Nitrogen Budget for Walnuts
Worksheet Instructions[1]

by

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Using the worksheet. This section includes instructions and a worksheet for the nitrogen budgeting approach to estimating nitrogen fertilizer needs in walnuts. This process necessarily includes assumptions and "best guesses" of nitrogen use and supply and is to be used as a tool for *estimating* fertilizer needs. Since leaf nitrogen concentration is the single best indicator of the effectiveness of a nitrogen fertilizer program, nitrogen budgeting should be used in conjunction with annual midsummer leaf nitrogen analysis to assess orchard nitrogen status and "fine tune" nitrogen fertilizer applications. If budget-based fertilizer application rates fail to increase leaf nitrogen to 2.7%, it will be necessary to reconsider some of the assumptions made and adjust estimated recovery factors in subsequent calculations. On the other hand, if leaf levels remain above 2.7%, this may indicate that nitrogen recovery factor is actually greater than originally estimated or that there are other unidentified nitrogen sources. Nitrogen budgeting should be repeated and adjusted annually in light of tree response, as indicated by leaf nitrogen concentration, vegetative vigor, nut yield, and other visual parameters of tree performance.

In order to use the nitrogen budgeting approach you will need:

- Yield data for the past few years
- Irrigation records
- Irrigation water nitrate analyses
- Records of compost or manure applications, including estimates of nitrogen and moisture content
- Estimates of cover crop yield and nitrogen content
- Calculator

Explanations of the line-by-line inputs for the worksheet follow. If your data are in metric units, convert the units using the information at the bottom of the worksheet.

Line 1. Nitrogen removed in the crop.
Enter the average yield (over the last 2 to 3 years) in tons per acre (in-shell basis) and multiply by 40. This estimates the pounds of nitrogen removed annually in the crop.

Line 2. Pounds nitrogen (N) from irrigation water.
Record the laboratory data for nitrogen concentration in irrigation water. Laboratory data can be reported as NO_3-N ppm or NO_3 ppm (milligrams per liter, or mg/L, is the same as ppm). Using the formula appropriate for your reported units, multiply the nitrogen concentration by the amount of applied irrigation water and the conversion factor. Enter the result on line 2c. Multiply this value by an estimated nitrogen recovery factor of 0.7 and enter the result on line 2.

Line 3. Nitrogen contributions from manure or compost.
Record the dry tons per acre of manure or compost applied (calculated from the actual tons of moist material applied and moisture content as reported by the supplier) on line 3a and the laboratory value for percent nitrogen in material on line 3b. For one-time applications of these materials, enter the estimated first-year nitrogen release factor from Table 1 on line 3c. Where there is a history of annual applications, use the "steady state" release factor of 100% to account for nitrogen contributions from the residual of past applications. Multiply these three numbers by an estimated nitrogen recovery factor of 0.5 and then multiply by 0.2 to determine the pounds of nitrogen per acre from these sources. Write your answer on line 3.

Table 1. *Estimated first-year nitrogen release from one-time application of selected organic amendments. Actual values may vary considerably from these examples.*

Type of manure or compost	Percentage of nitrogen released in the first year after application
Fresh poultry manure	65
Fresh beef or dairy manure	50
Dried or aged poultry or bovine manure	30
Cured or nearly cured compost	10

The nitrogen concentration of organic amendments such as manures, composts, and other animal products varies greatly with the source and handling procedures. Substantial nitrogen losses from manures can occur by ammonia volatilization during storage, handling and following application. These losses occur in other organic materials to a lesser extent.

Incorporate materials into the soil promptly after application for the greatest nitrogen recovery. Submit amendment samples for laboratory analysis of nitrogen content close to the time of application for more accurate estimates.

Line 4. Nitrogen-fixing cover crops.
Determining nitrogen contributions from cover crops is difficult as the content varies with the percentage of the orchard floor seeded, the type of cover crop (grasses, legumes, green manure), and development stage of the cover crop when it is tilled or mowed. Enter an estimated nitrogen contribution from cover crops in pounds of nitrogen per acre based on cover crop biomass per orchard acre and nitrogen concentration from analysis or an estimate on line 4a. Cover crop nitrogen content can be estimated by sampling a small (3-foot square) area of the aboveground portion of the mature cover crop. Weigh the sample immediately after cutting, place it in a plastic bag and submit it promptly to a commercial laboratory. The dry weight and nitrogen concentration of the sample reported by the laboratory is used to calculate the amount of nitrogen in the cover crop.

Management of the cover crop influences the amount of nitrogen contributed by the cover crop. On line 4b enter 0.5 if cover crop is mowed, or 0.7 if the cover crop is disked. Multiply 4a by 4b and enter the result on line 4. More detailed information can be found in *Cover Crops for California Agriculture* (UC ANR Publication 21471, 1989) and *Cover Cropping in Vineyards-A Grower's Handbook* (UC ANR Publication 3338, 1998).

