University of California
Agriculture and Natural Resources

ESTIMATING NITROGEN (N) FOR ORGANIC CROP PRODUCTION: WORKSHEET

Margaret Lloyd[1], Patricia Lazicki[2], Daniel Geisseler[2], Joji Muramoto[1], Richard Smith[1], Evelyn Smith[2]
[1] University of California Agriculture and Natural Resources, University of California Cooperative Extension
[2] University of California, Davis, Department of Land, Air and Water Resources

This worksheet is intended to be used with the companion "Estimating Nitrogen for Organic Crop Production: For N budgeting and other purposes". The figure and table references can be found in that document. It can be useful in developing a complete nitrogen budget, or for estimating and understanding plant availability of nitrogen from individual organic nitrogen sources, such as compost or cover crops.

Completing each section at least one time can be highly informative to understanding how organic sources of N that are regularly added or existing in your system, contribute to plant available N. This information is often translatable between crops or years. However, given the time it takes to fill out the worksheet, it can be challenging to routinely utilize for diverse cropping systems. In addition, there may be inaccuracies in making estimates of available N.

This worksheet focuses on plant available nitrogen from organic sources, but does not discuss the timing of the crop N demand in great detail. Understanding the timing of crop demand with the timing of plant available N is important when making fertilization decisions.

This crop-based budget worksheet is for_____
crop

PART 1. CROP N DEMAND

A. Crop N Uptake: How much N does your crop need? Select 1 method below to identify the N uptake demand.

Method 1. Use N uptake suggested by a reliable source

1. [ ] lb N/A **1. Total crop N uptake (average value or range) provided by a reliable source (e.g. Table 1)**
5.

Method 2. Use N uptake suggested by a reliable source and adjust based on your yield goal.

1. _____ lb N/A **1. Total crop N uptake (average value or range) provided by a reliable source (e.g. Table 1)**

2. _____ Ton/A **2. Yield associated with the above N value** (**Table 1**)

3. _____ Ton /A **3. Your predicted yield** (2000 lbs/Ton)

Then, (_____Ton/A /_____ Ton/A) x _____ lb N/A = [ ] lb N/A
3. 2. 1. 5.

Method 3. Use your predicted yield and estimated lbs N needed per ton yield

3. _____ Ton/A **3. Your predicted yield** (2000 lbs/Ton)

4. _____ lb N/T yield **4.Total crop N uptake** (**Table 1**)

Then, _____ Ton/A x _____lbs N/T = _____ lb N/A
3. 4. 5.

5. _____ lb N/A **5. Total crop N uptake. Insert result from box 5. based on method used above.**

PART 2. N SUPPLY: BASELINE

B. Available N from Soil Organic Matter (SOM)

6. _____ lb N/A **6. Estimated N from SOM** Reference Figure 3. A typical release rate will likely be from 50-120 lbs N/acre/season in the top 1' of soil, about 2% of the total soil N becomes available.

C. Available N from crop residue: cover crops and post-harvest residue

If a cover crop or commercial crop is incorporated no more than 6 weeks prior to planting the crop intended for this budget, the N from these residues should be accounted for. Choose from either the cover crop or crop residue options.

C1. N fixation from cover crops

The amount of N from a cover crop contribute depends on several factors including the species, how thick the stand is, and at what stage it is terminated. The C:N ratio is the best predictor of nitrate release rates.

_____ **Specify cover crop type**

_____C:N ratio of cover crop residue

7. _____ lb/A **7. Estimate legume biomass dry weight**
Use your own information of biomass dry weight, or reference UC SAREP cover crop database. When referencing another source providing a range, consider your own scenario regarding crop density and crop height/maturity to select a number in the range. For example, if a crop is terminated earlier, at 50% of maturity, select a number on the lower end of the range. More dense and longer production times will likely fall on the higher end of the range.

8. _____ % **8. Percent N in cover crop**
Use your own information from a sample sent to a lab, reference UC SAREP cover crop database or find other resources.

9. _____ lb N/A **9. Total N from cover crop** (Reference Fig. 5 to compare results)

_____ lbs/A x _____% /100 = _____ lbs N/A
7. 8. 9.

10. [ ] lb N/A **10. Total N from cover crop available this season**

It's estimated that about 4-35% of cover crop N is directly available for the next crop. Use a lower % availability when material is left on the surface, not incorporated, or when the soil is drier. Use an intermediate % for legume-cereal mixes. Use a higher % when the cover crop is terminated at optimum growth (early flower) and a lower % for more mature crops. C:N ratio is an excellent predictor of N availability. A C:N ratio greater than 20:1 will generally not release nitrogen, but rather be used to degrade the carbon, where as 10:1 will provide intermediate rates of release.

