This guidance pertains to:

- Nitrogen Use Metric

Introduction
Leguminous crops fix N in the soil. This estimation protocol requires the user to know only the rough height of the crop, approximate portion of the crop mix that is leguminous (for mixed cover crops), and an estimate of its maturity.

Formula

\[
\text{Fixed } N \text{ contributed to the soil} = \text{amount of biomass} \times \% N \text{ in biomass} \times \% \text{ of } N \text{ from fixation}
\]

Protocol
The amount of total legume biomass depends on the biomass in each legume plant (which includes both aboveground and belowground plant parts) and the coverage of legumes across the field. **Step 1** estimates only above-ground biomass; **Step 2** estimates fixed N that is in below-ground biomass; **Step 3** estimates N contribution from fixation.

**STEP 1: Estimate Legume Aboveground Biomass**

There are two alternatives for estimating the leguminous above-ground biomass.

**Alternative 1A: Approximation By Area and Height**

**1A/Step One: Estimate Coverage**

Coverage depends both on the contribution of legumes to planted areas and the proportion of the total area in plants vs. fallow. (See Examples, right.)

**1A/Step Two: Estimate Aboveground Biomass**

At 100 percent groundcover and 6-inch height, most non-woody legumes will contain roughly 2,000 lb./acre of dry matter. For each additional inch, add 150 lb.

You can use the following equation to approximate:

\[
\text{Aboveground Biomass} = 2000 \text{ lb/acre} + (\text{plant height (in.)} - 6") \times 150 \text{ lb/acre/in}
\]

**Example:**

- A field planted 100% in clover has 100% coverage.
- A field with 25% fallow and 75% clover has 75% coverage.
- A field with 25% fallow and a cover-crop mix in which legumes contribute about 50% of the cover on the remaining 75% of the land has a total of about 38% coverage

**Example:**

If: 18-inch high monoculture legume with 75% coverage

Then:

\[
\text{Aboveground Biomass} = 2000 \text{ lb/acre} + (18" - 6") \times 150 \text{ lb/acre/in} = 3,800 \text{ lb/acre}
\]
1A/Step Three: Multiply Coverage by Aboveground Biomass

Multiply total aboveground biomass by the coverage estimate from Step One.

**Alternative 1B: Direct Measurement of Weight**

1B/Step One: Collect Legume Sample
Use a yardstick or metal frame of known dimensions (1 foot X 2 feet, for example) and clip the legumes within that area at ground level. (If you clip all the plants, separate out the legumes.)

Repeat in two additional places in the field, keeping the legumes from each area separate.

1B/Step Two: Dry and Weigh Sample
Dry samples by leaving them out in the sun for a few consecutive days, or by putting them in an oven at about 140° F for 24 to 48 hours until they are “crunchy dry.”

Weigh the dried legumes from each area separately, and then combine the weights.

1B/Step Three: Calculate Aboveground Biomass
Use the following equation to determine per-acre yield of dry matter of legumes. (Modified from Sarrantonio in SARE 2007.)

\[
\text{Aboveground Yield (lb/Acre)} = \frac{\text{TOTAL weight of dried samples (lb.)}}{\text{TOTAL area sampled (square feet)}} \times \frac{\text{43,560 sq. ft.}}{\text{1 Acre}} \times \frac{\text{Planted area (acres)}}{\text{Total Field Area (acres)}}
\]

**STEP 2. Estimate Legume N Contribution**

To estimate the N contribution of the legume, you need to estimate how much N the legume contains, including both aboveground and belowground plant parts, and how much of that N is derived from N fixation. Legumes also take up N from the soil, and that N does not qualify as an external addition to the field.\(^1\) Reasonable assumptions are that:

- 65% of plant N is in aboveground parts and 35% is in belowground parts.
- Therefore, to arrive at an estimate of total plant N, increase the estimate of aboveground N by 54%.
- Therefore: Total plant N = aboveground N * 1.54

There are two alternatives for estimating the total N content in the legume:

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**Alternative 1. Estimate the N Content Using Rules of Thumb**

Estimate the N content of the legume to the soil using rough rules of thumb:

- Annual legumes prior to flowering (younger material)  
  4% N in aboveground parts
- Annual legumes prior to flowering (older material)  
  3.5% N in aboveground parts
- Annual legumes after flowering  
  3.25%

To account for N allocated belowground, increase this estimate by 54%.

Perennial legumes that have a significant number of thick, fibrous or woody stems, reduce estimates for annuals by one percent.²

**Alternative 2. Obtain Lab Measurements**

Estimate the N content of the legume to the soil by sending a representative sample of the biomass to a laboratory. To collect a representative sample, use procedure from Alternative 1B. in Step 1 above.

If only aboveground biomass is collected, total N content will need to be estimated by increasing aboveground N by 54%, as explained above. If roots as well as aboveground parts are collected and included in the analysis, then no correction is necessary.

**STEP 3. Estimate N Contribution from Fixation**

To estimate N contribution of N fixation, multiply total N of the plant by 0.8.

This is the estimate of total N contributed to your field from your leguminous crop.

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² From Saarrantonio “How much N?” pp. 22-23 in Managing Cover Crops Profitably. SARE.