Line 5. Total amount of available N from nonfertilizer sources.
Add lines 2, 3, and 4. Enter the result on line 5.

Line 6. Tree nitrogen needs from fertilizer.
To determine the nitrogen needs of the tree beyond that supplied by nonfertilizer sources, subtract line 5 from line 1. Write the answer on line 6. If this number is 0 or negative, the trees do not need any additional nitrogen fertilizer this year.

Line 7. Fertilizer application rate.
The percentage of fertilizer nitrogen recovered in walnut orchards varies greatly and depends primarily on soil texture and the rate, timing, and method of water and fertilizer applications (Table 2). For example, as little as 20% of the applied nitrogen may be recovered in flood irrigated orchards on sandy soils with broadcast fertilizer applications. Expect greater recovery on loamy or clay soils with drip or microsprinkler irrigation, and banded fertilizer or fertigation. In these situations, use a "best guess" fertilizer recovery factor of 40% for nitrogen budgeting purposes. These figures provide a starting point. Adjust the recovery factor in future seasons if annual leaf nitrogen analysis results are not in the optimum range.

Table 2. *Soil texture and the methods used to apply water and nitrogen fertilizer are the principal factors that affect how much nitrogen may potentially be lost from orchards by volatilization, leaching, and denitrification.*

	Soil type	**Irrigation method**	**Fertilizer applied by**
High nitrogen recovery	Clay loam	Localized (drip, micro-sprinkler)	Fertigation
↕	Silt loam	Full-coverage sprinklers	Banding along tree rows
Low nitrogen recovery	Sandy loam	Flood	Broadcast

Divide line 6 by 0.4 to adjust fertilizer application rate for an estimated nitrogen recovery factor of 40%. Use a value less than 0.4 if your particular soil, irrigation, and fertilizer application conditions warrant it. If the nitrogen fertilizer is applied through a drip or microsprinkler irrigation system (fertigation) use a nitrogen recovery factor of 0.8 instead of 0.4. Write the answer on line 7. This is your estimated nitrogen fertilization rate.

Nitrogen Budgeting Worksheet for Walnuts			
Name		**Date**	
Block ID			
1	**Nitrogen removed in the crop**	1a.______________ x 40 (lb N/ton yield of walnuts) = Yield in tons of walnuts/acre	1.________lb N/acre lost in crop per year
2	**Nitrogen contributions from irrigation water**	If units are in NO_3-N ppm use line 2a; if units are NO_3 ppm use line 2b- not both. Put the result of line 2a or 2b on line 2c. 2a.____________ x ___________ x 2.7 = NO_3N-N ppm or mg/l Water applied (ft) OR 2c.________lb N/acre x 0.7 = Estimated N recovery 2b.____________ x ___________ x 0.614 = NO_3 ppm or mg/l Water applied (ft)	2.________lb N/acre from irrigation water
3	**Nitrogen contributions from manure or compost**	If none applied, skip to line 4. 3a.________ x 3b.________ x 3c.________ x 0.5 x 0.2** = Tons/acre dry % N % N released* Estimated N recovery *For one-time applications use first-year release value from Section 1, Table 1. For annual applications, use 100% **Converts tons to pounds.	3.________lb N/acre from manure or compost
4	**Nitrogen contributions from cover crops**	If none, skip to line 5. 4a.______________ x 4b.______________ = lb N/orchard acre in cover crop Nitrogen recovery factor For mowing, use 0.5; For disking, use 0.7	4.________lb N/acre from cover crop
5	**Total nitrogen available from nonfertilizer sources**	Add lines 2, 3, and 4. Enter the result on line 5.	5.________lb N/acre
6	**Additional nitrogen needed**	To figure how much additional nitrogen is needed by your trees, subtract line 5 from line 1. Enter the result on line 6. If the answer is negative, no fertilizer is needed.	6.________lb N/acre needed by trees
7	**Nitrogen fertilizer application rate**	Divide the amount on line 6 by an estimated nitrogen recovery factor of 0.4 (or use a lower value, see instructions). Use 0.8 for fertigation. _____________ ÷ _____________ = lb fertilizer N/acre needed by trees (line 6) Estimated nitrogen recovery factor	7.________lb N/acre fertilizer rate
Note: Converting metric values for use in the table: 1 kg = 2.2 lb; 1 metric ton = 1.1 ton; 1 kg/T = 1.9 lb/ton; 1 kg/ha = 0.9 lb/ac; 1,000 m^3 = 1,556 acre-feet.			

[1] Adapted from "Guide to Efficient Nitrogen Fertilizer Use in Walnut Orchards" (UC ANR Publication 21623, 2006). Refer to the publication for more in-depth information on maximizing nitrogen fertilization efficiency and economics.