_____ lb N/A x _____% / 100 = _____ lb N/A
9. 4-35% 10.

C2. Available N from Previous Crop

_____ **Specify previous crop**

_____C:N ratio of previous crop residue at time of incorporation.

11. _____ Ton/A **11. Previous crop yield**

12. _____ lb N/T **12. N in crop residue (**Column 2 of Fig. 6.)

13. _____lb N/A **13. Estimated N in crop residue**

The amount of N expected to be in the residues can be adjusted for the actual expected yield by multiplying the actual yield by the value for lbs N/ton yield.

_____ Tons/A x _____ lbs N/ton = _____ lbs N/A
11. 12. 13.

13A. [ ] **lb N/A I. Total N from previous crop available this season**

Use a lower % N available when material is left on the surface and not incorporated, or when the soil is drier. C:N ratio is an excellent predictor of N availability. A C:N ratio greater than 20:1 will generally not release nitrogen, but rather be used to degrade the carbon, whereas 10:1 will provide intermediate rates of release.

_____ lb N/A x _____% / 100 = _____ lb N/A
13. 4-45% 13A

D. Interpreting Soil and Water Tests

D1. Interpreting soil tests

When using results from a soil test, consider the timing of the soil test. The results from a soil test can be used for a budget when it is taken before amendments are added and before crop residue (or cover crop) incorporation. However, if a soil test is taken after cover crop, crop residue and/or organic amendment applications are added, the soil test results will include some of the N made available from the recent activity. As such, the soil test should be fully counted towards the budget, but the crop residue and organic amendments can be reduced. Adjust accordingly. Similarly, if soil samples are more than several months old, consider what activities have occurred since then that could influence N levels (crop production, rain, amendment application, etc). To use a soil test to adjust the quantity of fertilizer applied to meet the crop needs, test for residual soil nitrate prior to a fertilization.

14. [ ] lb N/A **14. Available N at time of soil test** [Test, result: _____date: _____]

Conversion tool

1 mg/kg = 1ppm

If soil test is in NO_3, convert to NO_3-N: _____ppm / 4.42 = _____ppm
Result NO_3 Result NO_3-N

If soil test is in ppm, convert: _____ppm x ____3.6_____= _____lbs N/A
NO_3-N soil bulk density* 14.

If a soil sample was taken to a depth of 12", use 3.6 for soil bulk density. If a soil sample was taken to a depth of 6", use 1.8 for soil bulk density. For vegetables, 12" soil sampling depth is recommended for most crops in order to capture the soil where the majority of roots will encounter.

D2. Sampling water for testing
To convert NO_3-N concentration in the water to lb N/acre inch, NO_3-N concentration reported in ppm is multiplied by 0.227 and by the number of acre-inches of water applied. For example, for 1 acre-inch of water containing 10 ppm nitrate-N: (10 ppm) x (1 acre-inch) x (0.227) = 2.27 lb N are applied per acre.

15. _____lb N/A **15. N contribution from irrigation water based on water test result**
[Test, result: _____date: _____]

Estimate total water use _____ acre-inches x _____lb N/A = _____ lb N
Water use NO_3-N in water 15.

Conversion Tool
Convert ppm to lb N/A _____ppm x 0.227 = _____lbs N/A
NO_3-N NO_3-N

PART 3. N SUPPLY: SEASONAL INPUTS

E. Available N from Organic Amendments

E1. Compost
Most compost companies will provide an analysis of the compost material which will include the total % N and C:N ratio.

_____**Product name**

16. _____ C:N ratio **16. Identify the C:N ratio of the compost**

17. _____ % water **17. Identify the amount of water in the compost**

18. _____ % N **18. Total N in compost (dry weight)** (Check the report to see if the total N is given in wet or dry weight basis. 'As is' or 'fresh weight' is typically equivalent to 'wet weight'.)

***Conversion Tool**
See 'compost' section of conversion tool for
Yards to tons
5-gallon bucket to tons
Beds to acres

If your compost N is given in dry weight, adjust the amount of compost you applied 'as is' to dry weight:

19. _____ lb/A **19. Application rate in lb, wet weight ('as is' or 'fresh weight') ***
(1 T = 2000 lb)(1 T = 2-2.5 cubic yards)

20. _____ lb/A **20. Application rate in lb, adjusted to dry weight**

_____ lb/A * (100-_____%) / 100 = _____lb/A
19. 17. 20.

21. _____ lb N/A **21. Estimated total N from compost added to field**

_____**%** / 100 x _____ lb/A = _____ lb N/A
18 20. 21.

22. _____ lb N/A **22. Estimated available N from compost**
Composts are estimated to release 0-30% of total N in the first year (Fig. 7). Plant based composts can initially tie up N whereas manure-based composts have more N available. Take a look at Figure 7 to see estimates of percent N release from composts, and Figure 8 to see the correlation between C:N ratio and available nitrogen. Place the C:N ratio of the compost used (L.) on the curve to estimate the N release percent.

