scheduling are critical to reduce these losses.

Due of the uncertainty of precipitation during the growing season, we suggest that the nitrogen contained in 80% of the 5-year average irrigation depth be used when calculating the N contribution by irrigation water. If your field site is within an NRD with an annual water allocation, use the annual allocation in place of the 5-year average. An example will show how to calculate the N provided by irrigation water containing N.

Example: Calculating the irrigation water N credit

Irrigation water contains 15 ppm nitrate-nitrogen. The 5-year average irrigation water application depth is 10 inches per year. Using 80% of the 5-year average, how much crop available N is in the irrigation water?

(ppm) x (0.2267) x (in. of water) = lb of nitrogen/acre in the water

0.8 x 15 ppm x 0.227 x 10 in. = 34 lb of nitrogen/acre

Organic resource credit

Livestock and poultry manures, composted meat processing wastes, dewatered sewage sludge, and composted plant material are examples of organic resources. They may contain a combination of organic nitrogen, ammonium, and nitrate. All of the ammonium and nitrate is potentially available to the crop the first year. In contrast, a fraction of the organic nitrogen will become available only after mineralization by soil micro-organisms. This occurs over a period of several months to several years.

The amount of nutrients released from organic resources varies considerably. Thirty to seventy percent of the nutrients in organic form can be made available to the next crop after application, depending on the type of organic resource and soil conditions (mainly moisture and temperature). Research and on-farm evaluations have been used to project the amount of nitrogen available to the next crop from organic resources (*Table F-4*). The values in the table are conservative and can be used with confidence. These amounts will vary depending on the method and timing of application and nitrogen content of the organic resource. Producers should always collect samples of organic resources and have the samples analyzed to determine a more accurate credit. Manure sampling procedures are presented in NebGuide G1450 at: *www.ianrpubs.unl.edu/sendIt/g1450.pdf.*

Organic resources are usually used to supply nitrogen for the next crop. However, there are other nutrients in organic resources such as phosphorus, potassium, sulfur, and trace elements like iron, zinc, and copper that can also be beneficial in subsequent crop years.

Long-term use of organic resources to fully meet nitrogen requirements usually results in excessive buildup of available phosphorus and potassium in the soil. To avoid this problem, organic material application should be based on replacing the phosphorus removed in the crop. Applying organic resources to meet the crop's needs for phosphorus instead of nitrogen will require three to seven times more land area. Heavy applications of organic resources without consideration of crop needs can result in over-application of nutrients. Groundwater and surface water contamination can then occur.

Table F-4. Typical available nitrogen expected from application of organic resources.

Organic Source	Available Nitrogen Furnished* to the Next Crop
Beef feedlot manure	4-5 lb/ton
Dairy Cattle manure	3 lb/ton
Sheep manure	5 lb/ton
Poultry manure	15 lb/ton
Swine manure	10 lb/ton
Plant compost	3-5 lb/ton
Meat processing waste	1-6 lb/1,000 gal
Sewage sludge	2-3 lb/ton
Swine slurry	2-10 lb/1,000 gal
Beef slurry	2-10 lb/1,000 gal
Dairy slurry	2-6 lb/1,000 gal

*These numbers will vary widely depending on storage, handling, application methods, and conditions after application.

More Extension Publications (available at ianrpubs.unl.edu)

G1335, Determining Crop Available Nutrients from Manure

G1450, Manure Testing for Nutrient Content.

G1519, Calculating the Value of Manure for Crop Production

G1563, Manure Incorporation and Crop Residue Cover - Part I: Reducation of Cover

G1564, Manure Incorporation and Crop Residue Cover - Part II: Fine-Tuning the System

G1939, Sewage Sludge Utilization for Crop Production

For More Information

More information can also be found at: *manure.unl.edu*