_____ lb N/A x _____% / 100 = _____ lb N/A
21. 0-30% 22.

E2. Granular fertilizers

_____**Product name**

***Conversion Tool**
See conversion tool for
yards to tons
5-gallon bucket to tons
Beds to acres

23. _____ % N **23. Total N in product** (ex. 5-8-0 is 5% N)

24. _____ lb N/lb **24. Pounds of N per pound of product**

_____% /100 = _____lbs N/lb
23. 24.

25. _____ lb/A **25. Application rate***

26. _____ lb N/A **26. Total N applied**

_____lb N/lb x _____ lb/A = _____ lb N / A
24. 25. 26.

27. _____ lb N/A **27. Total available N**
For crops grown with regular water in warm weather, granular fertilizers with a low C:N (ex. 6:1 or lower) are estimated to release 40-90% of total N in a season (See Fig. 7). Colder and/drier conditions will reduce the nitrogen release rate. Surface applied granular fertilizer releases a lower percentage of the total it contains. Granular fertilizer shanked into the soil releases a higher percent of the N it contains. Higher analysis fertilizers release a greater percentage of N than lower N (Hartz and Johnstone, 2006)

_____ lb N/A x _____% / 100 = _____ lb N/A
26. 40-90% 27.

E3. Liquid fertilizers

Liquid fertilizers are estimated to release 65-70% of total N in the season. (Fig. 7).

_____**Product name**

28. _____ lb/gal **28. Fertilizer density** Read product label to determine (Water is 8 lbs/gal; Many products range from 9-10.5 lb/gal)

29. _____ % N **29. Percent of N in product (3-2-2= 3% N)**

30. _____ gal/A **30. Application rate**

31. _____ lb N/A **31. Total N applied**
_____ lb/Gal x _____% x _____ gal/A / 100 = _____ lb N/A
28. 29. 30. 31.

32. _____ lb N/A **32. Total available N**

_____ lb N/A x _____% /100 = _____ lb N/A
31. 65-70% 32.

THE BUDGET

PART 1. CROP N DEMAND	lb N/ A
5. Crop Demand	

PART 2. N SUPPLY: BASELINE	lb N/ A
6. SOM contributions	
10. Cover Crop or 13A. Previous Crop	
14. Residual soil N (from a soil test) Only include if soil analyses were taken prior to 'seasonal inputs' application OR reduce values for seasonal inputs	
15. Irrigation Water	
TOTAL (E + I + Y + Z)	

PART 3. N SUPPLY: SEASONAL INPUTS	lb N/ A
22. Compost	
27. Granular fertilizer	
32. Liquid fertilizer	
TOTAL (P + T + X)	
AVAILABLE N ***GRAND TOTAL (Baseline + Amendment)***	

Does the total available N meet the crop demand?

N balance _____ - _____ = _____ lbN/Ac

Available N grand total | Crop demand lb-N/ac | N balance

If the N balance is positive, it suggests that the crop is likely to have enough N supply. However, the larger the positive number, the more chance to lose N to the environment. Although a firm threshold has not been established, limiting excess N to 50 lb/A or less is a good initial goal.

If the N balance is negative, it suggests N supply is not adequate to meet the crop demand. Consider increasing the N supply by adding more fertilizers and re-calculate the N balance until a positive number is reached.

Timing for N demand

- Consider soil moisture, soil temperature and timing of crop demand when deciding when to add each material (Fig. 3).
- Become familiar with the crop uptake curve in order to understand the timing of N demand

Table 1. Number of beds per acre	
Bed Spacing*	No. of 100-LBF per acre
4	108.9
5	87.1
6	72.6
8	54.6

* Bed spacing is measured from the center of one bed to the center of the adjacent bed.

Table 2. Conversion of fertilizer rates in pounds per acre to pounds per 100 LBF									
Typical bed spacing (ft)	Recommended fertilizer rate (lbs/A)								
	20	40	60	80	100	120	140	160	180
	Resulting fertilizer rate (lbs per 100 LBF)								
3	0.14	0.28	0.41	0.55	0.69	0.83	0.96	1.1	1.24
4	0.18	0.37	0.55	0.73	0.92	1.1	1.29	1.47	1.65
5	0.23	0.46	0.69	0.92	1.15	1.38	1.61	1.84	2.07
6	0.28	0.55	0.83	1.1	1.38	1.65	1.93	2.2	2.48
8	0.37	0.73	1.1	1.47	1.84	2.2	2.57	2.94	3.31